2015 Scheme

Common Subjects

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

I SEMESTER B.E./B.TECH.

PHYSICS GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT11	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15PHY12	Engineering Physics	BS	Physics	Basic Sc.	4 (T)	80	20	100	4
3	15CIV13	Elements of Civil Engg. & Mechanics	ES	Civil Engg.	Civil Engg.	4 (T)	80	20	100	4
4	15EME14	Elements of Mechanical Engg.	ES	Mech. Engg.	Mech. Engg.	4 (T)	80	20	100	4
5	15ELE15	Basic Electrical Engg.	ES	E & E	E & E	4 (T)	80	20	100	4
6	15WSL16	Workshop Practice	ES	Mech., Auto, IP, IEM, Mfg. Engg.	Mech. Engg.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
7	15PHYL17	Engg. Physics Lab	BS	Physics	Basic Sc.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
8	15CPH18	Constitution of India, Professional Ethics and Human Rights (CPH)	MNC	Humanities		2 (Tutorial)	40	10	50	--
9		Language (Kan.)	Mandatory Learning	Humanities		1 (T)	-	-	-	--
						29	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
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IISEMESTER B.E./B.TECH.

PHYSICS GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT21	Engineering Maths-II	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15PHY22	Engineering Physics	BS	Physics	Basic Sc.	4 (T)	80	20	100	4
3	15CIV23	Elements of Civil Engg. & Mechanics	ES	Civil Engg.	Civil Engg.	4 (T)	80	20	100	4
4	15EME24	Elements of Mechanical Engg.	ES	Mech. Engg.	Mech. Engg.	4 (T)	80	20	100	4
5	15ELE25	Basic Electrical Engg.	ES	E & E	E & E	4 (T)	80	20	100	4
6	15WSL26	Workshop Practice	ES	Mech., Auto, IP, IEM, Mfg. Engg.	Mech. Engg.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
7	15PHYL27	Engg. Physics Lab	BS	Physics	Basic Sc.	3(2 hrs lab+ 1 hr instruction)	80	20	100	2
8	15CPH28	Constitution of India, Professional Ethics and Human Rights	MNC	Humanities		2 (Tutorial)	40	10	50	--
9		Language (Kan.)	Mandatory Learning	Humanities		1 (T)	-	-	-	--
						29	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

I SEMESTER B.E./B.TECH.

CHEMISTRY GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT11	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15CHE12	Engineering Chemistry	BS	Chemistry	Basic Sc.	4 (T)	80	20	100	4
3	15PCD13	Programming in C & Data Structures	ES	Any Engineering Department	CSE	4 (T)	80	20	100	4
4	15CED14	Computer Aided Engineering Drawing	ES	Mech./IP/Auto/ Mfg.Engg./ IEM	Mech. Engg.	6 (2I+ 4P)	80	20	100	4
5	15ELN15	Basic Electronics	ES	E & C / E & E / TC / IT	E & C	4 (T)	80	20	100	4
6	15CPL16	Computer Programming Lab	ES	Any Engineering Department	CSE	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
7	15CHEL17	Engg. Chemistry Lab	BS	Chemistry	Basic Sci.	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
8	15CIV18	Environmental Studies	MNC	Civil / Environmental	Civil	2 (Tutorial)	40	10	50	--
9		Language (Eng.)	Mandatory Learning	Humanities		1 (T)	-	-	-	--
					Total	31	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

II SEMESTER B.E./B.TECH.

CHEMISTRY GROUP

Sl. No.	Subject Code	**Subject**		**Teaching Department**	**Board**	**Theory /Lab/ Drawing (Hrs/ Week)**	**Examination Marks**			**Credits**
							Th./Pr.	**I.A.**	**Total**	
1	15MAT21	Engineering Maths-II	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15CHE22	Engineering Chemistry	BS	Chemistry	Basic Sc.	4 (T)	80	20	100	4
3	15PCD23	Programming in C & Data Structures	ES	Any Engineering Department	CSE	4 (T)	80	20	100	4
4	15CED24	Computer Aided Engineering Drawing	ES	Mech./IP/Auto/ Mfg.Engg./ IEM	Mech. Engg.	6 (2I+ 4P)	80	20	100	4
5	15ELN25	Basic Electronics	ES	E & C / E & E / TC / IT	E & C	4 (T)	80	20	100	4
6	15CPL26	Computer Programming Lab	ES	Any Engineering Department	CSE	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
7	15CHEL27	Engg. Chemistry Lab	BS	Chemistry	Basic Sc.	3(2 hrs lab+ 1 hr Tutorial)	80	20	100	2
8	15CIV28	Environmental Studies	MNC	Civil / Environmental	Civil	2 (Tutorial)	40	10	50	--
9		Language (Eng.)	Mandatory Learning	Humanities		1 (T)	-	-	-	--
					Total	31	600	150	750	24

Note: The Subjects Kannada and English are Audit Courses

ENGINEERING MATHEMATICS-I

[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
SEMESTER - I/II

Subject Code	15MAT11	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Objectives:

To enable the students to apply the knowledge of Mathematics in various engineering fields by making them to learn the following:

- n^{th} derivatives of product of two functions and polar curves.
- Partial derivatives
- Vector calculus
- Reduction formulae of integration; To solve First order differential equations.
- Solution of system of linear equations , quadratic forms.

Module - 1	**Hours – 10**
Differential Calculus -1: determination of n^{th} order derivatives of Standard functions - Problems. Leibnitz's theorem (without proof) - problems. **Polar Curves** - angle between the radius vector and tangent, angle between two curves, Pedal equation of polar curves. Derivative of arc length - Cartesian, Parametric and Polar forms (without proof) - problems. Curvature and Radius of Curvature – Cartesian, Parametric, Polar and Pedal forms (without proof) -problems	

Module -2

Differential Calculus -2	Hours - 10
Differential Calculus -2 Taylor's and Maclaurin's theorems for function of one variable(statement only)- problems. Evaluation of Indeterminate forms. **Partial derivatives** – Definition and simple problems, Euler's theorem(without proof) – problems, total derivatives, partial differentiation of composite functions-problems. Definition and evaluation of Jacobians	**Hours - 10**
Module – 3	
Vector Calculus: Derivative of vector valued functions, Velocity, Acceleration and related problems, Scalar and Vector point functions. Definition of Gradient, Divergence and Curl-problems. Solenoidal and Irrotational vector fields. Vector identities - div(ϕA), curl (ϕA), curl(grad ϕ), div(curl A).	**Hours - 10**
Module-4	
Integral Calculus: Reduction formulae - $\int Sin^n x\, dx, \int Cos^n x\, dx\, , \int Sin^m x\, Cos^n x\, dx,$ (m and n are positive integers), evaluation of these integrals with standard limits (0 to π/2) and problems. **Differential Equations** ; **Solution of first order and first degree differential equations** – Exact, reducible to exact and Bernoulli's differential equations .Orthogonal trajectories in Cartesian and polar form. Simple problems on Newton's law of cooling.	**Hours - 10**
Module-5	

Linear Algebra	**Hours - 10**
Rank of a matrix by elementary transformations, solution of system of linear equations - Gauss-elimination method, Gauss –Jordan method and Gauss-Seidel method Eigen values and Eigen vectors, Rayleigh's power method to find the largest Eigen value and the corresponding Eigen vector. Linear transformation, diagonalisation of a square matrix . Reduction of Quadratic form to Canonical form	

Course outcomes:

On completion of this course, students are able to

- Use partial derivatives to calculate rates of change of multivariate functions.
- Analyze position, velocity, and acceleration in two or three dimensions using the calculus of vector valued functions.
- Recognize and solve first-order ordinary differential equations, Newton's law of cooling
- Use matrices techniques for solving systems of linear equations in the different areas of Linear Algebra.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna publishers, 42^{nd} edition, 2013.

2. Erwin Kreyszig, "**Advanced Engineering Mathematics**I, Wiley, 2013
Reference Books: 1. B.V. Ramana, "**Higher Engineering M athematics**", Tata Mc Graw-Hill, 2006 2. N.P.Bali and Manish Goyal, "**A text book of Engineering mathematics"**, Laxmi publications, latest edition. 3. H.K. Dass and Er. RajnishVerma, "**Higher Engineerig Mathematics**", S.Chand publishing, 1st edition, 2011.

ENGINEERING MATHEMATICS-II [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Subject Code	15MAT21	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course objectives:

To enable students to apply the knowledge of Mathematics in various engineering fields by making them to learn the following'

- Ordinary differential equations
- Partial differential equations
- Double and triple integration
- Laplace transform

Module – I	**Teaching Hours**
Linear differential equations with constant coefficients: Solutions of second and higher order differential equations - inverse differential operator method, method of undetermined coefficients and method of variation of parameters.	**10 Hours**
Module -2	
Differential equations-2: **Linear differential equations with variable coefficients:** Solution of Cauchy's and Legendre's linear differential equations. **Nonlinear differential equations** - Equations solvable for p, equations solvable for y, equations solvable for x, general and singular solutions, Clairauit's equations and equations reducible to Clairauit's form.	**10 Hours**

Module – 3	
Partial Differential equations: Formulation of Partial differential equations by elimination of arbitrary constants/functions, solution of non-homogeneous Partial differential equations by direct integration, solution of homogeneous Partial differential equations involving derivative with respect to one independent variable only. Derivation of one dimensional heat and wave equations and their solutions by variable separable method.	**10 Hours**
Module-4	
Integral Calculus: **Double and triple integrals:** Evaluation of double and triple integrals. Evaluation of double integrals by changing the order of integration and by changing into polar co-ordinates. Application of double and triple integrals to find area and volume. **. Beta and Gamma functions:** definitions, Relation between beta and gamma functions and simple problems.	**10 Hours**
Module-5	
Laplace Transform Definition and Laplace transforms of elementary functions. Laplace transforms of $e^{at}f(t),\ t^n f(t)\ and\ \frac{f(t)}{t}$ (without proof) , periodic functions and unit-step function- problems **Inverse Laplace Transform** Inverse Laplace Transform - problems, Convolution theorem to find the inverse Laplace transforms(without proof) and problems, solution of linear differential equations using Laplace Transforms.	**10 Hours**

Course outcomes:

On completion of this course, students are able to,

- solve differential equations of electrical circuits, forced oscillation of mass spring and elementary heat transfer.
- solve partial differential equations fluid mechanics, electromagnetic theory and heat transfer.
- Evaluate double and triple integrals to find area , volume, mass and moment of inertia of plane and solid region.
- Use curl and divergence of a vector valued functions in various applications of electricity, magnetism and fluid flows.
- Use Laplace transforms to determine general or complete solutions to linear ODE

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

- B. S. Grewal," Higher Engineering Mathematics", Khanna publishers, 42nd edition, 2013.
- Kreyszig, "Advanced Engineering Mathematics " - Wiley, 2013

Reference Books:

- B.V.Ramana "Higher Engineering M athematics" Tata Mc Graw-Hill, 2006
- N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, latest edition.

  H. K Dass and Er. Rajnish Verma ,"Higher Engineerig Mathematics", S. Chand publishing,1st edition, 2011.

ENGINEERING PHYSICS [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Subject Code	15PHY12/15PHY22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

COURSE OBJECTIVES:

The Objective of this course is to make students learn and understand basic concepts and principles of physics to analyze practical engineering problems and apply its solutions effectively and meaningfully. To understand building up of models, design issues, practical oriented skills and problem solving challenges are the great task of the course. To know about shock waves and practical applications is the prime motto to introduce new technology at the initial stage of Engineering.

Module -1	**Teaching Hours**
Modern Physics and Quantum Mechanics Black body radiation spectrum, Assumptions of quantum theory of radiation, Plank's law, Weins law and Rayleigh Jeans law, for shorter and longer wavelength limits. Wave Particle dualism, deBroglie hypothesis. Compton Effect. Matter waves and their Characteristic properties, Definition of Phase velocity and group velocity, Relation between phase velocity and group velocity, Relation between group velocity and particle velocity. Heisenberg's uncertainity principle and its application, (Non-existence of electron in the nucleus).Wave function, Properties and physical significance of wave function, Probability density and Normalization of wave function. Setting up of one dimensional time independent Schrodinger wave equation. Eigen values and Eigen functions. Application of Schrodinger wave equation for a particle in a potential well of infinite depth and for free particle.	**10 Hours**

Module -2	
Electrical Properties of Materials Free–electron concept (Drift velocity, Thermal velocity, Mean collision time, Mean free path, relaxation time). Failure of classical free electron theory. Quantum free electron theory, Assumptions, Fermi factor, density of states (qualitative only) Fermi–Dirac Statistics. Expression for electrical conductivity based on quantum free electron theory, Merits of quantum free electron theory. Conductivity of Semi conducting materials, Concentration of electrons and holes in intrinsic semiconductors, law of mass action. Temperature dependence of resistivity in metals and superconducting materials. Effect of magnetic field (Meissner effect). Type I and Type II superconductors–Temperature dependence of critical field. BCS theory (qualitative). High temperature superconductors. Applications of superconductors –. Maglev vehicles.	**10 Hours**
Module – 3	
Lasers and Optical Fibers Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for laser action. Principle, Construction and working of CO_2 laser and semiconductor Laser. Applications of Laser – Laser welding, cutting and drilling. Measurement of atmospheric pollutants. Holography–Principle of Recording and reconstruction of images. Propagation mechanism in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Attenuation, Block diagram discussion of point to point communication, applications.	**10 Hours**
Module-4	

Crystal Structure	10 Hours
Space lattice, Bravais lattice–Unit cell, primitive cell. Lattice parameters. Crystal systems. Direction and planes in a crystal. Miller indices. Expression for inter – planar spacing. Co-ordination number. Atomic packing factors (SC,FCC,BCC). Bragg's law, Determination of crystal structure using Bragg's X–ray difractometer. Polymarphism and Allotropy. Crystal Structure of Diamond, qualitative discussion of Pervoskites.	
Module-5	
Shock waves and Science of Nano Materials	**10 Hours**
Definition of Mach number, distinctions between- acoustic, ultrasonic, subsonic and supersonic waves. Description of a shock wave and its applications. Basics of conservation of mass, momentum and energy. Normal shock equations (Rankine-Hugonit equations). Method of creating shock waves in the laboratory using a shock tube, description of hand operated Reddy shock tube and its characteristics. Introduction to Nano Science, Density of states in 1D, 2D and 3D structures. Synthesis : Top–down and Bottom–up approach, Ball Milling and Sol–Gel methods. CNT – Properties, synthesis: Arc discharge, Pyrolysis methods, Applications. Scanning Electron microscope: Principle, working and applications.	

Course outcomes:

On Completion of this course, students are able to –

- Learn and understand more about basic principles and to develop problem solving skills and implementation in technology.
- Gain Knowledge about Modern physics and quantum mechanics will update the basic concepts to implement the skills.
- Study of material properties and their applications is the prime role to understand and use in engineering applications and studies.
- Study Lasers and Optical fibers and its applications are to import knowledge and to develop skills and to use modern instruments in the engineering applications.
- Understand Crystal structure and applications are to boost the technical skills and its applications.
- Expose shock waves concept and its applications will bring latest technology to the students at the first year level to develop research orientation programs at higher semester level.
- Understand basic concepts of nano science and technology.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. Wiley precise Text, **Engineering Physics,** Wiley India Private Ltd., New Delhi.
   Book series – 2014,
2. Dr. M.N. Avadhanulu, Dr. P.G.Kshirsagar, **Text Book of Engineering Physics,** S Chand Publishing, New Delhi - 2012

Reference Books:

1. S.O.Pillai, **Solid State Physics, New** Age International. Sixth Edition.
2. Chintoo S Kumar ,K Takayana and K P J Reddy, **Shock waves made simple,** Willey India Pvt. Ltd. New Delhi,2014
3. A Marikani, **Engineering Physics,** PHI Learning Private Limited, Delhi - 2013
4. Prof. S. P. Basavaraju, **Engineering Physics,** Subhas Stores, Bangalore – 2
5. V Rajendran ,**Engineering Physics,** Tata Mc.Graw Hill Company Ltd., New Delhi - 2012
6. S Mani Naidu, **Engineering Physics,** Pearson India Limited - 2014

ELEMENTS OF CIVIL ENGINEERING AND ENGINEERING MECHANICS
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
SEMESTER - I/II

Subject Code	15CIV13/23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

COURSE OBJECTIVES:
The objectives of this course is to make students to learn basics of Civil Engineering concepts and infrastructure development, solve problems involving Forces, loads and Moments and know their applications in allied subjects. It is a pre-requisite for several courses involving Forces, Moments, Centroids, Moment of inertia and Kinematics.

Particulars	**Hours**
Module 1: Introduction to Civil Engineering &Engineering Mechanics	**10**
Introduction to Civil Engineering Scope of different fields of Civil Engineering - Surveying, Building Materials, Construction Technology, Geotechnical Engineering, Structural Engineering, Hydraulics, WaterResources and Irrigation Engineering, Transportation Engineering, Environmental Engineering.	01
Infrastructure: Types of infrastructure, Role of Civil Engineer in theInfrastructural Development, Effect of the infrastructural facilities onsocio-economic development of a country.	01
Roads: Classification of Roads and their functions, Comparison of Flexible and Rigid Pavements (Advantages and Limitations)	01

Bridges: Types of Bridges and Culverts, RCC, Steel and Composite Bridges	01
Dams: Different types of Dams based on Material, Structural behavior and functionality with simple sketches.	01
Introduction to Engineering Mechanics: Basic idealizations - Particle, Continuum and Rigid body; Newton's laws Force and its characteristics, types of forces-Gravity, Lateral and its distribution on surfaces, Classification of force systems, Principle of physical independence, superposition, transmissibility of forces, , Introduction to SI units. Couple, Moment of a couple, Characteristics of couple, Moment of a force, Equivalent force - Couple system; Numerical problems on moment of forces and couples, on equivalent force - couple system.	02 03
Module 2: Analysis of Concurrent Force Systems	**10**
Concepts: Resultants and Equilibrium Composition of forces - Definition of Resultant; Composition of coplanar -concurrent force system, Parallelogram Law of forces, Principle of resolved parts;	03
Numerical problems on composition of coplanar concurrent force systems. Equilibrium of forces - Definition of Equilibrant; Conditions of static equilibrium for different force systems, Lami's theorem; Numerical problems on equilibrium of coplanar – concurrent and non-concurrent force systems.	03
Application- Static Friction in rigid bodies in contact Types of friction, Laws of static friction, Limiting friction, Angle of friction, angle of repose; Impending motion on horizontal and inclined planes; Numerical Problems on single and two blocks on inclined planes	02 02
Module - 3 Analysis of Non-Concurrent Force Systems	**10**

Concepts: Resultants and Equilibrium Composition of coplanar - non-concurrent force system, Varignon's principle of moments; Numerical problems on composition of coplanar non-concurrent Force system.	05
Application-Support Reaction in beams Types of Loads and Supports, statically determinate beams, Numerical problems onsupport reactions for statically determinate beams with Point load (Normal and inclined) and uniformly distributed and uniformly varying loads and Moments.	05
Module 4 Centroids and Moments of Inertia of Engineering Sections:	**10**
Centroids Introduction to the concept, centroid of line and area, centroid of basic geometrical figures, computing centroid for– T, L, I, Z and full/quadrant circular sections and their built up sections. Numerical problems **Moment of Inertia** Introduction to the concept, Radius of gyration, Parallel axis theorem, Perpendicular axis theorem, Moment of Inertia of basic planar figures, computing moment of Inertia for – T, L, I, Z and full/quadrant circular sections and their built up sections. Numerical problems	05 05
Module 5: Kinematics	**10**
Concepts and Applications Definitions – Displacement – Average velocity – Instantaneous velocity – Speed – Acceleration - Average acceleration – Variable acceleration – Acceleration due to gravity – Newton's Laws of Motion.	02
Rectilinear Motion–Numerical problems.	02
Curvilinear Motion – Super elevation – ProjectileMotion – Relative motion – Numerical problems.	03
Motion under gravity – Numerical problems.	03
COURSE OUTCOMES After a successful completion of the course, the student will be able to: 1. Know basics of Civil Engineering, its scope of study, knowledge about Roads, Bridges and Dams;	

2. Comprehend the action of Forces, Moments and other loads on systems of rigid bodies;
3. Compute the reactive forces and the effects that develop as a result of the external loads;
4. Locate the Centroid and compute the Moment of Inertia of regular cross-sections.
5. Express the relationship between the motion of bodies and
6. Equipped to pursue studies in allied courses in Mechanics.

Question Paper Pattern:

- 10 Questions are to be set such that 2 questions are selected from each module.
- 2 Questions are to be set under respective modules.
- Intra module questions are to be set such that the questions should cover the entire module and further, should be answerable for the set marks.
- Each question should be set for 16 marks (Preferably 8 marks each)
- Not more than 3 sub questions are to be set under any main question
- Students should answer 5 full questions selecting at least 1 from each module.

TEXT BOOKS

1. Elements of Civil Engineering and Engineering Mechanics by M.N. Shesha Prakash and Ganesh. B. Mogaveer, PHI Learning, 3rd Revised edition (2014)
2. Engineering Mechanics-Statics and Dynamics by A Nelson, Tata McGraw Hill Education Private Ltd, New Delhi, 2009.
3. Elements of Civil Engineering (IV Edition) by S.S. Bhavikatti, New Age International Publisher, New Delhi, 3rd edition 2009.

REFERENCES

1. Engineering Mechanics by S.Timoshenko,D.H.Young, and J.V.Rao, TATA McGraw-Hill Book Company, New Delhi
2. Beer FP and Johnson ER, **"Mechanics for Engineers- Dynamics and Statics"**- 3rd SI Metric edition, Tata McGraw Hill. - 2008
3. Shames IH, **"Engineering Mechanics – Statics & Dynamics"**- PHI – 2009

ELEMENTS OF MECHANICAL ENGINEERING [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Subject Code	15EME14/15EME24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course objectives:

Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and process.

Module -1	Teaching Hours
Energy Resources : Non-renewable and renewable energy resources, **Petroleum based** solid, liquid and gaseous fuels, Calorific values of fuels, Combustion and combustion products of fuels, **Solar Power :** Solar Radiation, Solar constant (definition only), Solar Thermal energy harvesting, ex: liquid flat plate collectors, solar ponds (principle of operation only), Solar photovoltaic principle.**WindPower :**principle of operation of a typical windmill. **Hydro Power :**Principles of electric power generation from hydropowerplants, **Nuclear Power :** Principles of Nuclear power plants, **Bio Fuels :** introduction to bio fuels, examples of various biofuels used in engineering applications, Comparison of biofuels with petroleum fuels in terms of calorific value and emission. **Steam Formation and Properties :** Classification of boilers, Lancashire boiler, Babcock and Wilcox boiler, boiler mountings and accessories (No sketches for mountings and accessories), wet steam, saturated and superheated steam, specific volume, enthalpy andinternal energy. (No numerical problems in this module)	**10 Hours**

<table>
<tr><td colspan="2">Module -2</td></tr>
<tr><td>Turbines and IC Engines and Pumps Steam turbines :Classification, Principle of operation of Impulse and reaction turbines, Delaval’s turbine, Parson’s turbine. (No compounding of turbines).

Gas turbines :Classification, Working principles and Operations of Open cycle and closed cycle gas turbines.

Water turbines :Classification, Principles and operations of Pelton wheel, Francis turbine and Kaplan turbine

Internal Combustion Engines :Classification, I.C. Engines parts, 2 Stroke and 4 stroke Petrol engines, 4 stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Problems on indicated power, brake power, indicated

thermal efficiency, brake thermal efficiency, mechanical efficiency, and specific fuel consumption, [numericals on IC Engines].</td><td>10 Hours</td></tr>
<tr><td colspan="2">Module - 3</td></tr>
<tr><td>Machine Tools and Automation Machine Tools Operations :
Turning, facing, knurling, Thread cutting, Taper Turning by swivelling the compound rest, Drilling, Boring, Reaming, Tapping, Counter Sinking, Counter Boring, -Plane milling, End milling, Slot milling. (No sketches of Machine tools, sketches to be used only for explaining operations. Students to be shown the available machine tools in the Machine Shop of the college before explaining the operations)

Robotics and Automation :

Robotics :Introduction, classification based on robots configuration; Polar, cylindrical, Cartesian Coordinate and spherical. Application, Advantages, and disadvantages

Automation :Definition, types –Fixed, Programmable & Flexible automation, NC/ CNC machines: Basic elements with simple block diagrams, advantages and disadvantages.</td><td>10 Hours</td></tr>
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<table>
<tr><td colspan="2">Module-4</td></tr>
<tr><td>Engineering materials and joining processes :

Engineering Materials :Types and applications of Ferrous & Nonferrous metals and alloys,

Composites :Introduction: Definition, Classification and applications (Air craft and Automobiles)

Soldering, Brazing and Welding :

Definitions, classification and method of soldering, Brazing and welding. Differences between soldering, Brazing and Welding. Description of Electric Arc Welding and Oxy-Acetylene Welding.</td><td>10 Hours</td></tr>
<tr><td colspan="2">Module-5</td></tr>
<tr><td>Refrigeration, Air-Conditioning :
Refrigerants :properties of refrigerants, list of commonly used refrigerants. Refrigeration –Definitions – Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, Relative COP, unit of Refrigeration. Principle and working of vapor compression refrigeration and vapour absorption refrigeration: Principles and applications of air conditioners, Room air conditioner.</td><td>10 Hours</td></tr>
<tr><td colspan="2">Course outcomes:
Students shall demonstrate knowledge associated with,
1. Various Energy sources, Boilers, Prime movers such as turbines and IC engines, refrigeration and air-conditioning systems
2. Metal removal process using Lathe, drilling, Milling Robotics and Automation.
3. Fair understanding of application and usage of various engineering materials.</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Question paper pattern:
• The question paper will have ten questions.
• Each full Question consisting of 16 marks
• There will be 2 full questions(with a maximum of four sub questions)</td></tr>
</table>

from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.from each module.
- Each full question will have sub questions covering all the topics under a module.

Text Books:

1. V.K.Manglik, **"Elements of Mechanical Engineering"**, PHI Publications, 2013. (Module-1,2,4,5)
2. MikellP.Groover, **"Automation, Production Systems & CIM"**, 3rd Edition, PHI (Module -3)
3. K.R.Gopalkrishna, **"A text Book of Elements of Mechanical Engineering"**- Subhash Publishers, Bangalore. (Module -1,2,3,4,5)

Reference Books:

1. S.TrymbakaMurthy, **"A Text Book of Elements of Mechanical Engineering"**, 4th Edition 2006, Universities Press (India) Pvt Ltd, Hyderabad.
2. K.P.Roy, S.K.HajraChoudhury, Nirjhar Roy, **"Elements of Mechanical Engineering"**, Media Promoters & Publishers Pvt Ltd,Mumbai,7th Edition,2012
3. Pravin Kumar, **"Basic Mechanical Engineering"**, 2013 Edition, Pearson.

BASIC ELECTRICAL ENGINEERING [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Subject Code	15ELE15/15ELE25	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits - 04			

Course objectives:

- Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
- Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
- Develop selection skill to identify the type of generators or motors required for particular application.
- Highlight the importance of transformers in transmission and distribution of electric power.
- Emphasize the effects of electric shock and precautionary measures.
- Improve the ability to function on multi-disciplinary teams.

Module -1	**Teaching Hours**
D C circuits: Ohm's Law and Kirchhoff's Laws, analysis of series, parallel and series- parallel circuits excited by independent voltage sources. Power and Energy. Illustrative examples.	**5 Hours**
Electromagnetism: Review of field around a conductor and coil, magnetic flux and flux density, magnetomotive force and magnetic field intensity, reluctance and permeability, definition of magnetic circuit and basic analogy between electric and magnetic circuits. (These topics are not to be considered for setting the examination questions). **Electromagnetic induction:** Definition of Electromagnetic Induction, Faradays Laws, Fleming's right hand rule, Lenz's Law, Statically and dynamically induced emf. Self-inductance, mutual inductance and coefficient of coupling. Energy stored in magnetic field. Illustrative examples. Force on current carrying conductor placed in a magnetic field, Fleming's left hand rule.	**5Hours**

Module -2	
DC Machines: Working principle of DC machine as a generator and a motor. Types and constructional features. Types of armature windings, Emf equation of generator, relation between induced emf and terminal voltage with a mention of brush contact drop and drop due to armature reaction. Illustrative examples, neglecting armature reaction. Operation of DC motor, back emf, torque equation. Types of DC motors, characteristics and applications. Significance of back emf. Necessity of a starter for DC motor. Illustrative examples on back emf and torque.	**7 Hours**
Measuring Instruments: Construction and Principle of operation of dynamometer type wattmeterand single phase induction type energy meter.	**3 Hours**
Module - 3	
Single-phase AC circuits: Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying quantities, phasor representation of alternating quantities. Analysis, with phasor diagrams, of R, L, C, R-L, R-C and R-L-C circuits and, parallel and series- parallel circuits. Real power, reactive power, apparent power and power factor. Illustrative examples.	**7 Hours**
Domestic wiring: Service mains, meter board and distribution board. Brief discussion on concealed conduit wiring. Two-way and three-way control. Elementary discussion on Circuit protective devices: fuse and Miniature Circuit Breaker (MCB's). Electric shock, precautions against shock, Objectives of Earthing, types of earthing; pipe and plate earthing, Residual current circuit breaker (RCCB).	**3 Hours**
Module-4	
Three Phase Circuits: Necessity and advantages of three phase systems, generation of three phase power. Definition of Phase sequence, balanced supply and balanced load. Relationship between line and phase values of balanced star and delta connections. Power in balanced three-phase circuits, measurement of power by two-wattmeter method. Determination power factor using wattmeter readings. Illustrative examples.	**6 Hours**

Three PhaseSynchronous Generators: Principle of operation, Types and constructional features, Advantages of rotating field type alternator, Synchronous speed, Frequency of generated voltage, Emf equation. Concept of winding factor (excluding the derivation of distribution and pitch factors). Illustrative examples on calculation of distribution factor, pitch factor and emf equation.	**4 Hours**
Module-5	
Single Phase Transformers: Necessity of transformer, Principle of operation and construction of single-phase transformers (core and shell types). Emf equation, losses, variation losses with respect to load, efficiency, Condition for maximum efficiency, Voltage regulation and its significance (Open Circuit and Short circuit tests, equivalent circuit and phasor diagrams are excluded). Illustrative problems on emf equation and efficiency only.	**6 Hours**
Three Phase Induction Motors: Principle of operation, Concept and production of rotating magnetic field, Synchronous speed, rotor speed, Slip, Frequency of the rotor induced emf, Types and Constructional features. Slip and its significance. Applications of squirrel - cage and slip - ring motors. Necessity of a starter, starting of motor using stars-delta starter. Illustrative examples on slip calculations.	**4 Hours**

Course outcomes:

After the completion of the course, the student should be able

- To predict the behaviour of electrical and magnetic circuits.
- Select the type of generator / motor required for a particular application.
- Realize the requirement of transformers in transmission and distribution of electric power and other applications.
- Practice Electrical Safety Rules & standards.
- To function on multi-disciplinary teams.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from

each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books

1	Basic Electrical Engineering	D. C. Kulshreshtha	TMH	1st Edition, Revised
2	Electrical Technology	Edward Hughes	Pearson	10th Edition, 2014
	ReferenceBooks			
3	Fundamentals of Electrical Engineering	Rajendra Prasad	PHI	Third Edition 2014
4	Basic Electrical Engineering	AbhijitChakrabarti, Chandan Kumar Chanda, Sudiptanath	TMH,	1st Edition 2010
5	Fundamentals of Electrical Engineering and Electronics	B. L. Theraja	S. Chand & Company Ltd	Reprint Edition 2013

WORKSHOP PRACTICE

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	**15WSL16/15WSL26**	IA Marks	20
Labs / Tutorial Hours/Week	3 (1 hr Tut +2 hrs lab)	Exam Marks	80
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS - 02

Course objectives:

- To impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
- Educate students of Safe handling of machines and tools.

Module -1	**Teaching Hours**
1. Demonstration on use of Hand Tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps.Minimum 3 models involving Dove tail joint,Triangular joint and Semicircular joint. 2. Welding: Study of electric arc welding tools &equipments, Models: Butt Joint, Lap Joint, T joint & L-joint. 3. Sheet Metal & Soldering Work: Development & Soldering of the models: Tray, Frustum of cone, Prism(Hexagon & Pentagon),Truncated Square Pyramid, Funnel.	**3 Hours**

Course outcomes:

At the end of the course, the student will be able to:

1. Demonstrate and produce different types of fitting models.
2. Gain knowledge of development of sheet metal models with an understanding of their applications.
3. Perform soldering and welding of different sheet metal & welded joints.
4. Understand the Basics of Workshop practices.

Ref Books:

1. Elements of Workshop Technology:Vol I:Manufacturing Processes, S K Hajra.

Choudhury, A K. Hajra Choudhury,15th Edition Reprinted 2013,Media Promoters &Publishers Pvt Ltd., Mumbai.

Note: ***No mini drafters and drawing boards required. Drawings (Developments) can be doneon sketch sheets using scale , pencil and Geometrical Instruments***

ENGINEERING PHYSICS LAB

Laboratory Code	15PHYL17 / 15PHYL27	IA Marks	20
Labs / Instructions Hours/Week	3 (1 hr Tutorial +2 hrs lab)	Exam Marks	80
Total Number of Lecture Hours	48	Exam Hours	03

CREDITS - 02

Course Objectives:

- The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments.
- Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

EXPERIMENTS:

1. Black box experiment; Identification of unknown passive electrical components and determine the value of Inductance and Capacitance
2. Series and parallel LCR Circuits (Determination of resonant frequency and quality factor)
3. I–V Characteristics of Zener Diode. (determination of knee voltage, zener voltage and forward resistance)
4. Characteristics of Transistor (Study of Input and Output characteristics and calculation of input resistance, output resistance and amplification factor)
5. Photo Diode Characteristics (Study of I–V characteristics in reverse bias and variation of photocurrent as a function of reverse voltage and intensity).
6. Dielectric constant (Measurement of dielectric constant).
7. Diffraction (Measurement of wavelength of laser source using diffraction grating).
8. Torsional pendulum (Determination of M.I. of wire and Rigidity modulus).
9. Determination of Fermi energy. (Measurement of Fermi energy in copper).
10. Uniform Bending Experiment (Determination of Youngs modulus of material bar).
11. Newtons Rings, (Determination of radius of curvature of plano convex lens).

12. Verification of Stefan's Law.

Course Outcomes:

On Completion of this course, students are able to –

- Develop skills to impart practical knowledge in real time solution.
- Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
- Design new instruments with practical knowledge.
- Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.
- Understand measurement technology, usage of new instruments and real time applications in engineering studies.

Note: 1) All the above twelve experiments are to be conducted

2) Two experiments are to be performed by the students in the examination

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS & HUMAN RIGHTS

Subject Code	15CPH18/15CPH28	IA Marks	20
Number of Lecture Hours/Week	02	Exam Marks	80
Total Number of Lecture Hours	25	Exam Hours	03
CREDITS - 01			

Course objectives:

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications

Module 1

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. **2 Hours**

Preamble to the Indian Constitution Fundamental Rights & its limitations. **3 Hours**

Module 2

Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. **2 Hours**

Union Executives – President, Prime Minister Parliament Supreme Court of India. **3 Hours**

Module 3

State Executives – Governor Chief Minister, State Legislature High Court of State. **2 Hours**

Electoral Process in India, Amendment Procedures, 42^{nd}, 44th, 74th, 76th, 86th &91^{st} Amendments. **3 Hours**

Module 4

Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India **3 Hours**

Powers and functions of Municipalities, Panchyats and Co - Operative Societies. **2 Hours**

Module 5

Scope & Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility. **2 Hours**

Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering.

3 Hours

Course outcomes:

After study of the course, the students are able to

- Have general knowledge and legal literacy and thereby to take up competitive examinations
- Understand state and central policies, fundamental duties
- Understand Electoral Process, special provisions
- Understand powers and functions of Municipalities, Panchayats and Co-operative Societies, and
- Understand Engineering ethics and responsibilities of Engineers.
- Have an awareness about basic human rights in India

Text Books:

1. Durga Das Basu: **"Introduction to the Constitution on India",** (Students Edn.) Prentice –Hall EEE, 19^{th} / 20^{th} Edn., 2001
2. Charles E. Haries, Michael S Pritchard and Michael J. Robins **"Engineering Ethics"** Thompson Asia, 2003-08-05.

Reference Books:

1. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
2. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, **"Engineering Ethics",** Prentice –Hall of India Pvt. Ltd. New Delhi, 2004
3. Brij Kishore Sharma,**"Introduction to the Constitution of India"**, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. Latest Publications of Indian Institute of Human Rights, New Delhi.

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ENGINEERING CHEMISTRY
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
SEMESTER - I/II

Subject Code	15CHE12/15CHE22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course objectives:

To provide students with knowledge of engineering chemistry for building technical competence in industries, research and development in the following fields

- Electrochemistry & Battery Technology.
- Corrosion & Metal Finishing.
- Fuels & Solar energy.
- Polymers.
- Water Technology & Nano Materials.

Module -1	Teaching Hours
Electrochemistry and Battery Technology **Electrochemistry**: Introduction, Derivation of Nernst equation for electrode potential. Reference electrodes: Introduction, construction, working and applications of calomel and Ag / AgCl electrodes. Measurement of electrode potential using calomel electrode. Ion selective electrode: Introduction; Construction and working of glass electrode, determination of pH using glass electrode. Concentration cells: Electrolyte concentration cells, numerical problems. **Battery Technology:** Introduction, classification - primary, secondary and reserve batteries. Characteristics - cell potential, current, capacity, electricity storage density, energy efficiency, cycle	**10 hours**

life and shelf life. Construction, working and applications of Zinc-Air, Nickel- metal hydride batteries. Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries. **Fuel Cells**: Introduction, difference between conventional cell and fuel cell, limitations & advantages. Construction, working & applications of methanol-oxygen fuel cell with H_2SO_4 electrolyte.	
Module -2	

Corrosion and Metal Finishing: **Corrosion**: Introduction, electrochemical theory of corrosion, galvanic series. Factors affecting the rate of corrosion: ratio of anodic to cathodic areas, nature of metal, nature of corrosion product, nature of medium – pH, conductivity, and temperature. Types of corrosion- Differential metal, differential aeration (Pitting and water line) and stress. Corrosion control: Inorganic coatings-Anodizing of Al and phosphating; Metal coatings-Galvanization and Tinning. Cathodic protection (sacrificial anodic and impressed current methods). **Metal Finishing:** Introduction, Technological importance. Electroplating: Introduction, principles governing-Polarization, decomposition potential and overvoltage. Factors influencing the nature of electro deposit-current density, concentration of metal ion & electrolyte; pH, temperature & throwing power of plating bath; additives- brighteners, levellers, structure modifiers & wetting agents. Electroplating of Nickel (Watt's Bath) and Chromium(decorative and hard). Electro less plating: Introduction, distinction between electroplating and electro less plating, electro less plating of copper & manufacture of double sided Printed Circuit Board with copper.	**10hours**
Module - 3	

Fuels and Solar Energy:	10 hours
Fuels: Introduction, classification, calorific value- gross and net calorific values, determination of calorific value of fuel using bomb calorimeter, numerical problems. Cracking: Introduction, fluidized catalytic cracking, synthesis of petrol by Fishcher-Tropsch process, reformation of petrol, octane and cetane numbers. Gasoline and diesel knocking and their mechanism, anti knocking agents, power alcohol & biodiesel. **Solar Energy:** Introduction, utilization and conversion, photovoltaic cells- construction and working. Design of PV cells: modules, panels & arrays. Advantages & disadvantages of PV cells. Production of solar grade silicon: Union carbide process, purification of silicon (zone refining), doping of silicon-diffusion technique (n&p types).	
Module - 4	

Polymers: Introduction, types of polymerization: addition and condensation, mechanism of polymerization- free radical mechanism taking vinyl chloride as an example. Molecular weight of polymers: number average and weight average, numerical problems. Glass transition temperature (T_g): Factors influencing T_g-Flexibility, inter molecular forces, molecular mass, branching & cross linking and stereo regularity. Significance of T_g. Structure property relationship: crystallinity, tensile strength, elasticity & chemical resistivity. Synthesis, properties and applications of PMMA (plexi glass), Polyurethane and polycarbonate. Elastomers: Introduction, synthesis, properties and applications of Silicone rubber. Adhesives: Introduction, synthesis, properties and applications of epoxy resin. Polymer Composites: Introduction, synthesis, properties and applications of Kevlar. Conducting polymers: Introduction, mechanism of conduction in Poly aniline and applications of conducting poly aniline.	**10 hours**
Module-5	

Water Technology and Nanomaterials: **Water Technology:** Introduction**,** boiler troubles with disadvantages & prevention methods-scale and sludge formation, priming and foaming, boiler corrosion(due to dissolved O_2, CO_2 and $MgCl_2$). Determination of DO, BOD and COD, numerical problems on COD. Sewage treatment: Primary, secondary (activated sludge method) and tertiary methods. Softening of water by ion exchange process. Desalination of sea water by reverse osmosis & electro dialysis (ion selective).. **Nano Materials:** Introduction, properties (size dependent). Synthesis-bottom up approach (sol-gel, precipitation, gas condensation & chemical vapour condensation processes). Nano scale materials- carbon nano tubes, nano wires, fullerenes, dendrimers, nano rods, & nano composites.	**10 hours**

Course outcomes:

On completion of this course, students will have knowledge in:

- Electrochemical and concentration cells. Classical & modern batteries and fuel cells.
- Causes & effects of corrosion of metals and control of corrosion. Modification of surface properties of metals to develop resistance to corrosion, wear, tear, impact etc. by electroplating and electro less plating.
- Production & consumption of energy for industrialization of country and living standards of people. Utilization of solar energy for different useful forms of energy.
- Replacement of conventional materials by polymers for various applications.
- Boiler troubles; sewage treatment and desalination of sea water, and
- Over viewing of synthesis, properties and applications of nanomaterials.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. B.S.Jai Prakash, R.Venugopal, Sivakumaraiah & Pushpa Iyengar., **"Chemistry for Engineering Students"**, Subhash Publications, Bangalore.

2. R.V.Gadag & A.Nityananda Shetty., **“Engineering Chemistry”**, I K International Publishing House Private Ltd. New Delhi.
3. P.C.Jain & Monica Jain.,**“Engineering Chemistry”**, Dhanpat Rai Publications, New Delhi.

Reference Books:

1. O.G.Palanna,**“Engineering Chemistry”**,Tata McGraw Hill Education Pvt. Ltd. New Delhi, Fourth Reprint.
2. G.A.Ozin & A.C. Arsenault, **“Nanochemistry A Chemical Approach to Nanomaterials”**, RSC publishing, 2005.
3. **“Wiley Engineering Chemistry”**, Wiley India Pvt. Ltd. New Delhi. Second Edition.
4. V.R.Gowariker, N.V.Viswanathan & J.Sreedhar., **“Polymer Science”**, Wiley-Eastern Ltd.
5. M.G.Fontana., **“Corrosion Engineering”**, Tata McGraw Hill Publishing Pvt. Ltd. New Delhi.

PROGRAMMING IN C AND DATA STRUCTURES **[**As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Subject Code	15PCD13/23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course objectives:

The objectives of this course is to make students to learn basic principles of Problem solving, implementing through C programming language and to design & develop programming skills. To gain knowledge of data structures and their applications.

Module -1 : INTRODUCTION TO C LANGUAGE	**Teaching Hours**
Pseudo code solution to problem, Basic concepts in a C program, Declaration, Assignment & Print statements, Data Types, operators and expressions etc, Programming examples and exercise. **Text 1:** Chapter 2, **and** **Text 2:** 1.1, 1.2, 1.3	**10Hours**
Module -2: BRANCHING AND LOOPING	
Two way selection (if, if-else, nested if-else, cascaded if-else), switch statement, ternary operator? Go to, Loops (For, while-do, do-while) in C, break and continue, Programming examples and exercises. **Text 1:** Chapter 3**.** **&** **Text 2:** 4.4.	**10 Hours**
Module – 3: FUNCTIONS, ARRAYS AND STRINGS	
ARRAYS AND STRINGS: Using an array, Using arrays with Functions, Multi-Dimensional arrays. String: Declaring, Initializing, Printing and reading strings, string manipulation functions, String input and output functions, array of strings, Programming examples and Exercises. **Text 1:** 5.7, & **Text 2**: 7.3, 7.4, chapter 9 **FUNCTIONS**: Functions in C, Argument Passing – call by value, call by reference, Functions and program structure, location of functions, void and parameter less Functions, Recursion, Programming examples and exercises. **Text 1:** 1.7, 1.8, Chapter 4. **Text 2:** 5.1 to 5.4.	**10 Hours**

<table>
<tr><td colspan="2">Module-4: STRUCTURES AND FILE MANAGEMENT</td></tr>
<tr><td>Basic of structures, structures and Functions, Array of structures, structure Data types, type definition, Defining, opening and closing of files, Input and output operations, Programming examples and exercises.

Text 1: 6.1 to 6.3. Text 2: 10.1 to 10.4, Chapter 11.</td><td>10 Hours</td></tr>
<tr><td colspan="2">Module-5: POINTERS AND PREPROCESSORS & Data Structures</td></tr>
<tr><td>Pointers and address, pointers and functions (call by reference) arguments, pointers and arrays, address arithmetic, character pointer and functions, pointers to pointer ,Initialization of pointer arrays, Dynamic memory allocations methods, Introduction to Preprocessors, compiler control Directives, Programming examples and exercises.

Text 1: 5.1 to 5.6, 5.8. Text 2: 12.2, 12.3, 13.1 to 13.7.

Introduction to Data Structures: Primitive and non primitive data types, Abstract data types, Definition and applications of Stacks, Queues, Linked Lists and Trees.

Text 2 : 14.1, 14.2, 14.11, 14.12, 14.13, 14.15, 14.16, 14.17, 15.1.</td><td>10 Hours</td></tr>
<tr><td colspan="2">Course outcomes: On completion of this course, students are able to
• Achieve Knowledge of design and development of C problem solving skills.
• Understand the basic principles of Programming in C language
• Design and develop modular programming skills.
• Effective utilization of memory using pointer technology
• Understands the basic concepts of pointers and data structures.</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Question paper pattern:
• The question paper will have ten questions.
• Each full Question consisting of 16 marks
• There will be 2 full questions(with a maximum of four sub questions) from each module.
• Each full question will have sub questions covering all the topics under a module.
• The students will have to answer 5 full questions, selecting one full question from each module.</td></tr>
</table>

Text Books:

1. Brian W. Kernighan and Dennis M. Ritchie: The C Programming Language, 2^{nd} Edition, PHI, 2012.
2. Jacqueline Jones & Keith Harrow: Problem Solving with C, 1^{st} Edition, Pearson 2011.

Reference Books:

1. Vikas Gupta: Computer Concepts and C Programming, Dreamtech Press 2013.
2. R S Bichkar, Programming with C, University Press, 2012.
3. V Rajaraman: Computer Programming in C, PHI, 2013.

<table>
<tr><td colspan="4" align="center">COMPUTER AIDED ENGINEERING DRAWING
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
SEMESTER - I/II</td></tr>
<tr><td>Subject Code</td><td>15CED14/15CED24</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>6 (2T + 4L)</td><td>Exam Marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>84</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS - 04</td></tr>
<tr><td colspan="4">Course objectives:
Engineering drawing is an important tool for all Engineers and for many others professionals. It is the language of Engineers. Engineering Drawing communicates all needed information from the engineer who designed a part to the workers who will manufacture it.

The aim of the subject is to equip students with the fundamentals of Computer Aided Engineering Drawing and to further the ability to communicate information by graphical means.</td></tr>
<tr><td colspan="3">Module -1</td><td>Teaching Hours</td></tr>
</table>

Introduction to Computer Aided Sketching Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practicing. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes. of HP, VP, RPP & LPP. of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. Dimensioning, line conventions, material conventions and lettering.	**06 Hours**
Module -2	**Teaching Hours**
Orthographic projections Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only), True and apparent lengths, True and apparent inclinations to reference planes (No application problems). Orthographic Projections of Plane Surfaces (First Angle Projection Only) Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method only (No problems on punched plates and composite plates).	**20Hours**
Module-3	

Projections of Solids (First angle Projection only) Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions (No problems on octahedrons and combination solid).	**28 Hours**
Module-4	
Sections And Development of Lateral Surfaces of Solids Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. (No problems on sections of solids) Development of lateral surfaces of above solids, their frustums and truncations. (No problems on lateral surfaces of trays, tetrahedrons, spheres and transition pieces).	**15Hours**
Module-5	
Isometric Projection (Using Isometric Scale Only) Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres and combination of solids (Maximum of three solids).	15 Hours
Course outcomes: After studying this course, 1. Students will be able to demonstrate the usage of CAD software. 2. Students will be able to visualize and draw Orthographic projections, Sections of solids and Isometric views of solids. 3. Students are evaluated for their ability in applying various concepts to solve practical problems related to engineering drawing.	

Question paper pattern:

1. Module -1 is only for practice and Internal Assessment and not for examination.
2. Question paper for each batch of students will be sent online by VTU and has to be downloaded before the commencement of Examination of each batch. The answer sheets will have to be jointly evaluated by the Internal & External examiners.
3. A maximum of **THREE** questions will be set as per the following pattern *(No mixing of questions from different Modules).*

Q. No.	From Chapters	Marks Allotted
1	Module 2(Choice between (Points+Lines or Planes)	25
2	Module 3	30
3	Module 4 or Module 5	25
Total		80

Q. No.	Solutions and Sketching in the Graph Book	Computer Display and Printout	Total Marks
1	10	15	25
2	12	18	30
3	13	12	25
Total Marks	35	45	80

Students have to submit the computer printouts and the sketches drawn on the graph sheets at the end of the examination. Both Internal & External examiners have to jointly evaluate the solutions (sketches) and computer display & printouts of each student for 80 marks (35 marks for solutions & sketches + 45 marks for computer display and printouts) and submit the marks list along with the solution (sketches) on graph sheets & computer printouts in separate covers.

4. Each batch must consist of a minimum of 10 students and a maximum of 12 students.
5. Examination can be conducted in parallel batches, if necessary.

Text Books:

1) **Engineering Drawing** - N.D. Bhatt & V.M. Panchal, 48^{th} edition, 2005- Charotar Publishing House, Gujarat.

2) "**Computer Aided Engineering Drawing**" by Dr. M H Annaiah, Dr C N Chandrappa and Dr B Sudheer Premkumar Fifth edition, New Age International Publishers.

Reference Books:

1) Computer Aided Engineering Drawing - S. Trymbaka Murthy, - I.K. International Publishing House Pvt. Ltd., New Delhi, 3^{rd} revised edition- 2006.

2) Engineering Graphics - K.R. Gopalakrishna, 32nd edition, 2005- Subash Publishers Bangalore.

3) Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production- Luzadder Warren J., Duff John M., Eastern Economy Edition, 2005- Prentice-Hall of India Pvt. Ltd., New Delhi.

4) A Primer on Computer Aided Engineering Drawing-2006, Published by VTU, Belgaum.

BASIC ELECTRONICS

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	15ELN15 / 15ELN25	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course objectives:

The course objective is to make students of all the branches of Engineering to understand the efficacy of Electronic principles which are pervasive in engineering applications

Module -1	**Teaching Hours**
Semiconductor Diodes and Applications (Text-1)**:** p-n junction diode, Characteristics and Parameters, Diode approximations, DC load line analysis, Half-wave rectifier, Two-diode Full-wave rectifier, Bridge rectifier, Capacitor filter circuit (only qualitative approch), Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. Numerical examples as applicable.	**06 Hours**
Bipolar Junction Transistors: BJT operation, BJT Voltages and Currents, BJT amplification, Common Base, Common Emitter and Common Collector Characteristics, Numerical examples as applicable.	**04 Hours**
Module -2	
BJT Biasing (Text-1): DC Load line and Bias Point, Base Bias, Voltage divider Bias, Numerical examples as applicable.	**04 Hours**
Introduction to Operational Amplifiers (Text-2)**:** Ideal OPAMP, Inverting and Non Inverting OPAMP circuits, OPAMP applications: voltage follower, addition, subtraction, integration, differentiation; Numerical examples as applicable.	**06 Hours**

Module – 3	
Digital Electronics (Text-2): Introduction, Switching and Logic Levels, Digital Waveform (Sections 9.1to 9.3). Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary, Converting Hexadecimal to Decimal, Converting Decimal to Hexadecimal, Octal Numbers: Binary to Octal Conversion. Complement of Binary Numbers. Boolean Algebra Theorems, De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, XOR Gate, NAND Gate, NOR Gate, X-NOR Gate. Algebraic Simplification, NAND and NOR Implementation (Sections 11.7 and 11.8): NAND Implementation, NOR Implementation. Half adder, Full adder.	**10 Hours**
Module-4	
Flip-Flops (Text-2)**:** Introduction to Flip-Flops (Section 12.1), NAND Gate Latch/ NOR Gate Latch, RS Flip-Flop, Gated Flip-Flops: Clocked RS Flip-Flop (Sections 12.3 to 12.5). **Microcontrollers** (Ref.1)**:** Introduction to Microcontrollers, 8051 Microcontroller Architecture and an example of Microcontroller based stepper motor control system (only Block Diagram approach).	**05 Hours** **05 Hours**
Module-5	
Communication Systems (Text-2): Introduction, Elements of Communication Systems, Modulation: Amplitude Modulation, Spectrum Power, AM Detection (Demodulation), Frequency and Phase Modulation. Amplitude and Frequency Modulation: A comparison. **Transducers (**Text-2)**:** Introduction, Passive Electrical Transducers, Resistive Transducers, Resistance Thermometers, Thermistor. Linear Variable Differential Transformer (LVDT). Active Electrical Transducers, Piezoelectric Transducer, Photoelectric Transducer.	**06 Hours** **04 Hours**

Course outcomes:
After studying this course, students will be able to:

- Appreciate the significance of electronics in different applications,
- Understand the applications of diode in rectifiers, filter circuits and wave shaping,
- Apply the concept of diode in rectifiers, filters circuits
- Design simple circuits like amplifiers (inverting and non inverting), comparators, adders, integrator and differentiator using OPAMPS,
- Compile the different building blocks in digital electronics using logic gates and implement simple logic function using basic universal gates, and
- Understand the functioning of a communication system, and different modulation technologies, and
- Understand the basic principles of different types of Transuducers.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. David A. Bell, **"Electronic Devices and Circuits"**, Oxford University Press, 5^{th} Edition, 2008.
2. D.P. Kothari, I. J. Nagrath, **"Basic Electronics"**, McGraw Hill Education (India) Private Limited, 2014.

Reference Books: MuhammadAli Mazidi, **"The 8051 Microcontroller and Embedded. Systems. Using Assembly and C."** Second Edition, 2011, Pearson India.

COMPUTER PROGRAMMING LABORATORY [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Laboratory Code	**15CPL16 / 15CPL26**	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
Total Number of Lecture Hours	48	Exam Hours	03
CREDITS - 02			

Course objectives: To provide basic principles C programming language. To provide design & develop of C programming skills. To provide practical exposures like designing flowcharts, algorithms, how to debug programs etc.

Descriptions (if any):

Demonstration of Personal Computer and its Accessories: Demonstration and Explanation on Disassembly and Assembly of a Personal Computer by the faculty-in-charge. Students have to prepare a write-up on the same and include it in the Lab record and evaluated.

Laboratory Session-1: Write-up on Functional block diagram of Computer, CPU, Buses, Mother Board, Chip sets, Operating System & types of OS, Basics of Networking & Topology and NIC.

Laboratory Session-2: Write-up on RAM, SDRAM, FLASH memory, Hard disks, Optical media, CD-ROM/R/RW, DVDs, Flash drives, Keyboard, Mouse, Printers and Plotters. Introduction to flowchart, algorithm and pseudo code.

Note: These **TWO Laboratory sessions** are used to fill the gap between theory classes and practical sessions. Both sessions are to be evaluated as lab experiments.

Laboratory Experiments:

Implement the following programs with WINDOWS / LINUX platform using appropriate C compiler.

1. Design and develop a flowchart or an algorithm that takes three coefficients (a, b, and c) of a Quadratic equation ($ax^2+bx+c=0$) as input and compute all possible roots. Implement a C program for the developed flowchart/algorithm and execute the same to output the possible roots for a given set of coefficients with appropriate messages.

2. Design and develop an algorithm to find the ***reverse*** of an integer number **NUM** and check whether it is PALINDROME or NOT. Implement a C program for the developed algorithm that takes an integer number as input and output the reverse of the same with suitable messages. Ex: Num: **2014**, Reverse: **4102**, Not a Palindrome

3.
   3a. Design and develop a flowchart to find the square root of a given number ***N***. Implement a C program for the same and execute for all possible inputs with appropriate messages. Note: **Don't use library function *sqrt(n)*.**

   3b. Design and develop a C program to read a ***year*** as an input and find whether it is ***leap year*** or not. Also consider end of the centuries.

4. Design and develop an algorithm to evaluate polynomial $\mathbf{f(x) = a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0}$, for a given value of x and its coefficients using Horner's method. Implement a C program for the same and execute the program with different set of values of coefficients and ***x***.

5. Draw the flowchart and Write a C Program to compute **Sin(x)** using Taylor series approximation given by $\mathbf{Sin(x) = x - (x^3/3!) + (x^5/5!) - (x^7/7!) + \ldots}$
   Compare your result with the built- in Library function. Print both the results with appropriate messages.

6. Develop an algorithm, implement and execute a C program that reads ***N*** integer numbers and arrange them in ascending order using ***Bubble Sort***.

7. Develop, implement and execute a C program that reads two matrices ***A*** (**m x n**) and ***B*** (**p x q**) and Compute product of matrices ***A*** and ***B***. Read matrix ***A*** and matrix ***B*** in row major order and in column major order respectively. Print both the input matrices and resultant matrix with suitable headings and output should be in matrix format only. Program must check the compatibility of orders of the matrices for multiplication. Report appropriate message in case of incompatibility.

8. Develop, implement and execute a C program to search a Name in a list of names using ***Binary searching*** Technique.

9. Write and execute a C program that

i. Implements string copy operation ***STRCOPY***(str1,str2) that copies a string *str1* to another string *str2* without using library function.

ii. Read a *sentence* and print frequency of vowels and total count of consonants.

10.

a. Design and develop a C function ***RightShift****(x ,n)* that takes two integers *x* and *n* as input and returns value of the integer *x* rotated to the right by *n* positions. Assume the integers are unsigned. Write a C program that invokes this function with different values for *x* and *n* and tabulate the results with suitable headings.

b. Design and develop a C function ***isprime***(num) that accepts an integer argument and returns 1 if the argument is prime, a 0 otherwise. Write a C program that invokes this function to generate prime numbers between the given range.

11. Draw the flowchart and write a ***recursive*** **C** function to find the factorial of a number, ***n*!**, defined by *fact*(*n*)=1, if *n*=0. Otherwise *fact*(*n*)=*n***fact*(*n*-1). Using this function, write a C program to compute the binomial coefficient $_{n}C_{r}$. Tabulate the results for different values of ***n*** and ***r*** with suitable messages.

12. Given two university information files “**studentname.txt**” and “**usn.txt**” that contains students Name and USN respectively. Write a C program to create a new file called “**output.txt**” and copy the content of files “studentname.txt” and “usn.txt” into output file in the sequence shown below . Display the contents of output file “output.txt” on to the screen.

Student Name	USN
Name 1	USN1
Name 2	USN2
….	….
….	….

Heading

13. Write a C program to maintain a record of **n** student details using an array of structures with four fields (Roll number, Name, Marks, and Grade). Assume appropriate data type for each field. Print the marks of the student, given the student name as input.

14. Write a C program using pointers to compute the sum, mean and standard deviation of all elements stored in an array of **n** real numbers.

Course outcomes:

- **Gaining Knowledge on various parts of a computer.**
- **Able to draw flowcharts and write algorithms**
- **Able design and development of C problem solving skills.**
- **Able design and develop modular programming skills.**
- **Able to trace and debug a program**

Conduction of Practical Examination:

1. All laboratory experiments (nos) are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks
4. **Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.**

ENGINEERING CHEMISTRY LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Laboratory Code	15CHEL17/15CHEL27	IA Marks	20
Number of Lecture Hours/Week	3 (1 hr Tutorial +2 hrs lab)	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 02

Course objectives:

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

Instrumental Experiments

1. Estimation of FAS potentiometrically using standard $K_2Cr_2O_7$ solution.
2. Estimation of Copper colorimetrically.
3. Estimation of Acids in acid mixture conductometrically.
4. Determination of pKa of weak acid using pH meter.
5. Determination of Viscosity co-efficient of the given liquid using Ostwald's viscometer.
6. Estimation of Sodium and Potassium in the given sample of water using Flame Photometer.

Volumetric Experiments

1. Estimation of Total hardness of water by EDTA complexometric method.
2. Estimation of CaO in cement solution by rapid EDTA method.
3. Determination of percentage of Copper in brass using standard sodium thiosulphate solution.
4. Estimation of Iron in haematite ore solution using standard $K_2Cr_2O_7$ solution by External Indicator method.
5. Estimation of Alkalinity (OH^-, CO_3^{--} & HCO_3^-) of water using standard HCl solution.
6. Determination of COD of waste water.

Course outcomes:

On completion of this course, students will have the knowledge in,

- Handling different types of instruments for analysis of materials using small quantities of materials involved for quick and accurate results, and
- Carrying out different types of titrations for estimation of concerned in materials using comparatively more quantities of materials involved for good results

Conduction of Practical Examination:

1. All experiments are to be included for practical examination.
2. One instrumental and another volumetric experiments shall be set.
3. Different experiments shall be set under instrumental and a common experiment under volumetric.
4. **Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.**

Reference Books:

1. G.H.Jeffery, J.Bassett, J.Mendham and R.C.Denney, **"Vogel's Text Book of Quantitative Chemical Analysis"**
2. O.P.Vermani & Narula, **"Theory and Practice in Applied Chemistry"**, New Age International Publisers.
3. Gary D. Christian, **"Analytical chemistry**", 6^{th} Edition, Wiley India.

ENVIRONMENTAL STUDIES

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	15CIV18/15CIV28	IA Marks	10
Number of Lecture Hours/Week	02	Exam Marks	40
Total Number of Lecture Hours	25	Exam Hours	02

Course Objectives:

1. **To identify the major challenges in environmental issues and evaluate possible solutions.**
2. **Develop analytical skills, critical thinking and demonstrate socio-economic skills for sustainable development.**
3. **To analyze an overall impact of specific issues and develop environmental management plan.**

Module - 1

Introduction: Environment - Components of Environment Ecosystem: Types & Structure of Ecosystem, Balanced ecosystem Human Activities – Food, Shelter, And Economic & Social Security. **2 Hours**

Impacts of Agriculture & Housing Impacts of Industry, Mining & Transportation Environmental Impact Assessment, Sustainable Development. **3 Hours**

Module - 2

Natural Resources, Water resources – Availability & Quality aspects, Water borne diseases & water induced diseases, Fluoride problem in drinking water Mineral resources, Forest Wealth Material Cycles – Carbon Cycle, Nitrogen Cycle & Sulphur Cycle. **2 Hours**

Energy – Different types of energy, Conventional sources & Non Conventional sources of energy Solar energy, Hydro electric energy, Wind Energy, Nuclear energy, Biomass & Biogas Fossil Fuels, Hydrogen as an alternative energy. **3 Hours**

Module -3 Environmental Pollution – Water Pollution, Noise pollution, Land Pollution, Public Health Aspects. **2 Hours** Global Environmental Issues: Population Growth, Urbanization, Land Management, Water & Waste Water Management. **3 Hours**
Module -4 Air Pollution & Automobile Pollution: Definition, Effects – Global Warming, Acid rain & Ozone layer depletion, controlling measures. **3 Hours** Solid Waste Management, E - Waste Management & Biomedical Waste Management - Sources, Characteristics & Disposal methods. **2 Hours**
Module - 5 Introduction to GIS & Remote sensing, Applications of GIS & Remote Sensing in Environmental Engineering Practices. **2 Hours** Environmental Acts & Regulations, Role of government, Legal aspects, Role of Non-governmental Organizations (NGOs) , Environmental Education & Women Education. **3 Hours**
Course Outcome: Students will be able to, 1. Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale, 2. Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment, 3. Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components 4. Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues
Text Books:

1. Benny Joseph (2005), **“Environmental Studies”**, Tata McGraw – Hill Publishing Company Limited.
2. R.J.Ranjit Daniels and Jagadish Krishnaswamy, (2009), **“Environmental Studies”,** Wiley India Private Ltd., New Delhi.
3. R Rajagopalan, **“Environmental Studies – From Crisis to Cure**”, Oxford University Press, 2005,
4. Aloka Debi, **“Environmental Science and Engineering”,** Universities Press (India) Pvt. Ltd. 2012.

Reference Books:

1. Raman Sivakumar, **“Principals of Environmental Science and Engineering”,** Second Edition, Cengage learning Singapore, 2005
2. P. Meenakshi, **“Elements of Environmental Science and Engineering”,** Prentice Hall of India Private Limited, New Delhi, 2006
3. S.M. Prakash, **“Environmental Studies”,** Elite Publishers Mangalore, 2007
4. Erach Bharucha, **“Text Book of Environmental Studies”**, for UGC, University press, 2005
5. G.Tyler Miller Jr., **“Environmental Science – working with the Earth”**, Tenth Edition, Thomson Brooks /Cole, 2004
6. G.Tyler Miller Jr., **“Environmental Science – working with the Earth”**, Eleventh Edition, Thomson Brooks /Cole, 2006
7. Dr.Pratiba Sing, Dr.AnoopSingh and Dr.Piyush Malaviya, **“Text Book of Environmental and Ecology”**, Acme Learning Pvt. Ltd. New Delhi.

Functional English

Introduction	Importance of Languages	
Grammer	Parts of Speech, Usage of Preposition and Article, Punctuation	5 Hours
Tenses & Degrees of Comparison		3 Hours
Transformation of Sentences	Active-Passive, Affirmative-Negative, Exclamatory-Assertive, Interrogative-Assertive, Kinds of sentences	5 Hours
Direct-Indirect Speech		5 Hours
Vocabulary Usage	Homonyms, Correcting Spelling, One-word equivalents	7 Hours
Precis Writing		3 Hours
Essay/Report Writing		5 Hours
Letter Writing	Personal, Official, Applications	5 Hours
Idioms & Phrases	Meaning & Usage in sentences	5 Hours
Comprehension	Of an unseen passage	2 Hours
Elaboration	Expansion of ideas, proverbs	2 Hours
Presentation	Preparation of materials and presentation – step	3 Hours

Suggested Text Books:

1) SLN Sharma & K Shankaranarayana **"Basic Grammar"**, Navakarnataka Publications.
2) Jones **"New International Business English"**, published by Cambridge University Press.

Reference Books:

1) G. Sankaran, **"English Rank Scorer"**, Addone Publishing group, Thiruvanantapuram, Kerala
2) Wren & Martin **"English Grammar"**.
3) John Seely, **"Oxford Guide to Speaking and Writing**", 2000

Kannada Kali

Lesson 1 :	Introducing each other – 1. Personal Pronouns, Possessive forms, Interrogative words.
Lesson 2 :	Introducing each other – 2. Personal Pronouns, Possessive forms, Yes/No Type Interrogation
Lesson 3 :	About Ramanaya. Possessive forms of nons, dubitive question, Relative nouns
Lesson 4 :	Enquiring about a room for rent. Qualitative and quantitative adjectives.
Lesson 5 :	Enquiring about the college. Predicative forms, locative case.
Lesson 6 :	In a hotel Dative case defective verbs.
Lesson 7 :	Vegetable market. Numeral, plurals.
Lesson 8 :	Planning for a picnic. Imperative, Permissive, hortative.
Lesson 9 :	Conversation between Doctor and the patient. Verb- iru, negation – illa, non – past tense.
Lesson 10:	Doctors advise to Patient. Potential forms, no – past continuous.
Lesson 11:	Discussing about a film. Past tense, negation.
Lesson 12:	About Brindavan Garden. Past tense negation.

Lesson 13:	About routine activities of a student. Verbal Participle, reflexive form, negation.
Lesson 14:	Telephone conversation. Past and present perfect past continuous and their negation.
Lesson 15:	About Halebid, Belur. Relative participle, negation.
Lesson 16:	Discussing about examination and future plan. Simple conditional and negative
Lesson 17:	Karnataka (Lesson for reading)
Lesson 18:	Kannada Bhaashe (Lesson for reading)
Lesson 19:	Mana taruva Sangati alla (Lesson for reading)
Lesson 20:	bEku bEDagaLu (lesson for reading)

ಕನ್ನಡ ಮನಸು

1. ಶ್ರಾವಣ (ಕವನ) ದ.ರಾ.ಬೇಂದ್ರೆ
2. ಡಾ. ವಿಶ್ವೇಶ್ವರಯ್ಯ ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ (ವ್ಯಕ್ತಿಚಿತ್ರ) ಎ.ಎನ್. ಮೂರ್ತಿರಾವ್
3. ದೋಣಿ ಹರಿಗೋಲುಗಳಲ್ಲಿ (ಪ್ರವಾಸ ಕಥನ) ಶಿವರಾಮ ಕಾರಂತ
4. ಅಣ್ಣಪ್ಪನ ರೇಷ್ಮೆ ಕಾಯಿಲೆ (ಪ್ರಬಂಧ) ಕುವೆಂಪು
5. ನಮ್ಮ ಎಮ್ಮೆಗೆ ಮಾತು ತಿಳಿಯುವುದೇ (ವಿನೋದ) ಗೋರೂರು ರಾಮಸ್ವಾಮಿ ಅಯ್ಯಂಗಾರ್
6. ಆನೆಹಳ್ಳದಲ್ಲಿ ಹುಡುಗಿಯರು(ವಿಜ್ಞಾನ ಲೇಖನ) ಬಿ.ಜಿ.ಎಲ್ ಸ್ವಾಮಿ
7. ಬೆಡ್ ನಂ. ಏಳು (ಕತೆ) ತ್ರಿವೇಣಿ
8. ರೊಟ್ಟಿ ಮತ್ತು ಕೋವಿ (ಕವನ) ಸು.ರಂ.ಎಕ್ಕುಂಡಿ
9. ಗುಬ್ಬಚ್ಚಿ ಗೂಡು (ಅಂಕಣ ಬರಹ) ಲಂಕೇಶ್
10. ಚೀಂಕ್ರ ಮೇಸ್ತ್ರಿ ಮತ್ತು ಹಾವುಮೀನು (ಪರಿಸರ ಲೇಖನ) ಕೆ.ಪೂರ್ಣಚಂದ್ರ ತೇಜಸ್ವಿ
11. ಗಾಂಧಿ (ಕತೆ) ಬೆಸಗರಹಳ್ಳಿ ರಾಮಣ್ಣ
12. ಬೆಲ್ಚಿಯ ಹಾಡು (ಕವನ) ಸಿದ್ಧಲಿಂಗಯ್ಯ
13. ಎಲ್ಲ ಹುಡುಗಿಯರ ಕನಸು (ಕವನ) ಸವಿತಾ ನಾಗಭೂಷಣ
14. ನೀರು (ಕತೆ) ಬಸವರಾಜ ಕುಕ್ಕರಹಳ್ಳಿ
15. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿ ಸ್ವರೂಪ (ಪರಿಚಯ ಲೇಖನ) ರಹಮತ ತರೀಕೆರೆ
16. ತಂತ್ರಜ್ಞಾನ ಕಲಿಕೆಯಲ್ಲಿ ಭಾಷೆ (ತಂತ್ರಜ್ಞಾನ ಬರಹ) ಎಸ್.ಸುಂದರ್
17. ಕೊಣವೇಗೌಡ (ಕಾವ್ಯ) ಜಾನಪದ

Civil Engineering

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

(Common to _______________)

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours / Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics – III	04		03	80	20	100	4
2	15CV32	Strength of Materials	04		03	80	20	100	4
3	15CV33	Fluid Mechanics	04		03	80	20	100	4
4	15CV34	Basic Surveying	04		03	80	20	100	4
5	15CV35	Engineering Geology	04		03	80	20	100	4
6	15CV36	Building Materials and Construction	04		03	80	20	100	4
7	15CVL37	Building Materials Testing Laboratory		1I+2P	03	80	20	100	2
8	15CVL38	Basic Surveying Practice		1I+2P	03	80	20	100	2
TOTAL			**24**	**6**	**24**	**640**	**160**	**800**	**28**

Note:

Core Subjects:	*15CV31, 15CV32, 15CV33, 15CV34, 15CV35, 15CV36*
Laboratory & Practice:	*15CVL37, 15CVL38*

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

(Common to ________________)

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours / Week		Examination				Credits
			Theory	Practical / Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics – IV	04		03	80	20	100	4
2	15CV42	Analysis of Determinate Structures	04		03	80	20	100	4
3	15CV43	Applied Hydraulics	04		03	80	20	100	4
4	15CV 44	Concrete Technology	04		03	80	20	100	4
5	15CV45	Basic Geotechnical Engineering	04		03	80	20	100	4
6	15CV46	Advanced Surveying	04		03	80	20	100	4
7	15CVL47	Fluid Mechanics Laboratory		1I+2P	03	80	20	100	2
8	15CVL48	Engineering Geology Laboratory		1I+2P	03	80	20	100	2
TOTAL			**24**	**06**	**24**	**640**	**160**	**800**	**28**

Note:

Core Subjects:	*15CV 41, 15CV42, 15CV43, 15CV 44, 15CV45, 15CV46*
Laboratory & Practice:	*15CVL47, 15CVL48*

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

V SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15CV51	Design of RC Structural Elements	04		03	80	20	100	4
2	15CV52	Analysis of Indeterminate Structures	04		03	80	20	100	4
3	15CV53	Applied Geotechnical Engineering	04		03	80	20	100	4
4	15CV54	Computer Aided Building Planning and Drawing	01	3D	03	80	20	100	4
5	15CV55X	Professional Elective-1	03		03	80	20	100	3
6	15CV56X	Open Elective-1	03		03	80	20	100	3
7	15CVL57	Geotechnical Engineering Laboratory		1I+2P	03	80	20	100	2
8	15CVL58	Concrete and Highway Materials Laboratory		1I+2P	03	80	20	100	2
		TOTAL	**19**	**09**	**24**	**640**	**160**	**800**	**26**

Professional Elective 1		**Open Elective 1**	
15CV551	Air pollution and Control	15CV561	Traffic Engineering
15CV552	Railways, Harbours, tunneling and Airports	15CV562	Sustainability Concepts in Engineering
15CV553	Masonry Structures	15CV563	Remote Sensing and GIS
15CV554	Theory of Elasticity	15CV564	Occupational Health and Safety
		15NC565	NCC

1. **Professional Elective:** Elective relevant to chosen specialization/ branch
2. **Open Elective**: Electives from other technical and/or emerging subject areas

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

VI SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15CV61	Construction Management and Entrepreneurship	04		03	80	20	100	4
2	15CV62	Design of Steel Structural Elements	04		03	80	20	100	4
3	15CV63	Highway Engineering	04		03	80	20	100	4
4	15CV64	Water Supply and Treatment Engineering	04		03	80	20	100	4
5	15CV65X	Professional Elective 2	03		03	80	20	100	3
6	15CV66X	Open Elective 2	03		03	80	20	100	3
7	15CVL67	Software Application Lab		1I+2P	03	80	20	100	2
8	15CVP68	Extensive Survey Project /Camp		1I+2P	03	80	20	100	2
TOTAL			**22**	**6**	**24**	**640**	**160**	**800**	**26**

Professional Elective-2		**Open Elective-2**	
15CV651	Solid Waste Management	15CV661	Water Resource Management
15CV652	Matrix Method of Structural Analysis	15CV662	Environmental Protection and Management
15CV653	Alternative Building Materials	15CV663	Numerical Methods and applications
15CV654	Ground Improvement Techniques	15CV664	Finite Element Analysis

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

VII SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CV71	Municipal and Industrial Waste Water Engineering	04		03	20	80	100	4
2	15CV72	Design of RCC and Steel Structures	04		03	20	80	100	4
3	15CV73	Hydrology and Irrigation Engineering	04		03	20	80	100	4
4	15CV74X	Professional Elective 3	03		03	20	80	100	3
5	15CV75X	Professional Elective 4	03		03	20	80	100	3
6	15CVL76	Environmental Engineering Laboratory		1I+2P	03	20	80	100	2
7	15CVL77	Computer Aided Detailing of Structures		1I+2D	03	20	80	100	2
8	15CVP78	Project Phase I +Project Seminar		3		100		100	2
TOTAL			**18**	**9**	**21**	**240**	**560**	**800**	**24**

Professional Elective 3		**Professional Elective 4**	
15CV741	Design of Bridges	15CV751	Urban Transportation and Planning
15CV742	Ground Water & Hydraulics	15CV752	Prefabricated Structures
15CV743	Design Concept of Building Services	15CV753	Rehabilitation and Retrofitting of Structures
15CV744	Structural Dynamics	15CV754	Reinforced Earth Structures

1. Project Phase-I + Seminar: Literature Survey, Problem Identification, objectives and Methodology, Submission of synopsis and seminar

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. CIVIL ENGINEERING

VIII SEMESTER

Sl. No.	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CV81	Quantity Surveying and Contracts Management	4	-	3	20	80	100	4
2	15CV82	Design of Pre Stressed Concrete Elements	4	-	3	20	80	100	4
3	15CV83X	Professional Elective 5	3	-	3	20	80	100	3
4	15CV84	Internship/Professional Practice	Industry Oriented		3	50	50	100	2
5	15CVP85	Project Work	-	6	3	100	100	200	6
6	15CVS86	Seminar on current trends in Engineering and Technology	-	4	-	100	-	100	1
TOTAL			**11**	**10**	**15**	**310**	**390**	**700**	**20**

Professional Elective 5	
15CV831	Earthquake Engineering
15CV832	Hydraulic Structures
15CV833	Pavement Design
15CV834	Advanced Foundation Design

Computer Science Engineering

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering/ B.E. Information Science & Engineering

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	**15MAT31**	**Engineering Mathematics - III**	04	--	03	80	20	100	4
2	**15CS32**	**Analog and Digital Electronics**	04	--	03	80	20	100	4
3	**15CS33**	**Data Structures and Applications**	04	--	03	80	20	100	4
4	**15CS34**	**Computer Organization**	04	--	03	80	20	100	4
5	**15CS35**	**Unix and Shell Programming**	04	--	03	80	20	100	4
6	**15CS36**	**Discrete Mathematical Structures**	04	--	03	80	20	100	4
7	**15CSL37**	**Analog and Digital Electronics Laboratory**	--	1I+2P	03	80	20	100	2
8	**15CSL38**	**Data Structures Laboratory**	--	1I+2P	03	80	20	100	2
TOTAL			**24**	**6**	**24**	**640**	**160**	**800**	**28**

Note: ‘I’ Stands for Instruction Hours and ‘P’ for practical Hours

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering/ B.E. Information Science & Engineering

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	**15MAT41**	**Engineering Mathematics - IV**	04	--	03	80	20	100	4
2	**15CS 42**	**Software Engineering**	04	--	03	80	20	100	4
3	**15CS43**	**Design and Analysis of Algorithms**	04	--	03	80	20	100	4
4	**15CS 44**	**Microprocessors and Microcontrollers**	04	--	03	80	20	100	4
5	**15CS45**	**Object Oriented Concepts**	04	--	03	80	20	100	4
6	**15CS46**	**Data Communication**	04	--	03	80	20	100	4
7	**15CSL47**	**Design and Analysis of Algorithm Laboratory**	--	1I+2P	03	80	20	100	2
8	**15CSL48**	**Microprocessors Laboratory**	--	1I+2P	03	80	20	100	2
TOTAL			**24**	**06**	**24**	**640**	**160**	**800**	**28**

Note: 'I' Stands for Instruction Hours and 'P' for practical Hours

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	**15CS51**	Management and Entrepreneurship for IT Industry	04	--	03	80	20	100	4
2	**15CS52**	Computer Networks	04	--	03	80	20	100	4
3	**15CS53**	Database Management System	04	--	03	80	20	100	4
4	**15CS54**	Automata theory and Computability	04	--	03	80	20	100	4
5	**15CS55x**	Professional Elective 1	03	--	03	80	20	100	3
6	**15CS56x**	Open Elective 1	03	--	03	80	20	100	3
7	**15CSL57**	Computer Network Laboratory	--	1I+2P	03	80	20	100	2
8	**15CSL58**	DBMS Laboratory with mini project	--	1I+2P	03	80	20	100	2
TOTAL			**22**	**6**	**24**	**640**	**160**	**800**	**26**

Professional Elective 1	
15CS551	Object Oriented Modeling and Design
15CS552	Introduction to Software Testing
15CS553	Advanced JAVA and J2EE
15CS554	Advanced Algorithms

1. **Professional Elective: Electives relevant to chosen specialization / branch**
2. **Open Elective: Electives from other technical and/or emerging subject areas (Announced separately)**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	**15CS61**	Cryptography, Network Security and Cyber Law	04	--	03	80	20	100	4
2	**15CS62**	Computer Graphics and Visualization	04	--	03	80	20	100	4
3	**15CS63**	System Software and Compiler Design	04	--	03	80	20	100	4
4	**15CS64**	Operating Systems	04	--	03	80	20	100	4
5	**15CS65x**	Professional Elective 2	03	--	03	80	20	100	3
6	**15CS66x**	Open Elective 2	03	--	03	80	20	100	3
7	**15CSL67**	System Software and Operating System Laboratory	--	1I+2P	03	80	20	100	2
8	**15CSL68**	Computer Graphics Laboratory with mini project	--	1I+2P	03	80	20	100	2
TOTAL			**22**	**6**	**24**	**640**	**160**	**800**	**26**

Professional Elective 2	
15CS651	Data Mining and Data Warehousing
15CS652	Software Architecture and Design Patterns
15CS653	Operations research
15CS654	Distributed Computing system

1. **Professional Elective: Electives relevant to choosen specialization / branch**
2. **Open Elective: Electives from other technical and/or emerging subject areas (Announced separately)**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CS71	Web Technology and its applications	04	--	03	20	80	100	4
2	15CS72	Advanced Computer Architectures	04	--	03	20	80	100	4
3	15CS73	Machine Learning	04	--	03	20	80	100	4
4	15CS74x	Professional Elective 3	03	--	03	20	80	100	3
5	15CS75x	Professional Elective 4	03	--	03	20	80	100	3
6	15CSL76	Machine Learning Laboratory	--	1I+2P	03	20	80	100	2
7	15CSL77	Web Technology Laboratory with mini project	--	1I+2P	03	20	80	100	2
8	15CSP78	Project Phase 1 + Seminar	--	--	--	100	--	100	2
		TOTAL	18	6	21	240	560	800	24

Professional Elective 3		Professional Elective 4	
15CS741	Natural Language Processing	15CS751	Soft and Evolutionary Computing
15CS742	Cloud Computing and its Applications	15CS752	Computer Vision and Robotics
15CS743	Information and Network Security	15CS753	Digital Image Processing
15CS744	Unix System Programming	15CS754	Storage Area Networks

1. Professional Elective: Electives relevant to choosen specialization / branch
2. Project Phase 1 + Seminar : Literature Survey, Problem Identification, Objectives and Methodology, Submission of Synopsis and Seminar

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Computer Science & Engineering

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15CS81	Internet of Things and Applications	4	--	3	20	80	100	4
2	15CS82	Big Data Analytics	4	--	3	20	80	100	4
3	15CS83x	Professional Elective 5	3	--	3	20	80	100	3
4	15CS84	Internship / Professional Practice	Industry Oriented		3	50	50	100	2
5	15CSP85	Project work phase II	--	6	3	100	100	200	5
6	15CSS86	Seminar	--	4	--	100	--	100	2
TOTAL			11	10	15	310	390	700	20

Professional Elective 5	
15CS831	High Performance Computing
15CS832	User Interface Design
15CS833	Network management
15CS834	System Modeling and Simulation

1. Professional Elective: Electives relevant to chosen specialization / branch
2. Internship / Professional Practice: To be carried out between 6^{th} and 7^{th} semester vacation or 7^{th} and 8^{th} semester vacation period

Electronics and Communication Engineering

SCHEME OF TEACHING AND EXAMINATION
B.E Electronics & Communication Engineering / Telecommunication Engineering
(Common to Electronics & Communication and Telecommunication Engineering)

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics –III*	04		03	80	20	100	4
2	15EC32	Analog Electronics	04		03	80	20	100	4
3	15EC33	Digital Electronics	04		03	80	20	100	4
4	15EC34	Network Analysis	04		03	80	20	100	4
5	15EC35	Electronic Instrumentation	04		03	80	20	100	4
6	15EC36	Engineering Electromagnetics	04		03	80	20	100	4
7	15ECL37	Analog Electronics Lab		1I+2P	03	80	20	100	2
8	15ECL38	Digital Electronics Lab		1I+2P	03	80	20	100	2
TOTAL			**24**	**6**	**24**	**640**	**160**	**800**	**28**

*Additional course for Lateral entry students only:

1	15MATDIP31	Additional Mathematics - I	03		03	80	--	80	--

SCHEME OF TEACHING AND EXAMINATION
B.E Electronics & Communication Engineering / Telecommunication Engineering
(Common to Electronics & Communication and Telecommunication Engineering)

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical / Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT41	Engineering Mathematics –IV*	04		03	80	20	100	4
2	15EC42	Microprocessor	04		03	80	20	100	4
3	15EC43	Control Systems	04		03	80	20	100	4
4	15EC44	Signals and Systems	04		03	80	20	100	4
5	15EC45	Principles of Communication Systems	04		03	80	20	100	4
6	15EC46	Linear Integrated Circuits	04		03	80	20	100	4
7	15ECL47	Microprocessor Lab		1I+2P	03	80	20	100	2
8	15ECL48	Linear ICs and Communication Lab		1I+2P	03	80	20	100	2
TOTAL			**24**	**06**	**24**	**640**	**160**	**800**	**28**

*Additional course for Lateral entry students only:

1	15MATDIP41	Additional Mathematics - II	03		03	80	--	80	--

SCHEME OF TEACHING AND EXAMINATION
B.E.: Electronics & Communication Engineering

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical /Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ES51	Management and Entrepreneurship Development	04		03	80	20	100	4
2	15EC52	Digital Signal Processing	04		03	80	20	100	4
3	15EC53	Verilog HDL	04		03	80	20	100	4
4	15EC54	Information Theory & Coding	04		03	80	20	100	4
5	15EC55X	Professional Elective-1	03		03	80	20	100	3
6	15EC56X	Open Elective-1	03		03	80	20	100	3
7	15ECL57	DSP Lab		1I+2P	03	80	20	100	2
8	15ECL58	HDL Lab		1I+2P	03	80	20	100	2
TOTAL			**22**	**06**	**24**	**640**	**160**	**800**	**26**

Professional Elective-1			**Open Elective – 1* (List offered by EC/TC Board only)**	
15EC551	Nanoelectronics		15EC561	Automotive Electronics
15EC552	Switching & Finite Automata Theory		15EC562	Object Oriented Programming Using C++
15EC553	Operating System		15EC563	8051 Microcontroller
15EC554	Electrical Engineering Materials			
15EC555	MSP430 Microcontroller			

1. **Professional Elective:** Elective relevant to chosen specialization/ branch.
2. *** Open Elective List**: For other Open Electives offered by other Boards, refer the Scheme of other Boards or Consolidated list in VTU Website.

SCHEME OF TEACHING AND EXAMINATION
B.E.: Electronics & Communication Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EC61	Digital Communication	04		03	80	20	100	4
2	15EC62	ARM Microcontroller & Embedded Systems	04		03	80	20	100	4
3	15EC63	VLSI Design	04		03	80	20	100	4
4	15EC64	Computer Communication Networks	04		03	80	20	100	4
5	15EC65X	Professional Elective-2	03		03	80	20	100	3
6	15EC66X	Open Elective-2	03		03	80	20	100	3
7	15ECL67	Embedded Controller Lab		1I+2P	03	80	20	100	2
8	15ECL68	Computer Networks Lab		1I+2P	03	80	20	100	2
TOTAL			**22**	**6**	**24**	**640**	**160**	**800**	**26**

Professional Elective-2			**Open Elective – 2* (List offered by EC/TC Board only)**	
15EC651	Cellular Mobile Communication		15EC661	Data Structures Using C++
15EC652	Adaptive Signal Processing		15EC662	Power Electronics
15EC653	Artificial Neural Networks		15EC663	Digital System Design using Verilog
15EC654	Digital Switching Systems			
15EC655	Microelectronics			

1. Professional Elective: Elective relevant to chosen specialization/branch.
2. * Open Elective List: For other Open Electives offered by other Boards, refer the Scheme of other Boards or Consolidated list in VTU Website.

SCHEME OF TEACHING AND EXAMINATION
B.E.: Electronics & Communication Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				15EC
			Theory	Practical/Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EC71	Microwave and Antennas	04		03	20	80	100	4
2	15EC72	Digital Image Processing	04		03	20	80	100	4
3	15EC73	Power Electronics	04		03	20	80	100	4
4	15XX74X	Professional Elective-3	03		03	20	80	100	3
5	15EC75X	Professional Elective-4	03		03	20	80	100	3
6	15ECL76	Advanced Communication Lab		1I+2P	03	20	80	100	2
7	15ECL77	VLSI Lab		1I+2P	03	20	80	100	2
8	15ECP78	Project Work Phase–I + Project work Seminar		03		100	-	100	2
TOTAL			**18**	**09**	**21**	**240**	**560**	**800**	**24**

Professional Elective-3		**Professional Elective-4**	
15EC741	Multimedia Communication	15EC751	DSP Algorithms and Architecture
15EC742	Biomedical Signal Processing	15EC752	IoT and Wireless Sensor Networks
15EC743	Real Time Systems	15EC753	Pattern Recognition
15EC744	Cryptography	15EC754	Advanced Computer Architecture
15EC745	CAD for VLSI	15EC755	Satellite Communication

1. **Project Phase –I + Project Work Seminar:** Literature Survey, Problem Identification, Objectives and Methodology. Submission of Synopsis and Seminar.

SCHEME OF TEACHING AND EXAMINATION
B.E.: Electronics & Communication Engineering

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EC81	Wireless Cellular and LTE 4G Broadband	4	-	3	20	80	100	4
2	15EC82	Fiber Optics & Networks	4	-	3	20	80	100	4
3	15EC83X	Professional Elective-5	3	-	3	20	80	100	3
4	15EC84	Internship/Professional Practice	Industry Oriented		3	50	50	100	2
5	15ECP85	Project Work	-	6	3	100	100	200	6
6	15ECS86	Seminar	-	4	-	100	-	100	1
TOTAL			**11**	**10**	**15**	**310**	**390**	**700**	**20**

Professional Elective -5	
15EC831	Micro Electro Mechanical Systems
15EC832	Speech Processing
15EC833	Radar Engineering
15EC834	Machine learning
15EC835	Network and Cyber Security

1. Internship / Professional Practice: To be carried between the (6th and 7th Semester) or (7th and 8th) Semester Vacation period.

B.E., III Semester, Electronics & Communication Engineering /Telecommunication Engineering

<table>
<tr><td colspan="5" align="center"><u>ENGINEERING MATHEMATICS-III</u>
B.E., III Semester, Common to all Branches
[As per Choice Based Credit System (CBCS) scheme]</td></tr>
<tr><td>Subject Code</td><td>15MAT31</td><td>IA Marks</td><td colspan="2">20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam marks</td><td colspan="2">80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5" align="center">Credits – 04</td></tr>
<tr><td colspan="5">Course Objectives: This course will enable students to:
Introduce most commonly used analytical and numerical methods in the different engineering fields.
Learn Fourier series, Fourier transforms and Z-transforms, statistical methods, numerical methods.
Solve algebraic and transcendental equations, vector integration and calculus of variations.</td></tr>
<tr><td colspan="4" align="center">Modules</td><td align="center">RBT Level</td></tr>
<tr><td colspan="4" align="center">Module-1</td><td></td></tr>
<tr><td colspan="4">Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period $2c$. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from engineering field.</td><td align="center">L1, L2, L4</td></tr>
<tr><td colspan="4" align="center">Module-2</td><td></td></tr>
<tr><td colspan="4">Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transform.
Z-transform: Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse z-transform. Applications of z-transforms to solve difference equations.</td><td align="center">L2, L3, L4</td></tr>
<tr><td colspan="4" align="center">Module-3</td><td></td></tr>
<tr><td colspan="4">Statistical Methods: Review of measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –Problems
Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$.
Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula- Falsi Method and Newton-Raphson method.</td><td align="center">L3</td></tr>
<tr><td colspan="4" align="center">Module-4</td><td></td></tr>
<tr><td colspan="4">Finite differences: Forward and backward differences, Newton's forward and backward interpolation formulae. Divided differences- Newton's divided difference formula. Lagrange's interpolation formula and inverse interpolation formula (all formulae without proof)-Problems.
Numerical integration: Simpson's $(1/3)^{th}$ and $(3/8)^{th}$ rules, Weddle's rule (without proof)–Problems.</td><td align="center">L3</td></tr>
</table>

Module-5	
Vector integration: Line integrals-definition and problems, surface and volume integrals-definition, Green's theorem in a plane, Stokes and Gauss-divergence theorem(without proof) and problems.	L3, L4
Calculus of Variations: Variation of function and Functional, variational problems. Euler's equation, Geodesics, hanging chain, Problems.	L2, L4
Course outcomes: On completion of this course, students are able to: • Know the use of periodic signals and Fourier series to analyze circuits and system communications. • Explain the general linear system theory for continuous-time signals and digital signal processing using the Fourier Transform and z-transform. • Employ appropriate numerical methods to solve algebraic and transcendental equations. • Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems. • Determine the extremals of functionals and solve the simple problems of the calculus of variations.	

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. *B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.*
2. *E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons,10th Ed., 2015.*

Reference Books:

1. *N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers, 7th Ed., 2010.*
2. *B.V.Ramana: "Higher Engineering Mathematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.*

Web Link and Video Lectures:

1. *http://nptel.ac.in/courses.php?disciplineID=111*
2. *http://www.khanacademy.org/*
3. *http://www.class-central.com/subject/math*

<table>
<tr><td colspan="5" align="center"><u>ADDITIONAL MATHEMATICS - I</u>
B.E., III Semester, Common to all Branches
(A Bridge course for Lateral Entry students of III Sem. B. E.)
[As per Choice Based Credit System (CBCS) scheme]</td></tr>
<tr><td>Subject Code</td><td>15MATDIP31</td><td>IA Marks</td><td colspan="2">--</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam marks</td><td colspan="2">80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40 (08 Hours per Module)</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5" align="center">Credits – 00</td></tr>
<tr><td colspan="5">Course Objectives: This course will enable students to:
• Acquire basic concepts of complex trigonometry, vector algebra, differential & integral calculus and vector differentiation.
• Solve first order differential equations.</td></tr>
<tr><td colspan="4" align="center">Modules</td><td align="center">RBT Level</td></tr>
<tr><td colspan="4" align="center">Module-1</td><td></td></tr>
<tr><td colspan="4">Complex Trigonometry: Complex Numbers: Definitions & properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).

Vector Algebra: Scalar and vectors. Vectors addition and subtraction. Multiplication of vectors (Dot and Cross products). Scalar and vector triple products-simple problems.</td><td align="center">L1</td></tr>
<tr><td colspan="4" align="center">Module-2</td><td></td></tr>
<tr><td colspan="4">Differential Calculus: Review of successive differentiation. Formulae for n^{th} derivatives of standard functions- Liebnitz's theorem (without proof). Polar curves–angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's series expansions- Illustrative examples. Partial Differentiation : Euler's theorem for homogeneous functions of two variables. Total derivatives-differentiation of composite and implicit function. Application to Jacobians.</td><td align="center">L1, L2</td></tr>
<tr><td colspan="4" align="center">Module-3</td><td></td></tr>
<tr><td colspan="4">Integral Calculus: Statement of reduction formulae for $sin^n x$, $cos^n x$, and $sin^m x \, cos^n x$ and evaluation of these with standard limits-Examples. Double and triple integrals-Simple examples.</td><td align="center">L1, L2</td></tr>
<tr><td colspan="4" align="center">Module-4</td><td></td></tr>
<tr><td colspan="4">Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.</td><td align="center">L1, L2</td></tr>
<tr><td colspan="4" align="center">Module-5</td><td></td></tr>
<tr><td colspan="4">Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: homogeneous, exact, linear differential equations of order one and equations reducible to above types.</td><td align="center">L1, L2</td></tr>
</table>

Course outcomes: On completion of the course, students are able to:

- Understand the fundamental concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- Use derivatives and partial derivatives to calculate rates of change of multivariate functions.
- Learn techniques of integration including double and triple integrals to find area, volume, mass and moment of inertia of plane and solid region.
- Analyze position, velocity and acceleration in two or three dimensions using the calculus of vector valued functions.
- Recognize and solve first-order ordinary differential equations occurring in different branches of engineering.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Ed., 2015.

Reference Books:

1. *E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.*

2. *N.P.Bali and Manish Goyal: Engineering Mathematics, Laxmi Publishers, 7th Ed., 2007.*

ANALOG ELECTRONICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III (EC/TC)			
Subject Code	15EC32	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Explain various BJT parameters, connections and configurations.
- Explain BJT Amplifier, Hybrid Equivalent and Hybrid Models.
- Explain construction and characteristics of JFETs and MOSFETs.
- Explain various types of FET biasing, and demonstrate the use of FET amplifiers.
- Construct frequency response of BJT and FET amplifiers at various frequencies.
- Analyze Power amplifier circuits in different modes of operation.
- Construct Feedback and Oscillator circuits using FET.

Modules	RBT Level
Module -1	
BJT AC Analysis: BJT Transistor Modeling, The re transistor model, Common emitter fixed bias, Voltage divider bias, Emitter follower configuration. Darlington connection-DC bias; The Hybrid equivalent model, Approximate Hybrid Equivalent Circuit- Fixed bias, Voltage divider, Emitter follower configuration; Complete Hybrid equivalent model, Hybrid π Model.	**L1, L2,L3**
Module -2	
Field Effect Transistors: Construction and Characteristics of JFETs, Transfer Characteristics, Depletion type MOSFET, Enhancement type MOSFET. **FET Amplifiers:** JFET small signal model, Fixed bias configuration, Self bias configuration, Voltage divider configuration, Common Gate configuration. Source-Follower Configuration, Cascade configuration.	**L1, L2, L3**
Module -3	
BJT and JFET Frequency Response: Logarithms, Decibels, Low frequency response – BJT Amplifier with RL, Low frequency response-FET Amplifier, Miller effect capacitance, High frequency response – BJT Amplifier, High frequency response-FET Amplifier, Multistage Frequency Effects.	**L1, L2, L3**
Module -4	

Feedback and Oscillator Circuits: Feedback concepts, Feedback connection types, Practical feedback circuits, Oscillator operation, FET Phase shift oscillator, Wien bridge oscillator, Tuned Oscillator circuit, Crystal oscillator, UJT construction, UJT Oscillator.	**L1,L2, L3**
Module -5	
Power Amplifiers: Definition and amplifier types, Series fed class A amplifier, Transformer coupled class A amplifier, Class B amplifier operation and circuits, Amplifier distortion, Class C and Class D amplifiers. **Voltage Regulators:** Discrete transistor voltage regulation - Series and Shunt Voltage regulators.	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Describe the working principle and characteristics of BJT, FET, Single stage, cascaded and feedback amplifiers.
- Describe the Phase shift, Wien bridge, tuned and crystal oscillators using BJT/FET/UJT.
- Calculate the AC gain and impedance for BJT using re and h parameters models for CE and CC configuration.
- Determine the performance characteristics and parameters of BJT and FET amplifier using small signal model.
- Determine the parameters which affect the low frequency and high frequency responses of BJT and FET amplifiers and draw the characteristics.
- Evaluate the efficiency of Class A and Class B power amplifiers and voltage regulators.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Robert L. Boylestad and Louis Nashelsky, “Electronics devices and Circuit theory”, Pearson, 10th/11th Edition, 2012, ISBN:978-81-317-6459-6.

Reference Books:

1. Adel S. Sedra and Kenneth C. Smith, “Micro Electronic Circuits Theory and Application”, 5th Edition ISBN:0198062257
2. Fundamentals of Microelectronics, Behzad Razavi, John Weily ISBN 2013 978-81-265-2307-8
3. J.Millman & C.C.Halkias—Integrated Electronics, 2nd edition, 2010, TMH. ISBN 0-07-462245-5
4. K. A. Navas, “Electronics Lab Manual”, Volume I, PHI, 5th Edition, 2015, ISBN:9788120351424.

DIGITAL ELECTRONICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III (EC/TC)			
Subject Code	15EC33	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Illustrate simplification of Algebraic equations using Karnaugh Maps and Quine-McClusky Techniques.
- Design combinational logic circuits.
- Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators.
- Describe Latches and Flip-flops, Registers and Counters.
- Analyze Mealy and Moore Models.
- Develop state diagrams Synchronous Sequential Circuits.

Modules	RBT Level
Module – 1	
Principles of combination logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, Incompletely specified functions (Don't care terms) Simplifying Max term equations, Quine-McCluskey minimization technique, Quine-McCluskey using don't care terms, Reduced prime implicants Tables.(Text 1, Chapter 3)	**L1, L2, L3**
Module -2	
Analysis and design of combinational logic: General approach to combinational logic design, Decoders, BCD decoders, Encoders, digital multiplexers, Using multiplexers as Boolean function generators, Adders and subtractors, Cascading full adders, Look ahead carry, Binary comparators**.**(Text 1, Chapter 4)	**L1, L2, L3**
Module -3	
Flip-Flops: Basic Bistable elements, Latches, Timing considerations, The master-slave flip-flops (pulse-triggered flip-flops): SR flip-flops,JK flip-flops, Edge triggered flip-flops, Characteristic equations. (Text 2, Chapter 6)	**L1,L2**
Module -4	
Simple Flip-Flops Applications: Registers, binary ripple counters, synchronous binary counters, Counters based on shift registers, Design of a synchronous counters, Design of a synchronous mod-n counter using clocked T , JK , D and SR flip-flops. (Text 2, Chapter 6)	**L1,L2, L3**

Module -5	
Sequential Circuit Design: Mealy and Moore models, State machine notation, Synchronous Sequential circuit analysis, Construction of state diagrams, counter design. (Text 1, Chapter 6)	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Develop simplified switching equation using Karnaugh Maps and Quine-McClusky techniques.
- Explain the operation of decoders, encoders, multiplexers, demultiplexers, adders, subtractors and comparators.
- Explain the working of Latches and Flip Flops (SR,D,T and JK).
- Design Synchronous/Asynchronous Counters and Shift registers using Flip Flops.
- Develop Mealy/Moore Models and state diagrams for the given clocked sequential circuits.
- Apply the knowledge gained in the design of Counters and Registers.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Digital Logic Applications and Design, John M Yarbrough, Thomson Learning, 2001. ISBN 981-240-062-1.
2. Donald D. Givone, "Digital Principles and Design", McGraw Hill, 2002. ISBN 978-0-07-052906-9.

Reference Books:

1. D. P. Kothari and J. S Dhillon, "Digital Circuits and Design", Pearson, 2016, ISBN:9789332543539.
2. Morris Mano, "Digital Design", Prentice Hall of India, Third Edition.
3. Charles H Roth, Jr., "Fundamentals of logic design", Cengage Learning.
4. K. A. Navas, "Electronics Lab Manual", Volume I, PHI, 5th Edition, 2015, ISBN: 9788120351424.

NETWORK ANALYSIS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III (EC/TC)			
Subject Code	15EC34	IA Marks	20
Number	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course enables students to:

- Describe basic network concepts emphasizing source transformation, source shifting, mesh and nodal techniques to solve for resistance/impedance, voltage, current and power.
- Explain network Thevenin's, Millman's, Superposition, Reciprocity, Maximum Power transfer and Norton's Theorems and apply them in solving the problems related to Electrical Circuits.
- Explain the behavior of networks subjected to transient conditions.
- Use applications of Laplace transforms to network problems.
- Describe Series and Parallel Combination of Passive Components as resonating circuits, related parameters and to analyze frequency response.
- Study two port network parameters like Z, Y, T and h and their inter-relationships and applications.

Modules	**RBT Level**
Module -1	
Basic Concepts: Practical sources, Source transformations, Network reduction using Star – Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks, Concepts of super node and super mesh.	**L1, L2,L3,L4**
Module -2	
Network Theorems: Superposition, Reciprocity, Millman's theorems, Thevinin's and Norton's theorems, Maximum Power transfer theorem.	**L1, L2, L3,L4**
Module -3	
Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their Representation, evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations. **Laplace Transformation & Applications**: Solution of networks, step, ramp and impulse responses, waveform Synthesis.	**L1, L2, L3,L4**
Module -4	
Resonant Circuits: Series and parallel resonance, frequency- response of series and Parallel circuits, Q–Factor, Bandwidth.	**L1, L2, L3,L4**
Module -5	

Two port network parameters: Definition of Z, Y, h and Transmission parameters, modeling with these parameters, relationship between parameters sets.	**L1, L2, L3,L4**

Course Outcomes: After studying this course, students will be able to:

- Determine currents and voltages using source transformation/ source shifting/ mesh/ nodal analysis and reduce given network using star-delta transformation/ source transformation/ source shifting.
- Solve network problems by applying Superposition/ Reciprocity/ Thevenin's/ Norton's/ Maximum Power Transfer/ Millman's Network Theorems and electrical laws to reduce circuit complexities and to arrive at feasible solutions.
- Calculate current and voltages for the given circuit under transient conditions.
- Apply Laplace transform to solve the given network.
- Evaluate for RLC elements/ frequency response related parameters like resonant frequency, quality factor, half power frequencies, voltage across inductor and capacitor, current through the RLC elements, in resonant circuits
- Solve the given network using specified two port network parameter like Z or Y or T or h.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. M.E. Van Valkenberg (2000), "Network analysis", Prentice Hall of India, 3rd edition, 2000, ISBN: 9780136110958.

2. Roy Choudhury, "Networks and systems", 2nd edition, New Age International Publications, 2006, ISBN: 9788122427677.

Reference Books:

1. Hayt, Kemmerly and Durbin "Engineering Circuit Analysis", TMH 7th Edition, 2010.
2. J. David Irwin /R. Mark Nelms, "Basic Engineering Circuit Analysis", John Wiley, 8th ed, 2006.
3. Charles K Alexander and Mathew N O Sadiku, " Fundamentals of Electric Circuits", Tata McGraw-Hill, 3rd Ed, 2009.

ELECTRONIC INSTRUMENTATION [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – III (EC/TC)**			
Subject Code	15EC35	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Define and describe accuracy and precision, types of errors, statistical and probability analysis.
- Describe the operation of Ammeters, Voltmeters, Multimeters and develop circuits for multirange Ammeters and Voltmeters.
- Describe functional concepts and operation of various Analog and Digital measuring instruments.
- Describe basic concepts and operation of Digital Voltmeters and Microprocessor based instruments.
- Describe and discuss functioning and types of Oscilloscopes, Signal generators, AC and DC bridges.
- Recognize and describe significance and working of different types of transducers.

Modules	RBT Level
Module -1 **Measurement and Error:** Definitions, Accuracy, Precision, Resolution and Significant Figures, Types of Errors, Measurement error combinations, Basics of Statistical Analysis. **(Text 2)** **Ammeters:** DC Ammeter, Multirange Ammeter, The Ayrton Shunt or Universal Shunt, Requirements of Shunt, Extending of Ammeter Ranges, RF Ammeter (Thermocouple), Limitations of Thermocouple. **(Text 1)** **Voltmeters and Multimeters:** Introduction, Basic Meter as a DC Voltmeter, DC Voltmeter, Multirange Voltmeter, Extending Voltmeter Ranges, Loading, AC Voltmeter using Rectifiers. Transistor Voltmeter, Differential Voltmeter, True RMS Voltmeter, Considerations in Choosing an Analog Voltmeter, Multimeter. **(Text 1)**	**L1, L2, L3**
Module -2	

Digital Voltmeters: Introduction, RAMP technique, Dual Slope Integrating Type DVM, Integrating Type DVM, Most Commonly used principles of ADC, Successive Approximations, Continuous Balance DVM, $3\frac{1}{2}$-Digit, Resolution and Sensitivity of Digital Meters, General Specifications of DVM, Microprocessor based Ramp type DVM. **(Text 1)** **Digital Instruments:** Introduction, Digital Multimeters, Digital Frequency Meter, Digital Measurement of Time, Universal Counter, Digital Tachometer, Digital pH Meter, Digital Phase Meter, Digital Capacitance Meter, Microprocessor based Instruments. **(Text 1)**	**L1, L2,L3**
Module -3	
Oscilloscopes: Introduction, Basic principles, CRT features, Block diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, Sweep or Time Base Generator, Storage Oscilloscope, Digital Readout Oscilloscope, Measurement of Frequency by Lissajous Method, Digital Storage Oscilloscope. **(Text 1)** **Signal Generators:** Introduction, Fixed and Variable AF Oscillator, Standard Signal Generator, Laboratory Type Signal Generator, AF sine and Square Wave Generator, Function Generator, Square and Pulse Generator, Sweep Generator. **(Text 1)**	**L1, L2**
Module -4	
Measuring Instruments: Output Power Meters, Field Strength Meter, Stroboscope, Phase Meter, Vector Impedance Meter, Q Meter, Megger, Analog pH Meter. **(Text 1)** **Bridges:** Introduction, Wheatstone's bridge, Kelvin's Bridge; AC bridges, Capacitance Comparison Bridge, Inductance Comparison Bridge, Maxwell's bridge, Wien's bridge, Wagner's earth connection. **(Text 1)**	**L1, L2,L3**
Module -5	
Transducers: Introduction, Electrical transducers, Selecting a transducer, Resistive transducer, Resistive position transducer, Strain gauges, Resistance thermometer, Thermistor, Inductive transducer, Differential output transducers, LVDT, Piezoelectric transducer, Photoelectric transducer, Photovoltaic transducer, Semiconductor photo diode and transistor, Temperature transducers-RTD. **(Text 1)**	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Describe instrument measurement errors and calculate them.
- Describe the operation of Ammeters, Voltmeters, Multimeters and develop circuits for multirange Ammeters and Voltmeters.
- Describe functional concepts and operation of Digital voltmeters and instruments to measure voltage, frequency, time period, phase difference of signals, rotation speed, capacitance and pH of solutions.
- Describe functional concepts and operation of various Analog measuring instruments to measure output power, field Strength, impedance, stroboscopic speed, in/out of phase, Q of coils, insulation resistance and pH.
- Describe and discuss functioning and types of Oscilloscopes, Signal generators and Transducers.
- Utilize AC and DC bridges for passive component and frequency measurements.

Question paper pattern: • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of Three sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.
Text Books: **1.** H. S. Kalsi, "Electronic Instrumentation", McGraw Hill, 3rd Edition, 2012, ISBN:9780070702066. **2.** David A. Bell, "Electronic Instrumentation & Measurements", Oxford University Press PHI 2nd Edition, 2006, ISBN 81-203-2360-2.
Reference Books: 1. A. D. Helfrick and W.D. Cooper, "Modern Electronic Instrumentation and Measuring Techniques", Pearson, 1st Edition, 2015,ISBN:9789332556065. 2. A. K. Sawhney, "Electronics and Electrical Measurements", Dhanpat Rai & Sons. ISBN -81-7700-016-0

ENGINEERING ELECTROMAGNETICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III (EC/TC)

Subject Code	15EC36	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Study the different coordinate systems, Physical signifiance of Divergence, Curl and Gradient.
- Understand the applications of Coulomb's law and Gauss law to different charge distributions and the applications of Laplace's and Poisson's Equations to solve real time problems on capacitance of different charge distributions.
- Understand the physical significance of Biot-Savart's, Amperes's Law and Stokes' theorem for different current distributions.
- Infer the effects of magnetic forces, materials and inductance.
- Know the physical interpretation of Maxwell' equations and applications for Plane waves for their behaviour in different media
- Acquire knowledge of Poynting theorem and its application of power flow.

Modules	**RBT Level**
Module - 1	
Coulomb's Law, Electric Field Intensity and Flux density Experimental law of Coulomb, Electric field intensity, Field due to continuous volume charge distribution, Field of a line charge, Electric flux density.	**L1, L2, L3**
Module -2	
Gauss's law and Divergence Gauss' law, Divergence. Maxwell's First equation (Electrostatics), Vector Operator ▼ and divergence theorem. **Energy, Potential and Conductors** Energy expended in moving a point charge in an electric field, The line integral, Definition of potential difference and potential, The potential field of point charge, Current and Current density, Continuity of current.	**L1, L2, L3**
Module -3	
Poisson's and Laplace's Equations Derivation of Poisson's and Laplace's Equations, Uniqueness theorem, Examples of the solution of Laplace's equation. **Steady Magnetic Field** Biot-Savart Law, Ampere's circuital law, Curl, Stokes' theorem, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic Potentials.	**L1, L2, L3**
Module -4	

Magnetic Forces Force on a moving charge, differential current elements, Force between differential current elements. **Magnetic Materials** Magnetisation and permeability, Magnetic boundary conditions, Magnetic circuit, Potential Energy and forces on magnetic materials.	**L1, L2, L3**
Module -5	
Time-varying fields and Maxwell's equations Farday's law, displacement current, Maxwell's equations in point form, Maxwell's equations in integral form. **Uniform Plane Wave** Wave propagation in free space and good conductors. Poynting's theorem and wave power, Skin Effect.	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Evaluate problems on electric field due to point, linear, volume charges by applying conventional methods or by Gauss law.
- Determine potential and energy with respect to point charge and capacitance using Laplace equation.
- Calculate magnetic field, force, and potential energy with respect to magnetic materials.
- Apply Maxwell's equation for time varying fields, EM waves in free space and conductors.
- Evaluate power associated with EM waves using Poynting theorem.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consisting of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

W.H. Hayt and J.A. Buck, "Engineering Electromagnetics", 7th Edition, Tata McGraw-Hill, 2009, ISBN-978-0-07-061223-5.

Reference Books:

1. John Krauss and Daniel A Fleisch, " Electromagnetics with applications", McGraw-Hill.
2. N. Narayana Rao, "Fundamentals of Electromagnetics for Engineering", Pearson.

ANALOG ELECTRONICS LABORATORY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III (EC/TC)			
Laboratory Code	15ECL37	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
RBT Level	L1, L2, L3	Exam Hours	03
CREDITS – 02			

Course objectives: This laboratory course enables students to get practical experience in design, assembly, testing and evaluation of:

- Rectifiers and Voltage Regulators.
- BJT characteristics and Amplifiers.
- JFET Characteristics and Amplifiers.
- MOSFET Characteristics and Amplifiers
- Power Amplifiers.
- RC-Phase shift, Hartley, Colpitts and Crystal Oscillators.

NOTE: The experiments are to be carried using discrete components only.

Laboratory Experiments:

1. Design and set up the following rectifiers with and without filters and to determine ripple factor and rectifier efficiency:
   (a)Full Wave Rectifier (b) Bridge Rectifier
2. Conduct experiment to test diode clipping (single/double ended) and clamping circuits (positive/negative).
3. Conduct an experiment on Series Voltage Regulator using Zener diode and power transistor to determine line and load regulation characteristics.
4. Realize BJT Darlington Emitter follower with and without bootstrapping and determine the gain, input and output impedances.
5. Design and set up the BJT common emitter amplifier using voltage divider bias with and without feedback and determine the gain- bandwidth product from its frequency response.
6. Plot the transfer and drain characteristics of a JFET and calculate its drain resistance, mutual conductance and amplification factor.
7. Design, setup and plot the frequency response of Common Source JFET/MOSFET amplifier and obtain the bandwidth.

8. Plot the transfer and drain characteristics of n-channel MOSFET and calculate its parameters, namely; drain resistance, mutual conductance and amplification factor.
9. Set-up and study the working of complementary symmetry class B push pull power amplifier and calculate the efficiency.
10. Design and set-up the RC-Phase shift Oscillator using FET, and calculate the frequency of output waveform.
11. Design and set-up the following tuned oscillator circuits using BJT, and determine the frequency of oscillation. (a) Hartley Oscillator (b) Colpitts Oscillator
12. Design and set-up the crystal oscillator and determine the frequency of oscillation.
Course Outcomes: On the completion of this laboratory course, the students will be able to: • Test circuits of rectifiers, clipping circuits, clamping circuits and voltage regulators. • Determine the characteristics of BJT and FET amplifiers and plot its frequency response. • Compute the performance parameters of amplifiers and voltage regulators • Design and test the basic BJT/FET amplifiers, BJT Power amplifier and oscillators.
Conduct of Practical Examination: • All laboratory experiments are to be included for practical examination. • Students are allowed to pick one experiment from the lot. • Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. • Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

DIGITAL ELECTRONICS LABORATORY [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – III (EC/TC)**			
Laboratory Code	15ECL38	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Mark	80
RBT Level	L1, L2, L3	Exam Hour	03
CREDITS – 02			

Course objectives: This laboratory course enables students to get practical experience in design, realisation and verification of

- Demorgan's Theorem, SOP, POS forms
- Full/Parallel Adders, Subtractors and Magnitude Comparator
- Multiplexer using logic gates
- Demultiplexers and Decoders
- Flip-Flops, Shift registers and Counters

NOTE:

1. Use discrete components to test and verify the logic gates. The IC umbers given are suggestive. Any equivalent IC can be used.
2. For experiment No. 11 and 12 any open source or licensed simulation tool may be used.

Laboratory Experiments:

1. Verify
   (a) Demorgan's Theorem for 2 variables.
   (b) The sum-of product and product-of-sum expressions using universal gates.
2. Design and implement
   (a) Full Adder using basic logic gates.
   (b) Full subtractor using basic logic gates.
3. Design and implement 4-bit Parallel Adder/ subtractor using IC 7483.
4. Design and Implementation of 4-bit Magnitude Comparator using IC 7485.
5. Realize
   (a) 4:1 Multiplexer using gates.
   (b) 3-variable function using IC 74151(8:1MUX).
6. Realize 1:8 Demux and 3:8 Decoder using IC74138.
7. Realize the following flip-flops using NAND Gates.
   (a) Clocked SR Flip-Flop (b) JK Flip-Flop.
8. Realize the following shift registers using IC7474
   (a) SISO (b) SIPO (c) PISO (d) PIPO.
9. Realize the Ring Counter and Johnson Counter using IC7476.
10. Realize the Mod-N Counter using IC7490.

11. Simulate Full- Adder using simulation tool.
12. Simulate Mod-8 Synchronous UP/DOWN Counter using simulation tool.
Course outcomes: On the completion of this laboratory course, the students will be able to: • Demonstrate the truth table of various expressions and combinational circuits using logic gates. • Design and test various combinational circuits such as adders, subtractors, comparators, multiplexers and demultiplexers. • Construct and test flips-flops, counters and shift registers. • Simulate full adder and up/down counters.
Conduct of Practical Examination: • All laboratory experiments are to be included for practical examination. • Students are allowed to pick one experiment from the lot. • Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. • Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

B.E E&C FOURTH SEMESTER SYLLABUS

<table>
<tr><td colspan="4" align="center"><u>ENGINEERING MATHEMATICS-IV</u>
B.E., IV Semester, Common to all Branches
[As per Choice Based Credit System (CBCS) scheme]</td></tr>
<tr><td>Subject Code</td><td>15MAT41</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50 (10 Hours per Module)</td><td></td><td></td></tr>
<tr><td colspan="4" align="center">Credits – 04</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
Conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.</td></tr>
</table>

Modules	RBT Level
Module-1	
Numerical Methods: Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae).	L1, L3
Module-2	
Numerical Methods: Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne's method. **Special Functions:** Series solution-Frobenious method. Series solution of Bessel's differential equation leading to $J_n(x)$-Bessel's function of first kind. Basic properties and orthogonality. Series solution of Legendre's differential equation leading to $P_n(x)$-Legendre polynomials. Rodrigue's formula, problems.	L3
Module-3	
Complex Variables: Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula, Residue, poles, Cauchy's Residue theorem (without proof) and problems.	L1, L3,
Transformations: Conformal transformations, discussion of transformations: $w=z^2$, $w=e^z$, $w=z+(1/z)(z\neq 0)$ and bilinear transformations-problems.	L3
Module-4	
Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.	L3

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.	
Module-5	
Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.	L3
Stochastic process: Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems.	L1
Course Outcomes: On completion of this course, students are able to: • Solve first and second order ordinary differential equations arising in flow problems using single step and multistep numerical methods. • Understand the analyticity, potential fields, residues and poles of complex potentials in field theory and electromagnetic theory. • Describe conformal and bilinear transformation arising in aerofoil theory, fluid flow visualization and image processing. • Solve problems of quantum mechanics, hydrodynamics and heat conduction by employing Bessel's function relating to cylindrical polar coordinate systems and Legendre's polynomials relating to spherical polar coordinate systems. • Solve problems on probability distributions relating to digital signal processing, information theory and optimization concepts of stability of design and structural engineering. • Draw the validity of the hypothesis proposed for the given sampling distribution in accepting or rejecting the hypothesis. • Determine joint probability distributions and stochastic matrix connected with the multivariable correlation problems for feasible random events. • Define transition probability matrix of a Markov chain and solve problems related to discrete parameter random process.	
Question paper pattern: • The question paper will have ten questions. • Each full Question consisting of 16 marks • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: *1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.*	

2. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons,10th Ed., 2015.	
Reference Books: *1. N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers,7th Ed., 2010.* *2. B.V.Ramana: "Higher Engineering Mathematics" Tata McGraw-Hill, 2006.* *3. H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.*	
Web Link and Video Lectures: *1. http://nptel.ac.in/courses.php?disciplineID=111* **2.** *http://www.khanacademy.org/* **3.** *http://www.class-central.com/subject/math*	

ADDITIONAL MATHEMATICS - II

B.E., IV Semester, Common to all Branches

(A Bridge course for Lateral Entry students of IV Sem. B. E.)

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15MATDIP41	IA Marks	--
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)		

Credits – 00

Course Objectives: This course will enable students to:

- Understand essential concepts of linear algebra.
- Solve second and higher order differential equations.
- Understand Laplace and inverse Laplace transforms and elementary probability theory.

Modules	RBT Level
Module-1	
Linear Algebra: Introduction - rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and Eigen vectors of a square matrix. Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples.	**L1,L3**
Module-2	
Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators. Solutions of initial value problems. Method of undetermined coefficients and variation of parameters.	**L1,L3**
Module-3	
Laplace transforms: Laplace transforms of elementary functions. Transforms of derivatives and integrals, transforms of periodic function and unit step function-Problems only.	**L1,L2**
Module-4	
Inverse Laplace transforms: Definition of inverse Laplace transforms. Evaluation of Inverse transforms by standard methods. Application to solutions of Linear differential equations and simultaneous differential equations.	**L1,L2**
Module-5	
Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples. Bayes's theorem-examples.	**L1,L2**
Course Outcomes: On completion of this course, students are able to: • Solve systems of linear equations in the different areas of linear algebra. • Solve second and higher order differential equations occurring in of electrical circuits, damped/un-damped vibrations.	

• Describe Laplace transforms of standard and periodic functions. • Determine the general/complete solutions to linear ODE using inverse Laplace transforms. • Recall basic concepts of elementary probability theory and, solve problems related to the decision theory, synthesis and optimization of digital circuits.	
Question paper pattern: • The question paper will have ten questions. • Each full Question consisting of 16 marks • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.	
Text Book: *B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.*	
Reference Books: 1. *E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.* 2. *N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers,7th Ed., 2007.*	

MICROPROCESSORS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Subject Code	15EC42	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Familiarize basic architecture of 8086 microprocessor
- Program 8086 Microprocessor using Assembly Level Language
- Use Macros and Procedures in 8086 Programs
- Understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design
- Understand the architecture of 8088, 8087 Coprocessor and other CPU architectures

Modules	**RBT Level**
Module -1	
8086 PROCESSOR: Historical background (refer Reference Book 1), 8086 CPU Architecture (1.1 – 1.3 of Text). Addressing modes, Machine language instruction formats, Machine coding the program (2.2, 2.1, 3.2 of Text). **INSTRUCTION SET OF 8086:** Data transfer and arithmetic instructions. Control/Branch Instructions, Illustration of these instructions with example programs (2.3 of Text).	**L1, L2, L3**
Module -2	
Logical Instructions, String manipulation instructions, Flag manipulation and Processor control instructions, Illustration of these instructions with example programs. Assembler Directives and Operators, Assembly Language Programming and example programs (2.3, 2.4, 3.4 of Text).	**L1, L2, L3**
Module -3	
Stack and Interrupts: Introduction to stack, Stack structure of 8086, Programming for Stack. Interrupts and Interrupt Service routines, Interrupt cycle of 8086, NMI, INTR, Interrupt programming, Passing parameters to procedures, Macros, Timing and Delays. (Chap. 4 of Text).	**L1, L2, L3**
Module -4	

8086 Bus Configuration and Timings: Physical memory Organization, General Bus operation cycle, I/O addressing capability, Special processor activities, Minimum mode 8086 system and Timing diagrams, Maximum Mode 8086 system and Timing diagrams. (1.4 to 1.9 of Text). **Basic Peripherals and their Interfacing with 8086 (Part 1)**: Static RAM Interfacing with 8086 (5.1.1), Interfacing I/O ports, PIO 8255, Modes of operation – Mode-0 and BSR Mode, Interfacing Keyboard and 7-Segment digits using 8255 (Refer 5.3, 5.4, 5.5 of Text).	**L1, L2, L3**
Module 5	
Basic Peripherals and their Interfacing with 8086 (Part 2): Interfacing ADC-0808/0809, DAC-0800, Stepper Motor using 8255 (5.6.1, 5.7.2, 5.8). Timer 8254 – Mode 0, 1, 2 & 3 and Interfacing programmes for these modes (refer 6.1 of Text). **INT 21H DOS Function calls** - for handling Keyboard and Display (refer Appendix-B of Text). **Other Architectures:** Architecture of 8088 (refer 1.10 upto 1.10.1 of Text) and Architecture of NDP 8087 (refer 8.3.1, 8.3.5 of Text). Von-Neumann & Harvard CPU architecture and CISC & RISC CPU architecture (refer Reference Book 1).	**L1, L2, L3**

Course Outcomes: At the end of the course students will be able to:

- Explain the History of evaluation of Microprocessors, Architecture and instruction set of 8086, 8088, 8087, CISC & RISC, Von-Neumann & Harvard CPU Architecture, Configuration & Timing diagrams of 8086 and Instruction set of 8086.
- Write8086 Assembly level programs using the 8086 instruction set
- Write modular programs using procedures and macros.
- Write 8086 Stack and Interrupts programming
- Interface 8086 to Static memory chips and 8255, 8254, 0808 ADC, 0800 DAC, Keyboard, Display and Stepper motors.
- Use INT 21 DOS interrupt function calls to handle Keyboard and Display.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Advanced Microprocessors and Peripherals - A.K. Ray and K.M. Bhurchandi, TMH, 3rd Edition, 2012, ISBN 978-1-25-900613-5.

Reference Books:

1. **Microprocessor and Interfacing**- Douglas V Hall, SSSP Rao, 3rd edition TMH, 2012.
2. **Microcomputer systems-The 8086 / 8088 Family** – Y.C. Liu and A. Gibson, 2nd edition, PHI -2003.
3. **The 8086 Microprocessor: Programming & Interfacing the PC** – Kenneth J Ayala, CENGAGE Learning, 2011.
4. **The Intel Microprocessor, Architecture, Programming and Interfacing** - Barry B. Brey, 6e, Pearson Education / PHI, 2003.

<u>**CONTROL SYSTEMS**</u>

<u>[As per Choice Based Credit System (CBCS) scheme]</u>

SEMESTER – IV (EC/TC)

Subject Code	15EC43	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Understand the basic features, configurations and application of control systems.
- Understand various terminologies and definitions for the control systems.
- Learn how to find a mathematical model of electrical, mechanical and electro-mechanical systems.
- Know how to find time response from the transfer function.
- Find the transfer function via Masons' rule.
- Analyze the stability of a system from the transfer function.

Modules	**RBT Level**
Module -1	
Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.	**L1, L2, L3**
Module -2	
Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design).	**L1, L2, L3**
Module -3	
Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci.	**L1, L2, L3**
Module -4	

Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, (Systems with transportation lag excluded) Introduction to lead, lag and lead-lag compensating networks (excluding design).	**L1, L2, L3**
Module -5	
Introduction to Digital Control System: Introduction, Spectrum Analysis of Sampling process, Signal reconstruction, Difference equations. Introduction to State variable analysis: Introduction, Concept of State, State variables & State model, State model for Linear Continuous & Discrete time systems, Diaganolisation.	**L1, L2, L3**

Course Outcomes: At the end of the course, the students will be able to

- Develop the mathematical model of mechanical and electrical systems
- Develop transfer function for a given control system using block diagram reduction techniques and signal flow graph method
- Determine the time domain specifications for first and second order systems
- Determine the stability of a system in the time domain using Routh-Hurwitz criterion and Root-locus technique.
- Determine the stability of a system in the frequency domain using Nyquist and bode plots
- Develop a control system model in continuous and discrete time using state variable techniques

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

J.Nagarath and M.Gopal, " Control Systems Engineering", New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-7.

Reference Books:

1. "Modern Control Engineering," K.Ogata, Pearson Education Asia/PHI, 4th Edition, 2002. ISBN 978-81-203-4010-7.
2. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
3. "Feedback and Control System," Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.

SIGNALS AND SYSTEMS [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – IV (EC/TC)**			
Subject Code	15EC44	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the mathematical description of continuous and discrete time signals and systems.
- Analyze the signals in time domain using convolution difference/differential equations
- Classify signals into different categories based on their properties.
- Analyze Linear Time Invariant (LTI) systems in time and transform domains.
- Build basics for understanding of courses such as signal processing, control system and communication.

Modules	**RBT Level**
Module -1	
Introduction and Classification of signals: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. **Elementary signals/Functions:** Exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sync functions. **Operations on signals:** Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding. **Systems:** Definition, Classification: linear and non-linear, time variant and invariant, causal and non- causal, static and dynamic, stable and unstable, invertible.	**L1, L2, L3**
Module -2	
Time domain representation of LTI System: System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral and convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.	**L1, L2, L3**
Module -3	

System interconnection, system properties in terms of impulse response, step response in terms of impulse response (4 Hours). **Fourier Representation of Periodic Signals**: Introduction to CTFS and DTFS, definition, properties (No derivation) and basic problems (inverse Fourier series is excluded) (06 Hours).	**L1, L2, L3**
Module -4	
Fourier Representation of aperiodic Signals: **FT representation of aperiodic CT signals - FT,** definition, FT of standard CT signals, Properties and their significance (4 Hours). **FT representation of aperiodic discrete signals-DTFT**, definition, DTFT of standard discrete signals, Properties and their significance (4 Hours). **Impulse sampling and reconstruction:** Sampling theorem (only statement) and reconstruction of signals (2 Hours).	**L1, L2, L3**
Module -5	
Z-Transforms: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Transform analysis of LTI systems.	**L1, L2, L3**

Course Outcomes: At the end of the course, students will be able to:

- Classify the signals as continuous/discrete, periodic/aperiodic, even/odd, energy/power and deterministic/random signals.
- Determine the linearity, causality, time-invariance and stability properties of continuous and discrete time systems.
- Compute the response of a Continuous and Discrete LTI system using convolution integral and convolution sum.
- Determine the spectral characteristics of continuous and discrete time signal using Fourier analysis.
- Compute Z-transforms, inverse Z- transforms and transfer functions of complex LTI systems.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Simon Haykins and Barry Van Veen, “Signals and Systems”, 2nd Edition, 2008, WileyIndia. ISBN 9971-51-239-4.

Reference Books:

1. **Michael Roberts,** "Fundamentals of Signals & Systems", 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
2. **Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab,** "Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
3. **H. P Hsu, R. Ranjan,** "Signals and Systems", Scham's outlines, TMH, 2006.
4. **B. P. Lathi,** "Linear Systems and Signals", Oxford University Press, 2005.
5. **Ganesh Rao and Satish Tunga,** "Signals and Systems", Pearson/Sanguine Technical Publishers, 2004.

PRINCIPLES OF COMMUNICATION SYSTEMS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV (EC/TC)			
Subject Code	15EC45	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Design simple systems for generating and demodulating AM, DSB, SSB and VSB signals.
- Understand the concepts in Angle modulation for the design of communication systems.
- Design simple systems for generating and demodulating frequency modulated signals.
- Learn the concepts of random process and various types of noise.
- Evaluate the performance of the communication system in presence of noise.
- Analyze pulse modulation and sampling techniques.

Modules	RBT Level
Module – 1	
AMPLITUDE MODULATION: Introduction, Amplitude Modulation: Time & Frequency – Domain description, Switching modulator, Envelop detector. **DOUBLE SIDE BAND-SUPPRESSED CARRIER MODULATION:** Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing. **SINGLE SIDE–BAND AND VESTIGIAL SIDEBAND METHODS OF MODULATION:** SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television. (Chapter 3 of Text).	**L1, L2, L3**
Module – 2	
ANGLE MODULATION: Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase–Locked Loop: Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems. The Superheterodyne Receiver (refer Chapter 4 of Text).	**L1, L2, L3**
Module – 3	

RANDOM VARIABLES & PROCESS: Introduction, Probability, Conditional Probability, Random variables, Several Random Variables. Statistical Averages: Function of a random variable, Moments, Random Processes, Mean, Correlation and Covariance function: Properties of autocorrelation function, Cross–correlation functions (refer Chapter 5 of Text). **NOISE**: Shot Noise, Thermal noise, White Noise, Noise Equivalent Bandwidth (refer Chapter 5 of Text), Noise Figure (refer Section 6.7 of Text).	**L1, L2, L3**
Module – 4	
NOISE IN ANALOG MODULATION: Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasis in FM (refer Chapter 6 of Text).	**L1, L2, L3**
Module – 5	
DIGITAL REPRESENTATION OF ANALOG SIGNALS: Introduction, Why Digitize Analog Sources?, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, The Quantization Process, Quantization Noise, Pulse–Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing (refer Chapter 7 of Text), Application to Vocoder (refer Section 6.8 of Reference Book 1).	**L1, L2, L3**

Course Outcomes: At the end of the course, students will be able to:

- Determine the performance of analog modulation schemes in time and frequency domains.
- Determine the performance of systems for generation and detection of modulated analog signals.
- Characterize analog signals in time domain as random processes and in frequency domain using Fourier transforms.
- Characterize the influence of channel on analog modulated signals
- Determine the performance of analog communication systems.
- Understand the characteristics of pulse amplitude modulation, pulse position modulation and pulse code modulation systems.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Communication Systems, Simon Haykins & Moher, 5th Edition, John Willey, India Pvt. Ltd, 2010, ISBN 978 – 81 – 265 – 2151 – 7.

Reference Books:

1. **Modern Digital and Analog Communication Systems,** B. P. Lathi, Oxford University Press., 4th edition.
2. **An Introduction to Analog and Digital Communication**, Simon Haykins, John Wiley India Pvt. Ltd., 2008, ISBN 978–81–265–3653–5.
3. **Principles of Communication Systems**, H.Taub & D.L.Schilling, TMH, 2011.
4. **Communication Systems**, Harold P.E, Stern Samy and A.Mahmond, Pearson Edition, 2004.
5. **Communication Systems**: **Analog and Digital,** R.P.Singh and S.Sapre: TMH 2nd edition, 2007.

LINEAR INTEGRATED CIRCUITS [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – IV (EC/TC)**			
Subject Code	15EC46	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Define and describe various parameters of Op-Amp, its characteristics and specifications.
- Discuss the effects of Input and Output voltage ranges upon Op-Amp circuits.
- Sketch and Analyze Op-Amp circuits to determine Input Impedances, output Impedances and other performance parameters.
- Sketch and Explain typical Frequency Response graphs for each of the Filter circuits showing Butterworth and Chebyshev responses where ever appropriate.
- Describe and Sketch the various switching circuits of Op-Amps and analyze its operations.
- Differentiate between various types of DACs and ADCs and evaluate the performance of each with neat circuit diagrams and assuming suitable inputs.

Modules	**RBT Level**
Module -1	
Operational Amplifier Fundamentals: Basic Op-amp circuit, Op-Amp parameters – Input and output voltage, CMRR and PSRR, offset voltages and currents, Input and output impedances, Slew rate and Frequency limitations. **OP-Amps as DC Amplifiers** – Biasing OP-amps, Direct coupled voltage followers, Non-inverting amplifiers, inverting amplifiers, Summing amplifiers, and Difference amplifiers. Interpretation of OP-amp LM741 & TL081 datasheet.**(Text1)**	**L1, L2,L3**
Module -2	
Op-Amps as AC Amplifiers: Capacitor coupled voltage follower, High input impedance – Capacitor coupled voltage follower, Capacitor coupled non inverting amplifiers, High input impedance – Capacitor coupled Non inverting amplifiers, Capacitor coupled inverting amplifiers, setting the upper cut-off frequency, Capacitor coupled difference amplifier. **OP-Amp Applications:** Voltage sources, current sources and current sinks, current amplifiers, instrumentation amplifier, precision rectifiers.**(Text1)**	**L1, L2,L3**
Module-3	
More Applications : Limiting circuits, Clamping circuits, Peak detectors, Sample and hold circuits, V to I and I to V converters, Differentiating Circuit, Integrator Circuit, Phase shift oscillator, Wien bridge oscillator, Crossing detectors**,** inverting Schmitt trigger. **(Text 1)** Log and antilog amplifiers, Multiplier and divider. **(Text2)**	**L1, L2,L3**

Module -4	
Active Filters: First order and second order active Low-pass and high pass filters, Bandpass Filter, Bandstop Filter. **(Text 1)** **Voltage Regulators:** Introduction, Series Op-amp regulator, IC voltage regulators. 723 general purpose regulators. **(Text 2)**	**L1, L2,L3**
Module -5	
Phase locked loop: Basic Principles, Phase detector/comparator, VCO. **DAC and ADC convertor**: DAC using R-2R, ADC using Successive approximation. **Other IC Application:** 555 timer, Basic timer circuit, 555 timer used as astable and monostable multivibrator. **(Text 2)**	**L1, L2,L3**

Course Outcomes: After studying this course, students will be able to:

- Explain Op-Amp circuit and parameters including CMRR, PSRR, Input & Output Impedances and Slew Rate.
- Design Op-Amp based Inverting, Non-inverting, Summing & Difference Amplifier, and AC Amplifiers including Voltage Follower.
- Test circuits of Op-Amp based Voltage/ Current Sources & Sinks, Current, Instrumentation and Precision Amplifiers.
- Test circuits of Op-Amp based linear and non-linear circuits comprising of limiting, clamping, Sample & Hold, Differentiator/ Integrator Circuits, Peak Detectors, Oscillators and Multiplier & Divider.
- Design first & second order Low Pass, High Pass, Band Pass, Band Stop Filters and Voltage Regulators using Op-Amps.
- Explain applications of linear ICs in phase detector, VCO, DAC, ADC and Timer.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. "Operational Amplifiers and Linear IC's", David A. Bell, 2nd edition, PHI/Pearson, 2004. ISBN 978-81-203-2359-9.
2. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.

Reference Books:

1. Ramakant A Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson, 4th Ed, 2015. ISBN 81-7808-501-1.
2. B Somanathan Nair, “Linear Integrated Circuits: Analysis, Design & Applications,” Wiley India, 1st Edition, 2015.
3. James Cox, “Linear Electronics Circuits and Devices”, Cengage Learning, Indian Edition, 2008, ISBN-13: 978-07-668-3018-7.
4. Data Sheet: http://www.ti.com/lit/ds/symlink/tl081.pdf.

MICROPROCESSOR LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Laboratory Code	15ECL47	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
RBT Level	L1, L2, L3	Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to:

- Get familiarize with 8086 instructions and DOS 21H interrupts and function calls.
- Develop and test assembly language programs to use instructions of 8086.
- Get familiarize with interfacing of various peripheral devices with 8086 microprocessor for simple applications.

Laboratory Experiments:

1. Programs involving:

Data transfer instructions like:

i) Byte and word data transfer in different addressing Modes
ii) Block move (with and without overlap)
iii) Block interchange

2. Programs involving:

Arithmetic & logical operations like:

i) Addition and Subtraction of multi precision nos.
ii) Multiplication and Division of signed and unsigned Hexadecimal nos.
iii) ASCII adjustment instructions.
iv) Code conversions.

3. Programs involving:

Bit manipulation instructions like checking:

i) Whether given data is positive or negative
ii) Whether given data is odd or even
iii) Logical 1's and 0's in a given data
iv) 2 out 5 code
v) Bit wise and nibble wise palindrome

4. Programs involving:

Branch/ Loop instructions like

i) Arrays: addition/subtraction of N nos., Finding largest and smallest nos., Ascending and descending order.
ii) Two application programs using Procedures and Macros (Subroutines).

5. Programs involving

String manipulation like string transfer, string reversing, searching for a string.

6. Programs involving

Programs to use DOS interrupt INT 21h Function calls for Reading a Character from keyboard, Buffered Keyboard input, Display of character/ String on console.

7. Interfacing Experiments:

Experiments on interfacing 8086 with the following interfacing modules through DIO (Digital Input/Output - PCI bus compatible card / 8086 Trainer)

1. Matrix keyboard interfacing
2. Seven segment display interface
3. Logical controller interface
4. Stepper motor interface
5. ADC and DAC Interface (8 bit)
6. Light dependent resistor (LDR), Relay and Buzzer Interface to make light operated switches

Course Outcomes: On the completion of this laboratory course, the students will be able to:

- Write and execute 8086 assembly level programs to perform data transfer, arithmetic and logical operations.
- Understand assembler directives, branch, loop operations and DOS 21H Interrupts.
- Write and execute 8086 assembly level programs to sort and search elements in a given array.
- Perform string transfer, string reversing, searching a character in a string with string manipulation instructions of 8086.
- Utilize procedures and macros in programming 8086.
- Demonstrate the interfacing of 8086 with 7 segment display, matrix keyboard, logical controller, stepper motor, ADC, DAC, and LDR for simple applications.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, one question from software and one question from hardware interfacing to be set.
- Students are allowed to pick one experiment from the lot.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

LINEAR ICS AND COMMUNICATION LAB

As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV (EC/TC)

Laboratory Code	15ECL48	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
RBT Level	L1, L2, L3	Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to:

- Design, Demonstrate and Analyze instrumentation amplifier, filters, DAC, adder, differentiator and integrator circuits, using op-amp.
- Design, Demonstrate and Analyze multivibrators and oscillator circuits using Op-amp
- Design, Demonstrate and Analyze analog systems for AM, FM and Mixer operations.
- Design, Demonstrate and Analyze balance modulation and frequency synthesis.
- Demonstrate and Analyze pulse sampling and flat top sampling.

Laboratory Experiments:

1. Design an instrumentation amplifier of a differential mode gain of 'A' using three amplifiers.
2. Design of RC Phase shift and Wien's bridge oscillators using Op-amp.
3. Design active second order Butterworth low pass and high pass filters.
4. Design 4 bit R – 2R Op-Amp Digital to Analog Converter (i) using 4 bit binary input from toggle switches and (ii) by generating digital inputs using mod-16 counter.
5. Design Adder, Integrator and Differentiator using Op-Amp.
6. Design of Monostable and Astable Multivibrator using 555 Timer.
7. Demonstrate Pulse sampling, flat top sampling and reconstruction.
8. Amplitude modulation using transistor/FET (Generation and detection).
9. Frequency modulation using IC 8038/2206 and demodulation.
10. Design BJT/FET Mixer.
11. DSBSC generation using Balance Modulator IC 1496/1596.
12. Frequency synthesis using PLL.

Course Outcomes: This laboratory course enables students to:

- Illustrate the pulse and flat top sampling techniques using basic circuits.
- Demonstrate addition and integration using linear ICs, and 555 timer operations to generate signals/pulses.
- Demonstrate AM and FM operations and frequency synthesis.
- Design and illustrate the operation of instrumentation amplifier, LPF, HPF, DAC and oscillators using linear IC.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

B.E E&C FIFTH SEMESTER SYLLABUS

MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

B.E., V Semester, EC/TC/EI/BM/ML

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ES51	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours / Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable students to:

- Understand basic skills of Management
- Understand the need for Entrepreneurs and their skills
- Understand Project identification and Selection
- Identify the Management functions and Social responsibilities
- Distinguish between management and administration

Module-1	RBT Level
Management: Nature and Functions of Management – Importance, Definition, Management Functions, Levels of Management, Roles of Manager, Managerial Skills, Management & Administration, Management as a Science, Art & Profession (Selected topics of Chapter 1, Text 1). **Planning:** Planning-Nature, Importance, Types, Steps and Limitations of Planning; Decision Making – Meaning, Types and Steps in Decision Making(Selected topics from Chapters 4 & 5, Text 1).	L1, L2
Module-2	
Organizing and Staffing: Organization-Meaning, Characteristics, Process of Organizing, Principles of Organizing, Span of Management (meaning and importance only), Departmentalisation, Committees–Meaning, Types of Committees; Centralization Vs Decentralization of Authority and Responsibility; **Staffing**-Need and Importance**,** Recruitment and Selection Process (Selected topics from Chapters 7, 8 & 11,Text 1). **Directing and Controlling:** Meaning and Requirements of Effective Direction, Giving Orders; Motivation-Nature of Motivation, Motivation Theories (Maslow's Need-Hierarchy Theory and Herzberg's Two Factor Theory); Communication – Meaning, Importance and Purposes of Communication; Leadership-Meaning, Characteristics, Behavioural Approach of Leadership; Coordination-Meaning, Types, Techniques of Coordination; Controlling – Meaning, Need for Control System, Benefits of Control, Essentials of Effective Control System, Steps in Control Process (Selected topics from Chapters 15 to 18 and 9, Text 1).	L1, L2
Module-3	
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance (Selected topics from Chapter 3, Text 1).	L1, L2

Entrepreneurship: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship (Selected topics from Chapter 2, Text 2).	
Module-4	
Modern Small Business Enterprises: Role of Small Scale Industries, Impact of Globalization and WTO on SSIs, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Ancillary Industry and Tiny Industry (Definition only)(Selected topics from Chapter1, Text 2). **Institutional Support for Business Enterprises:** Introduction, Policies & Schemes of Central Level Institutions, State Level Institutions (Selected topics from Chapter 4, Text 2).	L1, L2
Module-5	
Projects Management: AProject. Search for a Business idea**:** Introduction, Choosing an Idea, Selection of product, The Adoption process, Product Innovation, Product Planning and Development Strategy, Product Planning and Development Process. Concepts of Projects and Classification**:** Introduction, Meaning of Projects, Characteristics of a Project, Project Levels, Project Classification, Aspects of a Project, The project Cycle, Features and Phases of Project management, Project Management Processes. Project Identification**:** Feasibility Report, Project Feasibility Analysis. Project Formulation**:** Meaning, Steps in Project formulation, Sequential Stages of Project Formulation, Project Evaluation. **Project Design and Network Analysis:** Introduction, Importance of Network Analysis, Origin of PERT and CPM, Network, Network Techniques, Need for Network Techniques, Steps in PERT, CPM, Advantages, Limitations and Differences. (Selected topics from Chapters 16 to 20 of Unit 3, Text 3).	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Understand the fundamental concepts of Management and Entrepreneurship
- Select a best Entrepreneurship model for the required domain of establishment
- Describe the functions of Managers, Entrepreneurs and their social responsibilities
- Compare various types of Entrepreneurs
- Analyze the Institutional support by various state and central government agencies

Question paper pattern

- The question paper will have TEN questions.
- Each full question carries 16 marks.
- There will be two full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Management – P.C Tripathi, P.N Reddy, McGraw Hill Education, 6th Edition, 2017. ISBN-13:978-93-5260-535-4.
2. Entrepreneurship Development Small Business Enterprises- Poornima M Charantimath, Pearson Education 2008, ISBN 978-81-7758-260-4.
3. Dynamics of Entrepreneurial Development and Management by Vasant Desai. HPH 2007, ISBN: 978-81-8488-801-2.

Reference Book:

Essentials of Management: An International, Innovation and Leadership perspective by Harold Koontz, Heinz Weihrich McGraw Hill Education, 10th Edition 2016. ISBN- 978-93-392-2286-4.

DIGITAL SIGNAL PROCESSING

B.E., V Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC52	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours / Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Understand the frequency domain sampling and reconstruction of discrete time signals.
- Study the properties and the development of efficient algorithms for the computation of DFT.
- Realization of FIR and IIR filters in different structural forms.
- Learn the procedures to design of IIR filters from the analog filters using impulse invariance and bilinear transformation.
- Study the different windows used in the design of FIR filters and design appropriate filters based on the specifications.

Modules

Module-1	**RBT Level**
Discrete Fourier Transforms (DFT): Frequency domain sampling and reconstruction of discrete time signals. DFT as a linear transformation, its relationship with other transforms. Properties of DFT, multiplication of two DFTs- the circular convolution.	L1, L2
Module-2	
Additional DFT properties, use of DFT in linear filtering, overlap-save and overlap-add method. Fast-Fourier-Transform (FFT) algorithms: Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms).	L1, L2, L3
Module-3	
Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and decimation-in-frequency algorithms. Goertzel algorithm, and chirp-z transform.	L1, L2, L3
Module-4	
Structure for IIR Systems: Direct form, Cascade form, Parallel form structures. IIR filter design: Characteristics of commonly used analog filter – Butterworth and Chebyshev filters, analog to analog frequency transformations. Design of IIR Filters from analog filter using Butterworth filter: Impulse invariance, Bilinear transformation.	L1, L2, L3
Module-5	
Structure for FIR Systems: Direct form, Linear Phase, Frequency sampling	L1, L2,

structure, Lattice structure. FIR filter design: Introduction to FIR filters, design of FIR filters using - Rectangular, Hamming, Hanning and Bartlett windows.	L3

Course Outcomes: After studying this course, students will be able to:

- Determine response of LTI systems using time domain and DFT techniques.
- Compute DFT of real and complex discrete time signals.
- Computation of DFT using FFT algorithms and linear filtering approach.
- Solve problems on digital filter design and realize using digital computations.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Digital signal processing – Principles Algorithms & Applications, Proakis & Monalakis, Pearson education, 4th Edition, New Delhi, 2007.

Reference Books:

1. Discrete Time Signal Processing, Oppenheim & Schaffer, PHI, 2003.
2. Digital Signal Processing, S. K. Mitra, Tata Mc-Graw Hill, 3rd Edition, 2010.
3. Digital Signal Processing, Lee Tan: Elsevier publications, 2007.

Verilog HDL

B.E., V Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC53	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours / Module)	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to:

- Differentiate between Verilog and VHDL descriptions.
- Learn different Verilog HDL and VHDL constructs.
- Familiarize the different levels of abstraction in Verilog.
- Understand Verilog Tasks and Directives.
- Understand timing and delay Simulation.
- Learn VHDL at design levels of data flow, behavioral and structural for effective modeling of digital circuits.

Module-1	RBT Level
Overview of Digital Design with Verilog HDL Evolution of CAD, emergence of HDLs, typical HDL-flow, why Verilog HDL?, trends in HDLs. (Text1) **Hierarchical Modeling Concepts** Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block. (Text1)	L1, L2, L3
Module-2	
Basic Concepts Lexical conventions, data types, system tasks, compiler directives. (Text1) **Modules and Ports** Module definition, port declaration, connecting ports, hierarchical name referencing. (Text1)	L1, L2, L3
Module-3	
Gate-Level Modeling Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. (Text1) **Dataflow Modeling** Continuous assignments, delay specification, expressions, operators, operands, operator types. (Text1)	L1, L2, L3
Module-4	
Behavioral Modeling Structured procedures, initial and always, blocking and non-blocking	L1, L2, L3

statements, delay control, generate statement, event control, conditional statements, Multiway branching, loops, sequential and parallel blocks. (Text1)	
Module-5	
Introduction to VHDL **Introduction:** Why use VHDL?, Shortcomings, Using VHDL for Design Synthesis, Design tool flow, Font conventions. **Entities and Architectures:** Introduction, A simple design, Design entities, Identifiers, Data objects, Data types, and Attributes. (Text 2)	L1, L2, L3

Course Outcomes: At the end of this course, students should be able to

- Write Verilog programs in gate, dataflow (RTL), behavioral and switch modeling levels of Abstraction.
- Write simple programs in VHDL in different styles.
- Design and verify the functionality of digital circuit/system using test benches.
- Identify the suitable Abstraction level for a particular digital design.
- Write the programs more effectively using Verilog tasks and directives.
- Perform timing and delay Simulation.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Books:

1. Samir Palnitkar, "**Verilog HDL: A Guide to Digital Design and Synthesis"**, Pearson Education, Second Edition.
2. Kevin Skahill, "**VHDL for Programmable Logic**", PHI/Pearson education, 2006.

Reference Books:

1. Donald E. Thomas, Philip R. Moorby, "The Verilog Hardware Description Language", Springer Science+Business Media, LLC, Fifth edition.
2. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition.
3. Padmanabhan, Tripura Sundari, "Design through Verilog HDL", Wiley, 2016 or earlier.

INFORMATION THEORY AND CODING

B.E., V Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC54	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours / Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable students to:

- Understand the concept of Entropy, Rate of information and order of the source with reference to dependent and independent source.
- Study various source encoding algorithms.
- Model discrete & continuous communication channels.
- Study various error control coding algorithms.

Modules

Module-1	RBT Level
Information Theory: Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources (Section 4.1, 4.2 of Text 1).	L1, L2, L3
Module-2	
Source Coding: Source coding theorem, Prefix Codes, Kraft McMillan Inequality property – KMI (Section 2.2 of Text 2). Encoding of the Source Output, Shannon's Encoding Algorithm (Sections 4.3, 4.3.1 of Text 1). Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding, Arithmetic Coding, Lempel – Ziv Algorithm (Sections 3.6, 3.7, 3.8, 3.10 of Text 3).	L1, L2, L3
Module-3	
Information Channels: Communication Channels (Section 4.4 of Text 1). Channel Models, Channel Matrix, Joint probabilty Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity, Channel Capacity of : Binary Symmetric Channel, Binary Erasure Channel, Muroga,s Theorem, Contineuos Channels (Sections 4.2, 4.3, 4.4, 4.6, 4.7 of Text 3).	L1, L2, L3
Module-4	

Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error Correcting hamming Codes, Table lookup Decoding using Standard Array. **Binary Cyclic Codes:** Algebraic Structure of Cyclic Codes, Encoding using an (n-k) Bit Shift register, Syndrome Calculation, Error Detection and Correction (Sections 9.1, 9.2, 9.3, 9.3.1, 9.3.2, 9.3.3 of Text 1).	L1, L2, L3
Module-5	
Some Important Cyclic Codes: Golay Codes, BCH Codes(Section 8.4 – Article 5 of Text 2). **Convolution Codes**: Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram, The Viterbi Algorithm) (Section 8.5 – Articles 1,2 and 3, 8.6- Article 1 of Text 2).	L1, L2, L3

Course Outcomes: At the end of the course the students will be able to:

- Explain concept of Dependent & Independent Source, measure of information, Entropy, Rate of Information and Order of a source
- Represent the information using Shannon Encoding, Shannon Fano, Prefix and Huffman Encoding Algorithms
- Model the continuous and discrete communication channels using input, output and joint probabilities
- Determine a codeword comprising of the check bits computed using Linear Block codes, cyclic codes & convolutional codes
- Design the encoding and decoding circuits for Linear Block codes, cyclic codes, convolutional codes, BCH and Golay codes.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Books:

1. Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996.
2. Digital communication, Simon Haykin, John Wiley India Pvt. Ltd, 2008.
3. Information Theory and Coding, Muralidhar Kulkarni, K.S. Shivaprakasha, Wiley India Pvt. Ltd, 2015, ISBN:978-81-265-5305-1.

Reference Books:

1. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007
2. Principles of digital communication, J. Das, S. K. Mullick, P. K. Chatterjee, Wiley, 1986 - Technology & Engineering

3. Digital Communications – Fundamentals and Applications, Bernard Sklar, Second Edition, Pearson Education, 2016, ISBN: 9780134724058.
4. Information Theory and Coding, K.N.Haribhat, D.Ganesh Rao, Cengage Learning, 2017.

NANOELECTRONICS

B.E., V Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC551	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course Objectives: This course will enable students to:

- Enhance basic engineering science and technical knowledge of nanoelectronics.
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Know various nanostructures of carbon and the nature of the carbon bond itself.
- Learn the photo physical properties of sensor used in generating a signal.

Module-1	**RBT Level**
Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moore's law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometerlength scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).	L1, L2
Module-2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques (Text 1). **Inorganic semiconductor nanostructures:** overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text 1).	L1, L2
Module-3	
Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques.(Text 1). **Physical processes:** modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intraband absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical	L1, L2

electrical and structural (Text 1).	
Module-4	
Carbon Nanostructures: Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes. (Text 2)	L1, L2
Module-5	
Nanosensors: Introduction, What is Sensor and Nanosensors?, What makes them Possible?, Order From Chaos, Characterization, Perception, Nanosensors Based On Quantum Size Effects, Electrochemical Sensors, Sensors Based On Physical Properties, Nanobiosensors, Smart dust Sensor for the future. (Text 3) **Applications:** Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text 1).	L1, L2
Course outcomes: After studying this course, students will be able to: • Know the principles behind Nanoscience engineering and Nanoelectronics. • Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials. • Know the properties of carbon and carbon nanotubes and its applications. • Know the properties used for sensing and the use of smart dust sensors. • Apply the knowledge to prepare and characterize nanomaterials. • Analyse the process flow required to fabricate state-of-the-art transistor technology.	

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
2. Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011.
3. T Pradeep, "Nano: The essentials-Understanding Nanoscience and Nanotechnology", TMH.

Reference Book:

Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, "Hand Book of Nanoscience Engineering and Technology", CRC press, 2003.

SWITCHING & FINITE AUTOMATA THEORY

B.E., V Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC552	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course Objectives: This course will enable students to:

1. Understand the basics of threshold logic, effect of hazards on digital circuits and techniques of fault detection
2. Explain finite state model and minimization techniques
3. Know structure of sequential machines, and state identification
4. Understand the concept of fault detection experiments

Modules

Module-1	RBT Level
Threshold Logic: Introductory Concepts: Threshold element, capabilities and limitations of threshold logic, Elementary Properties, Synthesis of Threshold networks: Unate functions, Identification and realization of threshold functions, The map as a tool in synthesizing threshold networks. (Sections 7.1, 7.2 of Text)	L1, L2, L3
Module-2	
Reliable Design and Fault Diagnosis: Hazards, static hazards, Design of Hazard-free Switching Circuits, Fault detection in combinational circuits, Fault detection in combinational circuits: The faults, The Fault Table, Covering the fault table, Fault location experiments: Preset experiments, Adaptive experiments, Boolean differences, Fault detection by path sensitizing. (Sections 8.1, 8.2, 8.3, 8.4, 8.5 of Text)	L1, L2, L3
Module-3	
Sequential Machines: Capabilities, Minimization and Transformation The Finite state model and definitions, capabilities and limitations of finite state machines, State equivalence and machine minimization: k-equivalence, The minimization Procedure, Machine equivalence, Simplification of incompletely specified machines. (Section 10.1, 10.2, 10.3, 10.4 of Text)	L1, L2, L3
Module-4	
Structure of Sequential Machines: Introductory example, State assignment using partitions: closed partitions, The lattice of closed partitions, Reduction of output dependency, Input dependence and autonomous clocks, Covers and generation of closed partitions by state splitting: Covers, The implication graph, An application of state splitting to parallel decomposition. (Section 12.1, 12.2, 12.3, 12.4, 12.5, 12.6 of Text)	L1, L2, L3
Module-5	
State–Identification and Fault Detection Experiments: Experiments, Homing experiments, Distinguishing experiments, Machine identification,	L1, L2, L3

Fault detection experiments, Design of diagnosable machines, Second algorithm for the design of fault detection experiments. (Sections 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7 of Text)	

Course outcomes: At the end of the course, students should be able to:

- Explain the concept of threshold logic
- Understand the effect of hazards on digital circuits and fault detection and analysis
- Define the concepts of finite state model
- Analyze the structure of sequential machine
- Explain methods of state identification and fault detection experiments

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Book:

Switching and Finite Automata Theory – Zvi Kohavi, McGraw Hill, 2nd edition, 2010 ISBN: 0070993874.

Reference Books:

1. **Fault Tolerant And Fault Testable Hardware Design**-Parag K Lala, Prentice Hall Inc. 1985.
2. **Digital Circuits and Logic Design**.-Charles Roth Jr, Larry L. Kinney, Cengage Learning, 2014, ISBN: 978-1-133-62847-7.

OPERATING SYSTEM

B.E., V Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC553	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to:

- Understand the services provided by an operating system.
- Understand how processes are synchronized and scheduled.
- Understand different approaches of memory management and virtual memory management.
- Understand the structure and organization of the file system
- Understand interprocess communication and deadlock situations.

Module-1	RBT Level
Introduction to Operating Systems OS, Goals of an OS, Operation of an OS, Computational Structures, Resource allocation techniques, Efficiency, System Performance and User Convenience, Classes operating System, Batch processing, Multi programming, Time Sharing Systems, Real Time and distributed Operating Systems (Topics from Sections 1.2, 1.3, 2.2 to 2.8 of Text).	L1, L2
Module-2	
Process Management: OS View of Processes, PCB, Fundamental State Transitions, Threads, Kernel and User level Threads, Non-preemptive scheduling- FCFS and SRN, Preemptive Scheduling- RR and LCN, Long term, medium term and short term scheduling in a time sharing system (Topics from Sections 3.3, 3.3.1 to 3.3.4, 3.4, 3.4.1, 3.4.2 , 4.2, 4.3, 4.4.1 of Text).	L1, L2
Module-3	
Memory Management: Contiguous Memory allocation, Non-Contiguos Memory Allocation, Paging, Segmentation, Segmentation with paging, Virtual Memory Management, Demand Paging, Paging Hardware, VM handler, FIFO, LRU page replacement policies (Topics from Sections 5.5 to 5.9, 6.1 to 6.3, except Optimal policy and 6.3.1of Text).	L1, L2
Module-4	
File Systems: File systems and IOCS, File Operations, File Organizations, Directory structures, File Protection, Interface between File system and IOCS, Allocation of disk space, Implementing file access (Topics from Sections 7.1 to 7.8 of Text).	L1, L2, L3
Module-5	
Message Passing and Deadlocks: Overview of Message Passing, Implementing message passing, Mailboxes, Deadlocks, Deadlocks in resource allocation, Resource state modelling, Deadlock detection algorithm, Deadlock Prevention (Topics from Sections 10.1 to 10.3, 11.1 to	L1, L2, L3

11.5 of Text).	

Course outcomes: After studying this course, students will be able to:

- Explain the goals, structure, operation and types of operating systems.
- Apply scheduling techniques to find performance factors.
- Explain organization of file systems and IOCS.
- Apply suitable techniques for contiguous and non-contiguous memory allocation.
- Describe message passing, deadlock detection and prevention methods.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Book:

Operating Systems – A concept based approach, by Dhamdare, TMH, 2nd edition.

Reference Books:

1. Operating systems concepts, Silberschatz and Galvin, John Wiley India Pvt. Ltd, 5th edition,2001.
2. Operating system–internals and design system, William Stalling, Pearson Education, 4th ed, 2006.
3. Design of operating systems, Tannanbhaum, TMH, 2001.

ELECTRICAL ENGINEERING MATERIALS

B.E., V Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC554	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours/Module)	Exam Hours	03

CREDITS – 03

Course Objectives: This course will enable students to:

- Understand the formation of bands in materials and the classification of materials on the basis of band theory
- Understand the classification of magnetic materials on the basis of their behavior in an external magnetizing field.
- Understand the characteristics and properties of conducting and superconducting materials
- Understand the electrical characteristics of the material to be considered on the basis of their uses.
- Classify electrical engineering materials into low and high resistance materials

Modules

Module-1	RBT Level
Band Theory of Solids: Introduction to free electron theory, Kroning-Penney Model, Explanation for Discontinuities in E vs. K curve, Formation of Solid Material, Formation of Band in Metals, Formation of Bands in Semiconductors and Insulating Materials, Classification of Materials on the Basis of Band Structure, Explanation for differences in the Electrical properties of different Materials. Important Characteristics of a Band Electron, Number of energy states per band, Explanation for Insulating and Metallic Behavior of Materials, Concept of Hole.	L1, L2
Module-2	
Magnetic Properties of Materials: Introduction, Origin of Magnetism, Basic Terms in Magnetism, Relation between Magnetic Permeability and Susceptibility, Classification of magnetic Materials, Characteristics of Diamagnetic Materials, Paramagnetic Materials, Ferromagnetic Materials, Ferrimagnetic Materials, Langevin's Theory of Diamagnetism, Explanation of Dia, Para and Ferromagnetism, Ampere's Lam in Dia, Para and Ferromagnetism, Hystersis and Hystersis loss, Langevin's Theory of paramagnetism, Modification in the Langevin's Theory, Anti-Ferromagnetism and Neel Temperature, Ferrimagnetic Materials, Properties of some important Magnetic Materials, Magentostriction and Magnetostrictive Materials, Hard and Soft Ferromagnetic Materials and their Applications.	L1, L2
Module-3	
Behavior of Dielectric Materials in AC and DC Fields: Introduction, Classification of Dielectric Materials at Microscopic level, Polar Dielectric Materials, Non-polar Dielectric Materials, Kinds of Polarizations, behavior of	L1, L2

dielectric materials, Three electric Vectors, Gauss's Law in a Dielectric, Electric Susceptibility and Static Dielectric constant, Effect of Dielectric medium upon capacitance, macroscopic electric field, Microscopic Electric field, temperature dependence of dielectric constant, polar dielectric in ac and dc fields, behavior of polar dielectric at high frequencies, Dielectric loss, Dielectric strength and Dielectric Breakdown, Various kinds of Dielectric Materials, Hysteresis in Ferroelectric Materials, Applications of Ferroelectric Materials in Devices.	
Module-4	
Conductivity of Metals and Superconductivity: Introduction, Ohm's law, Explanation for the dependence of electrical resistivity upon temperature, Free-electron theory of metals, Application of Lorentz-Drude free-electron theory, Effect of various parameters on Electrical Conductivity, Resistivity Ratio, Variation of resistivity of alloys with temperature, Thermal Conductivity of Materials, Heat produced in Current Carrying Conductor, Thermoelectric Effect, Thermoelectric Series, Seebeck's Experiment. Discovery of superconductivity, superconductivity and transition temperature, superconducting materials, explanation of superconductivity phenomenon, characteristics of superconductors, change in thermodynamic parameters in superconducting state, frequency dependence of superconductivity, current status of high temperature superconductors, practical applications of superconductors.	L1, L2
Module-5	
Electrical Conducting and Insulating materials: Introduction, Classification of conducting materials, difference in properties of Hard-Drawn and Annealed copper, standard conductors, comparison between some popular Low-Resistivity Materials, Low-Resistivity Copper Alloys, Electrical contact materials and their selection, classification of contact materials, Materials for Lamp Filaments, Preparation of Tungsten Filaments. Insulating gases, Liquids and solids and their characteristics, Selection of the insulating material, other important properties of Insulating materials, Thermal characteristics, chemical properties of Insulating materials, classification of Insulating materials on the basis of structure.	L1, L2

Course Outcomes: At the end of the course, students will be able to

- Understand the various kinds of materials and their applications in ac and dc fields.
- Understand the conductivity of superconductivity of materials.
- Explain the electrical properties of different materials and metallic behavior of materials on the basis of band theory.
- Explain the properties and applications of all kind of magnetic materials.
- Explain the properties of electrical conducting and insulating materials.
- Assess a variety of approaches in developing new materials with enhanced performance to replace existing materials.

Question paper pattern:

- The question paper will have ten questions

- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Book:

R K Shukla and Archana Singh, "Electrical Engineering Materials" McGraw Hill, 2012, ISBN: 978-1-25-90062-03.

Reference Books:

1. S.O. KASAP, "Electronic Materials and Devices" 3rd edition, McGraw Hill, 2014, ISBN-978-0-07-064820-3.
2. C.S.Indulkar and S. Thiruvengadam, S., "An Introduction to Electrical Engineering Materials", ISBN-9788121906661.

MSP430 MICROCONTROLLER

B.E., V Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC555	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the architectural features and instruction set of 16 bit microcontroller MSP430.
- Program MSP430 using the various instructions for different applications.
- Understand the functions of the various peripherals which are interfaced with MSP430.
- Describe the power saving modes in MSP430.
- Explain the low power applications using MSP430.

Module-1	RBT Level
MSP430 Architecture: Introduction –Where does the MSP430 fit, The outside view, The inside view-Functional block diagram, Memory, Central Processing Unit, Memory Mapped Input and Output, Clock Generator, Exceptions: Interrupts and Resets, MSP430 family. (Text: Ch1- 1.3 to 1.7, Ch2- 2.1 to 2.7, Ch5- 5.1, 5.7 up to 5.7.1)	L1, L2
Module-2	
Addressing Modes & Instruction Set-Addressing Modes, Instruction set**,** Constant Generator and Emulated Instructions, Program Examples. (Text: Ch5- 5.2 to 5.5)	L1, L2, L3
Module-3	
Clock System, Interrupts and Operating Modes-Clock System, Interrupts, What happens when an interrupted is requested, Interrupt Service Routines, Low Power Modes of Operation, Watchdog Timer, Basic Timer1, Real Time Clock, Timer-A: Timer Block, Capture/Compare Channels, Interrupts from Timer-A. (Text: Ch5 - 5.8 upto 5.8.4, Ch 6-6.6 to 6.8, 6.10, Ch8 -8.1, 8.2, 8.3)	L1, L2
Module-4	
Analog Input-Output and PWM - Comparator-A, ADC10, ADC12, Sigma-Delta ADC, Internal Operational Amplifiers, DAC, Edge Aligned PWM, Simple PWM, Design of PWM. LCD interfacing. (Text: Ch9 – 9.1 up to 9.1.2, 9.4, 9.5 up to 9.5.1, 9.7, 9.8 up to 9.8.1, 9.11.5, 9.12 (without 9.12.1), 8.6.2 to 8.6.4)	L1, L2
Module-5	

Digital Input-Output and Serial Communication: Parallel Ports, Lighting LEDs, Flashing LEDs, Read Input from a Switch, Toggle the LED state by pressing the push button, LCD interfacing. Asynchronous Serial Communication, Asynchronous Communication with USCI_A, Communications, Peripherals in MSP430, Serial Peripheral Interface. (Text: Selected topics from Ch4 & Ch7 and Ch7- 7.1, Ch10 – 10.1, 10.2, and 10.12)	L1, L2, L3
Course outcomes: After studying this course, students will be able to: • Understand the architectural features and instruction set of 16 bit microcontroller MSP430. • Develop programs using the various instructions of MSP430 for different applications. • Understand the functions of the various peripherals which are interfaced with MSP430 microcontroller. • Describe the power saving modes in MSP430. • Explain the low power applications using MSP430 microcontroller.	

Evaluation of Internal Assessment Marks:

It is suggested that at least a few simple programs to be executed by students using any evaluation board of MSP430 for better understanding of the course. This activity can be considered for the evaluation of 5 marks out of 20 Internal assessment marks, reserved for the other activities.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Book:

John H Davies, MSP430 Microcontroller Basics, Newnes Publications, Elsevier, 2008.

References:

1. Chris Nagy, Embedded Systems Design using TI MSP430 Series, Newnes Publications, Elsevier, 2003.
2. User Guide from Texas Instruments.

DSP Lab

B.E., V Semester, EC/TC

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ECL57	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory=03	Exam Marks	80
RBT Levels	L1, L2, L3	Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to

- Simulate discrete time signals and verification of sampling theorem.
- Compute the DFT for a discrete signal and verification of its properties using MATLAB.
- Find solution to the difference equations and computation of convolution and correlation along with the verification of properties.
- Compute and display the filtering operations and compare with the theoretical values.
- Implement the DSP computations on DSP hardware and verify the result.

Laboratory Experiments

Following Experiments to be done using MATLAB / SCILAB / OCTAVE or equivalent:

1. Verification of sampling theorem.
2. Linear and circular convolution of two given sequences, Commutative, distributive and associative property of convolution.
3. Auto and cross correlation of two sequences and verification of their properties
4. Solving a given difference equation.
5. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum (using DFT equation and verify it by built-in routine).
6. (i) Verification of DFT properties (like Linearity and Parseval's theorem, etc.)
   (ii) DFT computation of square pulse and Sinc function etc.
7. Design and implementation of FIR filter to meet given specifications (using different window techniques).
8. Design and implementation of IIR filter to meet given specifications.

Following Experiments to be done using DSP kit

9. Linear convolution of two sequences
10. Circular convolution of two sequences
11. N-point DFT of a given sequence
12. Impulse response of first order and second order system
13. Implementation of FIR filter

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Understand the concepts of analog to digital conversion of signals and frequency domain sampling of signals.

- Modelling of discrete time signals and systems and verification of its properties and results.
- Implementation of discrete computations using DSP processor and verify the results.
- Realize the digital filters using a simulation tool and a DSP processor and verify the frequency and phase response.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
3. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

HDL Lab

B.E., V Semester, EC/TC

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ECL58	IA Marks	20
Number of Lecture Hours/Week	01 Hr Tutorial (Instructions) + 02 Hours Laboratory = 03	Exam Marks	80
RBT Levels	L1, L2, L3	Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to:

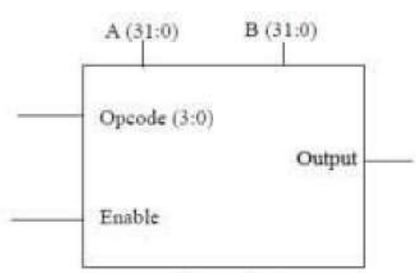
- Familiarize with the CAD tool to write HDL programs.
- Understand simulation and synthesis of digital design.
- Program FPGAs/CPLDs to synthesise the digital designs.
- Interface hardware to programmable ICs through I/O ports.
- Choose either Verilog or VHDL for a given Abstraction level.

Note: Programming can be done using any compiler. Download the programs on a FPGA/CPLD boards such as Apex/Acex/Max/Spartan/Sinfi or equivalent and performance testing may be done using 32 channel pattern generator and logic analyzer apart from verification by simulation with tools such as Altera/Modelsim or equivalent.

Laboratory Experiments

Part–A: PROGRAMMING

1. Write Verilog code to realize all the logic gates
2. Write a Verilog program for the following combinational designs
   a. 2 to 4 decoder
   b. 8 to 3 (encoder without priority & with priority)
   c. 8 to 1 multiplexer.
   d. 4 bit binary to gray converter
   e. Multiplexer, de-multiplexer, comparator.
3. Write a VHDL and Verilog code to describe the functions of a Full Adder using three modeling styles.
4. Write a Verilog code to model 32 bit ALU using the schematic diagram shown below



- ALU should use combinational logic to calculate an output based on the four bit op-code input.
- ALU should pass the result to the out bus when enable line in high, and tri-state the out bus when the enable line is low.

- ALU should decode the 4 bit op-code according to the example given below.

OPCODE	ALU Operation
1.	A+B
2.	A-B
3.	A Complement
4.	A*B
5.	A AND B
6.	A OR B
7.	A NAND B
8.	A XOR B

5. Develop the Verilog code for the following flip-flops, SR, D, JK and T.
6. Design a 4 bit binary, BCD counters (Synchronous reset and Asynchronous reset) and "any sequence" counters, using Verilog code.

Part–B: INTERFACING (at least four of the following must be covered using VHDL/Verilog)

1. Write HDL code to display messages on an alpha numeric LCD display.
2. Write HDL code to interface Hex key pad and display the key code on seven segment display.
3. Write HDL code to control speed, direction of DC and Stepper motor.
4. Write HDL code to accept Analog signal, Temperature sensor and display the data on LCD or Seven segment display.
5. Write HDL code to generate different waveforms (Sine, Square, Triangle, Ramp etc.,) using DAC - change the frequency.
6. Write HDL code to simulate Elevator operation.

Course Outcomes: At the end of this course, students should be able to:

- Write the Verilog/VHDL programs to simulate Combinational circuits in Dataflow, Behavioral and Gate level Abstractions.
- Describe sequential circuits like flip flops and counters in Behavioral description and obtain simulation waveforms.
- Synthesize Combinational and Sequential circuits on programmable ICs and test the hardware.
- Interface the hardware to the programmable chips and obtain the required output.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
3. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

5th Semester Open Electives Syllabus for the Courses offered by EC/TC Board

Automotive Electronics
B.E V Semester (Open Elective)
[As per Choice Based Credit System (CBCS) scheme

Subject Code	15EC561	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40(08 Hrs per Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the basics of automobile dynamics and design electronics to complement those features.
- Design and implement the electronics that attribute the reliability, safety, and smartness to the automobiles, providing add-on comforts.

Module-1	RBT Level
Automotive Fundamentals Overview – Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System (Text 1: Chapter1), Starter Battery –Operating principle: (Text 2: Pg. 407-410) (4 hours) **The Basics of Electronic Engine Control –** Motivation for Electronic Engine Control – Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition. (Text 1: Chapter 5) (4 hours)	L1, L2
Module-2	

Automotive Control System applications of Sensors and Actuators – Typical Electronic Engine Control System, Variables to be measured (Text 1: Chapter 6) (1 hour) **Automotive Sensors** – Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O2/EGO) Lambda Sensors, Piezoelectric Knock Sensor. (Text 1: Chapter 6) (5 hours) **Automotive Actuators –** Solenoid, Fuel Injector, EGR Actuator, Ignition System (Text 1: Chapter 6) (2 hours)	L1, L2
Module-3	
Digital Engine Control Systems – Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control - Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System - Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics. (Text 1: Chapter 7) (6 hours) **Control Units –** Operating conditions, Design, Data processing, Programming, Digital modules in the Control unit, Control unit software. (Text 2: Pg. 196-207) (2 hours)	L1, L2
Module-4	
Automotive Networking –Bus Systems – Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles (Text 2: Pg. 85-91), Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces. (Text 2: Pg. 92-151) (6 hours) **Vehicle Motion Control** – Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS) (Text 1: Chapter 8) (2 hours)	L1, L2
Module-5	
Automotive Diagnostics–Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems. (Text 1: Chapter 10) (2 hours) **Future Automotive Electronic Systems** – Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation – Navigation Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving Control (Text 1: Chapter 11) (6 hours)	L1, L2, L3

Course Outcomes: At the end of the course, students will be able to:

- Acquire an overview of automotive components, subsystems, and basics of Electronic Engine Control in today's automotive industry.
- Use available automotive sensors and actuators while interfacing with microcontrollers / microprocessors during automotive system design.
- Understand the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
- Design and implement the electronics that attribute the reliability, safety, and smartness to the automobiles, providing add-on comforts and get fair idea on future Automotive Electronic Systems.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.

2. Robert Bosch Gmbh (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley& Sons Inc., 2007.

Object Oriented Programming Using C++

B.E. V Semester (Open Elective)

[As per Choice Based Credit System (CBCS)scheme]

Subject Code	15EC562	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hrs/ Module	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Define Encapsulation, Inheritance and Polymorphism.
- Solve the problem with object oriented approach.
- Analyze the problem statement and build object oriented system model.
- Describe the characters and behavior of the objects that comprise a system.
- Explain function overloading, operator overloading and virtual functions.
- Discuss the advantages of object oriented programming over procedure oriented programming.

Module -1	RBT Level
Beginning with C++ and its features: What is C++?, Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++ (Topics from Ch -2,3 of Text).	L1, L2
Module -2	
Functions, classes and Objects: Functions, Inline function, function overloading, friend and virtual functions, Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions (Selected Topics from Chap-4,5 of Text).	L1, L2, L3
Module -3	
Constructors, Destructors and Operator overloading: Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators (Selected topics from Chap-6, 7 of Text).	L1, L2, L3
Module -4	
Inheritance, Pointers, Virtual Functions, Polymorphism: Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions (Selected topics from Chap-8,9 of Text).	L1, L2, L3

Module -5	
Streams and Working with files: C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF (Selected topics from Chap-10, 11 of Text).	L1, L2, L3

Course Outcomes: At the end of the course, students will be able to:

- Explain the basics of Object Oriented Programming concepts.
- Apply the object initialization and destroy concept using constructors and destructors.
- Apply the concept of polymorphism to implement compile time polymorphism in programs by using overloading methods and operators.
- Use the concept of inheritance to reduce the length of code and evaluate the usefulness.
- Apply the concept of run time polymorphism by using virtual functions, overriding functions and abstract class in programs.
- Use I/O operations and file streams in programs.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Object Oriented Programming with C++, E.Balaguruswamy, TMH, 6th Edition, 2013.

Reference Book:

Object Oriented Programming using C++, Robert Lafore, Galgotia publication 2010.

8051 MICROCONTROLLER

B.E., V Semester (Open Elective)

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC563	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hrs/ Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Understand the difference between a Microprocessor and a Microcontroller and embedded microcontrollers.
- Familiarize the basic architecture of 8051 microcontroller.
- Program 8051microprocessor using Assembly Level Language and C.
- Understand the interrupt system of 8051 and the use of interrupts.
- Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051.
- Interface 8051 to external memory and I/O devices using its I/O ports.

Module	RBT Level
Module -1	
8051 Microcontroller: Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.	L1, L2
Module -2	
8051 Instruction Set: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.	L1, L2
Module -3	
8051 Stack, I/O Port Interfacing and Programming: 8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops - Delay subroutine, Factorial of an 8 bit number (result maximum 8 bit), Block move without overlap, Addition of N 8 bit numbers, Picking smallest/largest of N 8 bit numbers. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.	L1, L2, L3
Module -4	
8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse	L1, L2, L3

using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS-232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.	
Module -5	
8051 Interrupts and Interfacing Applications: 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, LCD and Stepper motor and their 8051 Assembly language interfacing programming.	L1, L2, L3

Evaluation of Internal Assessment Marks:

It is suggested that at least a few simple programs to be executed by students using a simulation software or an 8051 microcontroller kit for better understanding of the course. This activity can be considered for the evaluation of 5 marks out of 20 Internal assessment marks, reserved for the other activities.

Course outcomes: At the end of the course, students will be able to:

- Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.
- Write 8051 Assembly level programs using 8051 instruction set.
- Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.
- Write 8051 Assembly language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port and to generate an external interrupt using a switch.
- Write 8051 C programs to generate square wave on 8051 I/O port pin using interrupt and to send & receive serial data using 8051 serial port.
- Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS: 1. **"The 8051 Microcontroller and Embedded Systems – using assembly and C ",** Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006. 2. **"The 8051 Microcontroller",** Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.
REFERENCE BOOKS: 1. **"The 8051 Microcontroller Based Embedded Systems",** Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4. 2. **"Microcontrollers: Architecture, Programming, Interfacing and System Design",** Raj Kamal, Pearson Education, 2005.

B.E E&C SIXTH SEMESTER SYLLABUS

DIGITAL COMMUNICATION

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC61	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours/Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: The objectives of the course is to enable students to:

- Understand the mathematical representation of signal, symbol, noise and channels.
- Apply the concept of signal conversion to symbols and signal processing to symbols in transmitter and receiver functional blocks.
- Compute performance issues and parameters for symbol processing and recovery in ideal and corrupted channel conditions.
- Compute performance parameters and mitigate for these parameters in corrupted and distorted channel conditions.

Module-1	RBT Level
Bandpass Signal to Equivalent Lowpass: Hilbert Transform, Pre-envelopes, Complex envelopes, Canonical representation of bandpass signals, Complex low pass representation of bandpass systems, Complex representation of band pass signals and systems (Text 1: 2.8, 2.9, 2.10, 2.11, 2.12, 2.13). **Line codes:** Unipolar, Polar, Bipolar (AMI) and Manchester code and their power spectral densities (Text 1: Ch 6.10). Overview of HDB3, B3ZS, B6ZS (Ref. 1: 7.2)	L1, L2, L3
Module-2	
Signaling over AWGN Channels- Introduction, Geometric representation of signals, Gram-Schmidt Orthogonalization procedure, Conversion of the continuous AWGN channel into a vector channel, Optimum receivers using coherent detection: ML Decoding, Correlation receiver, matched filter receiver (Text 1: 7.1, 7.2, 7.3, 7.4).	L1, L2, L3
Module-3	
Digital Modulation Techniques: Phase shift Keying techniques using coherent detection: generation, detection and error probabilities of BPSK and QPSK, M–ary PSK, M–ary QAM (Relevant topics in Text 1 of 7.6, 7.7). Frequency shift keying techniques using Coherent detection: BFSK	

generation, detection and error probability (Relevant topics in Text 1 of 7.8). Non coherent orthogonal modulation techniques: BFSK, DPSK Symbol representation, Block diagrams treatment of Transmitter and Receiver, Probability of error (without derivation of probability of error equation) (Text 1: 7.11, 7.12. 7.13).	
Module-4	
Communication through Band Limited Channels: Digital Transmission through Band limited channels: Digital PAM Transmission through Band limited Channels, Signal design for Band limited Channels: Design of band limited signals for zero ISI–The Nyquist Criterion (statement only), Design of band limited signals with controlled ISI-Partial Response signals, Probability of error for detection of Digital PAM: Probability of error for detection of Digital PAM with Zero ISI, Symbol–by–Symbol detection of data with controlled ISI (Text 2: 9.1, 9.2, 9.3.1, 9.3.2). Channel Equalization: Linear Equalizers (ZFE, MMSE), Adaptive Equalizers (Text 2: 9.4.2).	L1, L2, L3
Module-5	
Principles of Spread Spectrum: Spread Spectrum Communication Systems: Model of a Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Systems, Effect of De-spreading on a narrowband Interference, Probability of error (statement only), Some applications of DS Spread Spectrum Signals, Generation of PN Sequences, Frequency Hopped Spread Spectrum, CDMA based on IS-95 (Text 2: 11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.5, 11.4.2).	L1, L2, L3
Course Outcomes: At the end of the course, the students will be able to: • Associate and apply the concepts of Bandpass sampling to well specified signals and channels. • Analyze and compute performance parameters and transfer rates for low pas and bandpass symbol under ideal and corrupted non band limited channels. • Test and validate symbol processing and performance parameters at the receiver under ideal and corrupted bandlimited channels. • Demonstrate by simulation and emulation that bandpass signals subjected to corrupted and distorted symbols in a bandlimited channel, can be demodulated and estimated at receiver to meet specified performance criteria.	
Question paper pattern: • The question paper will have ten questions • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of Three sub questions) from each module. • Each full question will have sub questions covering all the topics under a module • The students will have to answer 5 full questions, selecting one full question from each module	
Text Books:	

1. Simon Haykin, “Digital Communication Systems”, John Wiley & sons, First Edition, 2014, ISBN 978-0-471-64735-5.
2. John G Proakis and Masoud Salehi, “Fundamentals of Communication Systems”, 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.

Reference Books:

1. B.P.Lathi and Zhi Ding, “Modern Digital and Analog communication Systems”, Oxford University Press, 4th Edition, 2010, ISBN: 978-0-198-07380-2.
2. Ian A Glover and Peter M Grant, “Digital Communications”, Pearson Education, Third Edition, 2010, ISBN 978-0-273-71830-7.
3. John G Proakis and Masoud Salehi, “Communication Systems Engineering”, 2nd Edition, Pearson Education, ISBN 978-93-325-5513-6.

ARM MICROCONTROLLER & EMBEDDED SYSTEMS

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering
[As per Choice Based Credit System (CBCS) scheme]

ARM MICROCONTROLLER & EMBEDDED SYSTEMS

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering
[As per Choice Based Credit System (CBCS) Scheme]

Course Code	**15EC62**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours / Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: This course will enable students to:

- Understand the architectural features and instruction set of 32 bit microcontroller ARM Cortex M3.
- Program ARM Cortex M3 using the various instructions and C language for different applications.
- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Develop the hardware software co-design and firmware design approaches.
- Explain the need of real time operating system for embedded system applications.

Module-1

ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, Debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 1: Ch 1, 2, 3) **L1, L2**

Module-2

ARM Cortex M3 Instruction Sets and Programming: Assembly basics, Instruction list and description, Useful instructions, Memory mapping, Bit-band operations and CMSIS, Assembly and C language Programming (Text 1: Ch-4, Ch-5, Ch-10 (10.1, 10.2, 10.3, 10.5 only) **L1, L2, L3**

Module-3

Embedded System Components: Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Core of an Embedded System including all types of processor/controller, Memory, Sensors, Actuators, LED, 7 segment LED display, Optocoupler, Relay, Piezo buzzer, Push button switch, Communication Interface (onboard and external types), Embedded firmware, Other system components.
(Text 2: All the Topics from Ch-1 and Ch-2, excluding 2.3.3.4 (stepper motor), 2.3.3.8 (keyboard) and 2.3.3.9 (PPI) sections). **L1, L2, L3**

Module-4

Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded

Systems-Application and Domain specific, Hardware Software Co-Design and Program Modelling (excluding UML), Embedded firmware design and development (excluding C language).

(Text 2: Ch-3, Ch-4, Ch-7 (Sections 7.1, 7.2 only), Ch-9 (Sections 9.1, 9.2, 9.3.1, 9.3.2 only) **L1, L2, L3**

Module-5

RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil), Disassembler/decompiler, simulator, emulator and debugging techniques

(Text 2: Ch-10 (Sections 10.1, 10.2, 10.3, 10.5.2 , 10.7, 10.8.1.1, 10.8.1.2, 10.8.2.2, 10.10 only), Ch 12, Ch-13 (a block diagram before 13.1, 13.3, 13.4, 13.5, 13.6 only)

L1, L2, L3

Course outcomes: After studying this course, students will be able to:

- Describe the architectural features and instructions of 32 bit microcontroller ARM Cortex M3.
- Apply the knowledge gained for Programming ARM Cortex M3 for different applications.
- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Develop the hardware /software co-design and firmware design approaches.
- Explain the need of real time operating system for embedded system applications.

Text Books:

1. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd Edition, Newnes, (Elsevier), 2010.
2. Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, 2nd Edition.

VLSI Design

B.E., VI Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC63	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours / Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: The objectives of the course is to enable students to:

- Impart knowledge of MOS transistor theory and CMOS technologies
- Impart knowledge on architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology
- Cultivate the concepts of subsystem design processes
- Demonstrate the concepts of CMOS testing

Module-1	RBT Level
Introduction: A Brief History, MOS Transistors, MOS Transistor Theory, Ideal I-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics (1.1, 1.3, 2.1, 2.2, 2.4, 2.5 of TEXT2). **Fabrication:** nMOS Fabrication, CMOS Fabrication [P-well process, N-well process, Twin tub process], BiCMOS Technology (1.7, 1.8,1.10 of TEXT1).	L1, L2
Module-2	
MOS and BiCMOS Circuit Design Processes: MOS Layers, Stick Diagrams, Design Rules and Layout. **Basic Circuit Concepts:** Sheet Resistance, Area Capacitances of Layers, Standard Unit of Capacitance, Some Area Capacitance Calculations, Delay Unit, Inverter Delays, Driving Large Capacitive Loads (3.1 to 3.3, 4.1, 4.3 to 4.8 of TEXT1).	L1, L2, L3
Module-3	
Scaling of MOS Circuits: Scaling Models & Scaling Factors for Device Parameters **Subsystem Design Processes:** Some General considerations, An illustration of Design Processes, **Illustration of the Design Processes-** Regularity, Design of an ALU Subsystem, The Manchester Carry-chain and Adder Enhancement Techniques(5.1, 5.2, 7.1, 7.2, 8.2, 8.3, 8.4.1, 8.4.2 of TEXT1).	L1, L2, L3
Module-4	
Subsystem Design: Some Architectural Issues, Switch Logic, Gate(restoring) Logic, Parity Generators, Multiplexers, The Programmable Logic Array (PLA) (6.1to 6.3, 6.4.1, 6.4.3, 6.4.6 of TEXT1). **FPGA Based Systems:** Introduction, Basic concepts, Digital design and FPGA's, FPGA based System design, FPGA architecture, Physical design for FPGA's (1.1 to 1.4, 3.2, 4.8 of TEXT3).	L1, L2, L3
Module-5	
Memory, Registers and Aspects of system Timing- System Timing Considerations, Some commonly used Storage/Memory elements (9.1, 9.2 of TEXT1).	L1, L2, L3

Testing and Verification: Introduction, Logic Verification, Logic Verification Principles, Manufacturing Test Principles, Design for testability (12.1, 12.1.1, 12.3, 12.5, 12.6 of TEXT 2).	

Course outcomes: At the end of the course, the students will be able to:

- Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.
- Draw the basic gates using the stick and layout diagrams with the knowledge of physical design aspects.
- Interpret Memory elements along with timing considerations
- Demonstrate knowledge of FPGA based system design
- Interpret testing and testability issues in VLSI Design
- Analyze CMOS subsystems and architectural issues with the design constraints.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Books:

1. **"Basic VLSI Design"**- Douglas A. Pucknell& Kamran Eshraghian, PHI 3rd Edition (original Edition – 1994).
2. **"CMOS VLSI Design- A Circuits and Systems Perspective"-** Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition, Pearson Education.
3. **"FPGA Based System Design"-** Wayne Wolf, Pearson Education, 2004, Technology and Engineering.

<u>COMPUTER COMMUNICATION NETWORKS</u>

B.E., VI Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

<u>COMPUTER COMMUNICATION NETWORKS</u>

B.E., VI Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) Scheme]

Course Code	**15EC64**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours / Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Understand the layering architecture of OSI reference model and TCP/IP protocol suite.
- Understand the protocols associated with each layer.
- Learn the different networking architectures and their representations.
- Learn the various routing techniques and the transport layer services.

Module-1

Introduction: Data Communications: Components, Representations, Data Flow, Networks: Physical Structures, Network Types: LAN, WAN, Switching, Internet.
Network Models: Protocol Layering: Scenarios, Principles, Logical Connections, TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP.
Data-Link Layer: Introduction: Nodes and Links, Services, Categories' of link, Sublayers, Link Layer addressing: Types of addresses, ARP. Data Link Control (DLC) services: Framing, Flow and Error Control, Data Link Layer Protocols: Simple Protocol, Stop and Wait protocol, Piggybacking. **L1, L2**

Module-2

Media Access Control: Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. Controlled Access: Reservation, Polling, Token Passing.
Wired LANs: Ethernet: Ethernet Protocol: IEEE802, Ethernet Evolution, Standard Ethernet: Characteristics, Addressing, Access Method, Efficiency, Implementation, Fast Ethernet: Access Method, Physical Layer, Gigabit Ethernet: MAC Sublayer, Physical Layer, 10 Gigabit Ethernet. **L1, L2**

Module-3

Wireless LANs: Introduction: Architectural Comparison, Characteristics, IEEE 802.11: Architecture, MAC Sublayer, Addressing Mechanism, Physical Layer, Bluetooth: Architecture, Layers.
Connecting Devices: Hubs, Switches, **Virtual LANs:** Membership, Configuration, Communication between Switches and Routers, Advantages.
Network Layer: Introduction, Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classful Addressing, Classless Addressing,

DHCP, Network Address Resolution, Forwarding of IP Packets: Based on destination Address and Label. **L1, L2**

Module-4

Network Layer Protocols: Internet Protocol (IP): Datagram Format, Fragmentation, Options, Security of IPv4 Datagrams, ICMPv4: Messages, Debugging Tools, Mobile IP: Addressing, Agents, Three Phases, Inefficiency in Mobile IP.

Unicast Routing: Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing, Unicast Routing Protocol: Internet Structure, Routing Information Protocol, Open Shortest Path First, Border Gateway Protocol Version 4. **L1, L2, L3**

Module-5

Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-Back-N Protocol, Selective repeat protocol, User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, Flow control, Error control, TCP congestion control. **L1, L2**

Course Outcomes: At the end of the course, the students will be able to:

- Identify the protocols and services of Data link layer.
- Identify the protocols and functions associated with the transport layer services.
- Describe the layering architecture of computer networks and distinguish between the OSI reference model and TCP/IP protocol suite.
- Distinguish the basic network configurations and standards associated with each network.
- Construct a network model and determine the routing of packets using different routing algorithms.

Text Book:

Data Communications and Networking , Forouzan, 5th Edition, McGraw Hill, 2016
ISBN: 1-25-906475-3

Reference Books:

1. Computer Networks, James J Kurose, Keith W Ross, Pearson Education, 2013, ISBN: 0-273-76896-4
2. Introduction to Data Communication and Networking, Wayarles Tomasi, Pearson Education, 2007, ISBN:0130138282

CELLULAR MOBILE COMMUNICATIONS

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC651	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course enables students to:

- Understand the application of multi user access in a cellular communication scenario.
- Understand the propagation mechanisms in an urban mobile communications using statistical and empirical models.
- Understand system architecture, call processing protocols and services of GSM, GPRS and EDGE.
- Understand system architecture, call processing protocols and services of CDMA based systems IS95 and CDMA2000.

Module-1	RBT Level
Cellular Concept: Frequency Reuse, Channel Assignment Strategies, Interference and System Capacity, Power Control for Reducing Interference, Trunking and Grade of Service, Improving Capacity in Cellular Systems. **Mobile Radio Propagation:** Large Scale path Loss- Free Space Model, Three basic propagation mechanisms, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models – Okumura, Hata, PCS Extension to Hata Model (explanations only) (Text 1).	L1, L2
Module-2	
Mobile Radio Propagation: Small-Scale Fading and Multipath: Small scale Multipath Propagation, Impulse Response Model of a Multipath Channel, Small-Scale Multipath Measurements, Parameters of Mobile Multipath Channels, Types of Small-Scale Fading, Rayleigh and Ricean Distributions, Statistical Model for Multipath Fading Channels (Clarke's Model for Flat Fading only).(Text 1)	L1, L2
Module-3	
System Architecture and Addressing: System architecture, The SIM concept, Addressing, Registers and subscriber data, Location registers (HLR and VLR) Security-related registers (AUC and EIR), Subscriber data, Network interfaces and configurations. **Air Interface – GSM Physical Layer:** Logical channels, Physical channels, Synchronization- Frequency and clock synchronization, Adaptive frame synchronization, Mapping of logical onto physical channels, Radio subsystem link control, Channel coding, source coding and speech processing, Source coding and speech processing, Channel coding, Power-up scenario. **GSM Protocols:** Protocol architecture planes, Protocol architecture of the user plane, Protocol architecture of the signaling plane, Signaling at the air interface (Um), Signaling at the A and Abis interfaces, Security-related network functions,	L1, L2

Signaling at the user interface.(Text 2)	
Module-4	
GSM Roaming Scenarios and Handover: Mobile application part interfaces, Location registration and location update, Connection establishment and termination, Handover. (up to 6.4.1 only in Text2) **Services:** Classical GSM services, Popular GSM services: SMS and MMS. **Improved data services in GSM**: **GPRS, HSCSD and EDGE** GPRS System architecture of GPRS , Services , Session management, mobility management and routing, Protocol architecture, Signaling plane, Interworking with IP networks, Air interface, Authentication and ciphering, Summary of GPRS . HSCSD: Architecture, Air interface, HSCSD resource allocation and capacity issues. EDGE: The EDGE concept, EDGE physical layer, modulation and coding, EDGE: effects on the GSM system architecture, ECSD and EGPRS. (Text 2)	L1, L2
Module-5	
CDMA Technology – Introduction to CDMA,CDMA frequency bands, CDMA Network and System Architecture, CDMA Channel concept, Forward Logical Channels, Reverse logical Channels, CDMA frame format, CDMA System Operations(Initialization/Registration), Call Establishment, CDMA Call handoff,IS-95B,CDMA2000,W-CDMA,UMTS,CDMA data networks, Evolution of CDMA to 3G, CDMA 2000 RAN Components, CDMA 2000 Packet Data Service. (Text 3)	L1, L2

Course outcomes: At the end of the course, the students will be able to:

- Apply the understanding of statistical characterization of urban mobile channels to compute the performance for simple modulation schemes.
- Demonstrate the limitations of GSM, GPRS and CDMA to meet high data rate requirements and limited improvements that are needed.
- Analyze the call process procedure between a calling number and called number for all scenarios in GSM or CDMA based systems.
- Test and validate voice and data call handling for various scenarios in GSM and CDMA systems for national and international interworking situations.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Books:

1. Theodore Rapport, “Wireless Communications – Principles and Practice”, Prentice Hall of India , 2nd Edition, 2007, ISBN 978-8-120-32381-0.
2. Jorg Eberspacher, Hans-Jorg Vogel, Christian Bettstetter, Christian Hartmann,

"GSM– Architecture, Protocols and Services”, Wiley,3rd Edition, 2009,ISBN-978-0-470-03070-7.

3. Gary J Mullet, “Introduction To Wireless Telecommunications Systems and Networks", Cengage Learning.

ADAPTIVE SIGNAL PROCESSING

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC652	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course Objectives: The objectives of this course are to:

- Introduce to the concept and need of adaptive filters and popular adaptive signal processing algorithms
- Understand the concepts of training and convergence and the trade-off between performance and complexity.
- Introduce to common linear estimation techniques
- Demonstrate applications of adaptive systems to sample problems.
- Introduce inverse adaptive modelling.

Module-1	RBT Level
Adaptive systems: Definitions and characteristics - applications – properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction - linear optimum filtering-orthogonality - Wiener – Hopf equation-performance surface(Chapters 1& 2 of Text).	L1, L2
Module-2	
Searching performance surface-stability and rate of convergence: Learning curve-gradient search - Newton's method - method of steepest descent - comparison - Gradient estimation - performance penalty - variance - excess MSE and time constants – mis-adjustments (Chapters 4& 5 of Text).	L1, L2
Module-3	
LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm - adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals (Chapters 6& 8 of Text).	L1, L2, L3
Module-4	
Applications-adaptive modeling and system identification: Multipath communication channel, geophysical exploration, FIR digital filter synthesis. (Chapter 9 of Text).	L1, L2, L3
Module-5	
Inverse adaptive modeling: Equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis(Chapter 10 of Text).	L1, L2, L3

Course Outcomes: At the end of the course, students should be able to:

- Devise filtering solutions for optimising the cost function indicating error in estimation of parameters and appreciate the need for adaptation in design.
- Evaluate the performance of various methods for designing adaptive filters

through estimation of different parameters of stationary random process clearly considering practical application specifications.

- Analyse convergence and stability issues associated with adaptive filter design and come up with optimum solutions for real life applications taking care of requirements in terms of complexity and accuracy.
- Design and implement filtering solutions for applications such as channel equalisation, interference cancelling and prediction considering present day challenges.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Bernard Widrow and Samuel D. Stearns, “Adaptive Signal Processing”, Person Education, 1985.

Reference Books:

1. Simon Haykin, “Adaptive Filter Theory”, Pearson Education, 2003.
2. John R. Treichler, C. Richard Johnson, Michael G. Larimore, “Theory and Design of Adaptive Filters”, Prentice-Hall of India, 2002.

ARITIFICAL NEURAL NETWORKS

B.E., VI Semester, Electronics & Communication Engineering / Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC653	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course Objectives: The objectives of this course are:

- Understand the basics of ANN and comparison with Human brain
- Provide knowledge on Generalization and function approximation and various architectures of building an ANN
- Provide knowledge of reinforcement learning using neural networks
- Provide knowledge of unsupervised learning using neural networks.

Module-1	RBT Level
Introduction: Biological Neuron – Artificial Neural Model - Types of activation functions – **Architecture**: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks. **Learning:** Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNs, Perceptron Learning Algorithm, Perceptron Convergence Theorem.	L1, L2
Module-2	
Supervised Learning: Perceptron learning and Non Separable sets, α-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, μ-LMS approximate to gradient descent, Application of LMS to Noise Cancelling, Multi-layered Network Architecture, Backpropagation Learning Algorithm, Practical consideration of BP algorithm.	L1, L2, L3
Module-3	
Support Vector Machines and Radial Basis Function: Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition.	L1, L2, L3
Module-4	
Attractor Neural Networks: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.	L1, L2, L3
Module-5	
Self-organization Feature Map: Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self-organization Feature Maps, Application of SOM, Growing Neural Gas.	L1, L2, L3

Course outcomes: At the end of the course, students should be able to:

- Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.
- Understand the concepts and techniques of neural networks through the study of the most important neural network models.
- Evaluate whether neural networks are appropriate to a particular application.
- Apply neural networks to particular applications, and to know what steps to take to improve performance.

Question paper pattern:

The question paper will have ten questions.

- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Neural Networks A Classroom Approach– Satish Kumar, McGraw Hill Education (India) Pvt. Ltd, Second Edition.

Reference Books:

1. **Introduction to Artificial Neural Systems-**J.M. Zurada, Jaico Publications 1994.
2. **Artificial Neural Networks-**B. Yegnanarayana, PHI, New Delhi 1998.

DIGITAL SWITCHING SYSTEMS

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC654	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to

- Understand the basics of telecommunication networks and digital transmission of data.
- Study about the evolution of switching systems and the digital switching.
- Study about the telecommunication traffic and its measurements.
- Learn the technologies associated with the data switching operations.
- Understand the use of software for the switching and its maintenance

Module-1	RBT Level
DEVELOPMENT OF TELECOMMUNICATIONS: Network structure, Network services, terminology, Regulation, Standards. Introduction to telecommunications transmission, Power levels, Four wire circuits, Digital transmission, FDM,TDM, PDH and SDH [Text-1]	L1, L2
Module-2	
EVOLUTION OF SWITCHING SYSTEMS: Introduction, Message switching, Circuit switching, Functions of switching systems, Distribution systems, Basics of crossbar systems, Electronic switching. **DIGITAL SWITCHING SYSTEMS:** Switching system hierarchy, Evolution of digital switching systems, Stored program control switching systems, Building blocks of a digital switching system, Basic call processing. [Text-1 and 2]	L1, L2
Module-3	
TELECOMMUNICATIONS TRAFFIC: Introduction, Unit of traffic, Congestion, Traffic measurement, Mathematical model, lost call systems, Queuing systems. **SWITCHING SYSTEMS:** Introduction, Single stage networks, Gradings, Link Systems, GOS of Linked systems. [Text-1]	L1, L2
Module-4	
TIME DIVISION SWITCHING: Introduction, space and time switching, Time switching networks, Synchronisation. **SWITCHING SYSTEM SOFTWARE:** Introduction, Basic software architecture, Software architecture for level 1to 3 control, Digital switching system software classification, Call models, Software linkages during call, Feature flow diagram, Feature interaction. [Text-1 and 2]	L1, L2
Module-5	
MAINTENANCE OF DIGITAL SWITCHING SYSTEM: Introduction , Software maintenance, Interface of a typical digital switching system central office, System outage and its impact on digital switching system reliability, Impact	L1, L2

of software patches on digital switching system maintainability, A methodology for proper maintenance of digital switching system **A GENERIC DIGITAL SWITCHING SYSTEM MODEL:** Introduction, Hardware architecture, Software architecture, Recovery strategy, Simple call through a digital system, Common characteristics of digital switching systems. Reliability analysis. [Text-2]	

Course Outcomes: At the end of the course, students should be able to:

- Describe the electromechanical switching systems and its comparison with the digital switching.
- Determine the telecommunication traffic and its measurements.
- Define the technologies associated with the data switching operations.
- Describe the software aspects of switching systems and its maintenance.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Books:

1. Telecommunication and Switching, Traffic and Networks - J E Flood: Pearson Education, 2002.
2. Digital Switching Systems, Syed R. Ali, TMH Ed 2002.

Reference Book:

Digital Telephony - John C Bellamy: Wiley India Pvt. Ltd, 3rd Ed, 2008.

MICROELECTRONICS

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC655	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course Objectives: This course will enable students to:

- Be familiar with the MOSFET physical structure and operation, terminal characteristics, circuit models and basic circuit applications.
- Confront integrated device and/or circuit design problems, identify the design issues, and develop solutions.
- Analyze and design microelectronic circuits for linear amplifier and digital applications.
- Contrast the input/output and gain characteristics of single-transistor, differential and common two-transistor linear amplifier building block stages.

Module-1	RBT Level
MOSFETS: Device Structure and Physical Operation, V-I Characteristics, MOSFET Circuits at DC, MOSFET as an amplifier and as a switch.	L1, L2
Module-2	
MOSFETS (continued): Biasing in MOS amplifier Circuits, Small Signal Operation and Models, Basic MOSFET amplifier, MOSFET internal capacitances, frequency response of CS amplifier.	L1, L2
Module-3	
MOSFETS (continued): Discrete circuit MOS amplifiers. **Single Stage IC Amplifier:** Comparison of MOSFET and BJT, Current sources, Current mirrors and Current steering circuits, high frequency response- general considerations.	L1, L2, L3
Module-4	
Single Stage IC Amplifier (continued): CS with active loads, high frequency response of CS, CG amplifiers with active loads, high frequency response of CG, Cascode amplifiers. CS with source degeneration (only MOS amplifiers to be dealt).	L1, L2
Module-5	
Differential and Multistage Amplifiers: The MOS differential pair, small signal operation of MOS differential pair, Differential amplifier with active loads, and frequency response of the differential amplifiers. Multistage amplifiers (only MOS amplifiers to be dealt).	L1, L2

Course outcomes: After studying this course, students will be able to:

- Explain the underlying physics and principles of operation of Metaloxide-semiconductor (MOS) capacitors and MOS field effect transistors (MOSFETs).
- Describe and apply simple large signal circuit models for MOSFETs.
- Analyze and design microelectronic circuits for linear amplifier for digital applications.

• Use of discrete MOS circuits to design Single stage and Multistage amplifiers to meet stated operating specifications.	

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

"Microelectronic Circuits", Adel Sedra and K.C. Smith, 6th Edition, Oxford University Press, International Version, 2009.

Reference Books:

1. **"Microelectronics An integrated approach",** Roger T Howe, Charles G Sodini, Pearson education.
2. **"Fundamentals of Microelectronics",** Behzad Razavi, John Wiley India Pvt. Ltd, 2008.
3. **"Microelectronics – Analysis and Design",** Sundaram Natarajan, Tata McGraw-Hill, 2007.

EMBEDDED CONTROLLER LAB

B.E., VI Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ECL67	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory = 03	Exam Marks	80
RBT Levels	L1, L2, L3	Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to:

- Understand the instruction set of ARM Cortex M3, a 32 bit microcontroller and the software tool required for programming in Assembly and C language.
- Program ARM Cortex M3 using the various instructions in assembly level language for different applications.
- Interface external devices and I/O with ARM Cortex M3.
- Develop C language programs and library functions for embedded system applications.

Laboratory Experiments

PART-A: Conduct the following Study experiments to learn ALP using ARM Cortex M3 Registers using an Evaluation board and the required software tool.

1. ALP to multiply two 16 bit binary numbers.
2. ALP to find the sum of first 10 integer numbers.

PART-B: Conduct the following experiments on an ARM CORTEX M3 evaluation board using evaluation version of Embedded 'C' & Keil uVision-4 tool/compiler.

1. Display “Hello World” message using Internal UART.
2. Interface and Control a DC Motor.
3. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.

4. Interface a DAC and generate Triangular and Square waveforms.
5. Interface a 4x4 keyboard and display the key code on an LCD.
6. Using the Internal PWM module of ARM controller generate PWM and vary its duty cycle.
7. Demonstrate the use of an external interrupt to toggle an LED On/Off.
8. Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between.
9. Interface a simple Switch and display its status through Relay, Buzzer and LED.
10. Measure Ambient temperature using a sensor and SPI ADC IC.

Course outcomes: After studying this course, students will be able to:

- Understand the instruction set of 32 bit microcontroller ARM Cortex M3, and the software tool required for programming in Assembly and C language.
- Develop assembly language programs using ARM Cortex M3 for different applications.
- Interface external devices and I/O with ARM Cortex M3.
- Develop C language programs and library functions for embedded system applications.

Conduction of Practical Examination:

1. PART-B experiments using Embedded-C are only to be considered for the practical examination. PART-A ALP programs are for study purpose and can be considered for Internal Marks evaluation.
2. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
3. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

COMPUTER NETWORKS LABORATORY

B.E., VI Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ECL68	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory = 03	Exam Marks	80
RBT Levels	L1, L2, L3	Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to:

- Choose suitable tools to model a network and understand the protocols at various OSI reference levels.
- Design a suitable network and simulate using a Network simulator tool.
- Simulate the networking concepts and protocols using C/C++ programming.
- Model the networks for different configurations and analyze the results.

Laboratory Experiments

PART-A: Simulation experiments using NS2/ NS3/ OPNET/ NCTUNS/ NetSim/ QualNet or any other equivalent tool

1. Implement a point to point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth.
2. Implement a four node point to point network with links n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP.
3. Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.
4. Implement Ethernet LAN using n nodes and assign multiple traffic to the nodes and obtain congestion window for different sources/ destinations.
5. Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.
6. Implementation of Link state routing algorithm.

PART-B: Implement the following in C/C++

1. Write a program for a HLDC frame to perform the following.

i) Bit stuffing

ii) Character stuffing.

2. Write a program for distance vector algorithm to find suitable path for transmission.

3. Implement Dijkstra's algorithm to compute the shortest routing path.
4. For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify the program for the cases

   a. Without error

b. With error

5. Implementation of Stop and Wait Protocol and Sliding Window Protocol
6. Write a program for congestion control using leaky bucket algorithm.

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Use the network simulator for learning and practice of networking algorithms.
- Illustrate the operations of network protocols and algorithms using C programming.
- Simulate the network with different configurations to measure the performance parameters.
- Implement the data link and routing protocols using C programming.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination one question from software and one question from hardware or only one hardware experiments based on the complexity to be set.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

6^{th} Semester Open Electives Syllabus for the courses offered by EC/TC Board:

DATA STRUCTURE USING C++ B.E VI Semester (Open Elective) [As per Choice Based Credit System (CBCS) Scheme]			
Course Code	**15EC661**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40 (08 Hrs per Module)**	**Exam Hours**	**03**
CREDITS – 03			

Course objectives: This course will enable students to

- Explain fundamentals of data structures and their applications essential for programming/problem solving
- Analyze Linear Data Structures: Stack, Queues, Lists
- Analyze Non Linear Data Structures: Trees
- Assess appropriate data structure during program development/Problem Solving

Module -1

INTRODUCTION: Functions and parameters, Dynamic memory allocation, Recursion.
LINEAR LISTS: Data objects and structures, Linear list data structures, Array Representation, Vector Representation, Singly Linked lists and chains. **L1, L2**

Module -2

ARRAYS AND MATRICS: Arrays, Matrices, Special matrices, Sparse matrices.

STACKS: The abstract data types, Array Representation, Linked Representation, Applications-Parenthesis Matching & Towers of Hanoi. **L1, L2, L3**

Module -3

QUEUES: The abstract data types, Array Representation, Linked Representation, Applications-Railroad car arrangement.

HASHING: Dictionaries, Linear representation, Hash table representation. **L1, L2, L3**

Module -4

BINARY AND OTHER TREES: Trees, Binary trees, Properties and representation of binary trees, Common binary tree operations, Binary tree traversal the ADT binary tree, ADT binary tree and the class linked binary tree. **L1, L2, L3**

Module -5

Priority Queues: Linear lists, Heaps, Applications-Heap Sorting.
Search Trees: Binary search trees operations and implementation, Binary Search trees with duplicates. **L1, L2, L3**

Course outcomes: After studying this course, students will be able to:

- Acquire knowledge of Dynamic memory allocation, Various types of data structures, operations and algorithms and Sparse matrices and Hashing
- Understand non Linear data structures trees and their applications
- Design appropriate data structures for solving computing problems
- Analyze the operations of Linear Data structures: Stack, Queue and Linked List and their applications

Text Book:

Data structures, Algorithms, and applications in C++, Sartaj Sahni, Universities Press, 2nd Edition, 2005.

Reference Books:

1. **Data structures, Algorithms, and applications in C++,** Sartaj Sahni, Mc. Graw Hill, 2000.
2. **Object Oriented Programming with C++,** E.Balaguruswamy**,** TMH, 6th Edition, 2013.
3. **Programming in C++,** E.Balaguruswamy. TMH, 4th, 2010.

POWER ELECTRONICS

B.E., VI Semester (Open Elective)

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC662	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to

- Understand the working of various power devices.
- Study and analysis of thyristor circuits with different triggering techniques.
- Learn the applications of power devices in controlled rectifiers, converters and inverters.
- Study of power electronics circuits under different load conditions.

Module-1	**RBT Level**
Introduction - Applications of Power Electronics, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits. Power Transistors: Power BJTs: Steady state characteristics. Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics. (Text 1)	L1, L2
Module-2	
Thyristors - Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, Two transistor model of SCR, Gate Characteristics of SCR, Turn-ON Methods, Turn-OFF Mechanism, Turn-OFF Methods: Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit. (Text 2)	L1, L2, L3
Module-3	
Controlled Rectifiers - Introduction, principle of phase controlled converter operation, Single phase full converters, Single phase dual converters. AC Voltage Controllers - Introduction, Principles of ON-OFF Control, Principle of Phase Control, Single phase control with resistive and inductive loads. (Text 1)	L1, L2, L3
Module-4	
DC-DC Converters - Introduction, principle of step-down operation and it's analysis with RL load, principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators. (Text 1)	L1, L2

Module-5	
Pulse Width Modulated Inverters- Introduction, principle of operation, performance parameters, Single phase bridge inverters, voltage control of single phase inverters, current source inverters, Variable DC-link inverter, Boost inverter. (Text 1)	L1, L2

Course outcomes: After studying this course, students will be able to:

- Describe the characteristics of different power devices and identify the applications.
- Illustrate the working of DC-DC converter and inverter circuit.
- Determine the output response of a thyristor circuit with various triggering options.
- Determine the response of controlled rectifier with resistive and inductive loads.

Evaluation of Internal Assessment Marks:

It is suggested that at least a few experiments of Power Electronics are conducted by the students for better understanding of the course. This activity can be considered for the evaluation of 5 marks out of 20 Internal assessment marks, reserved for the other activities.

Question paper pattern:

- The question paper will have ten questions
- Each full question consists of 16 marks**.**
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module
- The students will have to answer 5 full questions, selecting one full question from each module

Text Book:

1. Mohammad H Rashid, Power Electronics, Circuits, Devices and Applications, 3rd/4th Edition, Pearson Education Inc, 2014, ISBN: 978-93-325-1844-5.
2. M.D Singh and K B Khanchandani, Power Electronics, 2nd Edition, Tata Mc-Graw Hill, 2009, ISBN: 0070583897.

Reference Books:

4. L. Umanand, Power Electronics, Essentials and Applications, John Wiley India Pvt. Ltd, 2009.
5. Dr. P. S. Bimbhra, “Power Electronics”, Khanna Publishers, Delhi, 2012.
6. P.C. Sen, “Modern Power Electronics”, S Chand & Co New Delhi, 2005.

DIGITAL SYSTEM DESIGN USING VERILOG

B.E., VI Semester (Open Elective)

[As per Choice Based Credit System (CBCS) scheme]

Subject Code:	15EC663	IA Marks: 20
Number of Lecture Hours/Week:	03	Exam Marks: 80
Total Number of Lecture Hours:	40 (08 Hrs per module)	Exam Hours: 03
CREDITS – 03		

Course objectives: This course will enable students to:

- Understand the concepts of Verilog Language.
- Design the digital systems as an activity in a larger systems design context.
- Study the design and operation of semiconductor memories frequently used in application specific digital system.
- Inspect how effectively IC's are embedded in package and assembled in PCB's for different application.
- Design and diagnosis of processors and I/O controllers used in embedded systems.

Module -1	RBT Level
Introduction and Methodology: Digital Systems and Embedded Systems, Real-World Circuits, Models, Design Methodology (1.1, 1.3 to 1.5 of Text). **Combinational Basics:** Combinational Components and Circuits, Verification of Combinational Circuits.(2.3 and 2.4 of Text) **Sequential Basics**: Sequential Datapaths and Control Clocked Synchronous Timing Methodology (4.3 up to 4.3.1,4.4 up to 4.4.1 of Text).	L1, L2, L3
Module -2	
Memories: Concepts, Memory Types, Error Detection and Correction (Chap 5 of Text).	L1, L2, L3
Module -3	
Implementation Fabrics: Integrated Circuits, Programmable Logic Devices, Packaging and Circuit boards, Interconnection and Signal integrity (Chap 6 of Text).	L1, L2, L3
Module -4	
I/O interfacing: I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software (Chap 8 of Text).	L1, L2, L3
Module -5	
Design Methodology: Design flow, Design optimization, Design for test, Nontechnical Issues (Chap 10 of Text).	L1, L2, L3, L4

Course outcomes: After studying this course, students will be able to:

- Construct the combinational circuits, using discrete gates and programmable logic devices.
- Describe Verilog model for sequential circuits and test pattern generation.

- Design a semiconductor memory for specific chip design.
- Design embedded systems using small microcontrollers, larger CPUs/DSPs, or hard or soft processor cores.
- Synthesize different types of processor and I/O controllers that are used in embedded system.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks. There will be 2 full questions (with a maximum of Three sub questions from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Peter J. Ashenden, “Digital Design: An Embedded Systems Approach Using VERILOG”, Elesvier, 2010.

B.E E&C SEVENTH SEMESTER SYLLABUS

MICROWAVES AND ANTENNAS

B.E., VII Semester, Electronics &Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**15EC71**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours / Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: This course will enable students to:

- Describe the microwave properties and its transmission media
- Describe microwave devices for several applications
- Understand the basics of antenna theory
- Select antennas for specific applications

Module-1

Microwave Tubes: Introduction, Reflex Klystron Oscillator, Mechanism of Oscillations, Modes of Oscillations, Mode Curve (Qualitative Analysis only). (Text 1: 9.1, 9.2.2)
Microwave Transmission Lines: Microwave Frequencies, Microwave devices, Microwave Systems, Transmission Line equations and solutions, Reflection Coefficient and Transmission Coefficient, Standing Wave and Standing Wave Ratio, Smith Chart, Single Stub matching. (Text 2: 0.1, 0.2, 0.3, 3.1, 3.2, 3.3, 3.5, 3.6 Except Double stub matching) **L1, L2**

Module-2

Microwave Network theory: Symmetrical Z and Y-Parameters for Reciprocal Networks, S matrix representation of Multi-Port Networks. (Text 1: 6.1, 6.2, 6.3)
Microwave Passive Devices: Coaxial Connectors and Adapters, Attenuators, Phase Shifters, Waveguide Tees, Magic tees. (Text 1: 6.4.2, 6.4.14, 6.4.15, 6.4.16) **L1, L2**

Module-3

Strip Lines: Introduction, Micro Strip lines, Parallel Strip lines, Coplanar Strip lines, Shielded Strip Lines. (Text 2: Chapter 11)
Antenna Basics: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain, Antenna Apertures, Effective Height, Bandwidth, Radio Communication Link, Antenna Field Zones & Polarization. (Text 3: 2.1- 2.11, 2.13,2.15) **L1, L2, L3**

Module-4
Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing.(Text 3: 5.1 – 5.10,5.13) **Electric Dipoles:** Introduction, Short Electric Dipole, Fields of a Short Dipole (General and Far Field Analyses), Radiation Resistance of a Short Dipole, Thin Linear Antenna (Field Analyses), Radiation Resistances of Lambda/2 Antenna. (Text 3: 6.1 -6.6) **L1, L2, L3, L4**
Module-5
Loop and Horn Antenna: Introduction, Small loop, Comparison of Far fields of Small Loop and Short Dipole, The Loop Antenna General Case, Far field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Horn antennas Rectangular Horn Antennas.(Text 3: 7.1-7.8, 7.19, 7.20) **Antenna Types:** Helical Antenna, Helical Geometry, Practical Design Considerations of Helical Antenna, Yagi-Uda array, Parabola General Properties, Log Periodic Antenna. (Text 3: 8.3, 8.5, 8.8, 9.5, 11.7) **L1, L2, L3**
Course Outcomes: At the end of the course, students will be able to: • Describe the use and advantages of microwave transmission • Analyze various parameters related to microwave transmission lines and waveguides • Identify microwave devices for several applications • Analyze various antenna parameters necessary for building an RF system • Recommend various antenna configurations according to the applications
Text Books: 1. **Microwave Engineering** – Annapurna Das, Sisir K Das TMH Publication, 2^{nd}, 2010. 2. **Microwave Devices and circuits**- Liao, Pearson Education. 3. **Antennas and Wave Propagation,** John D. Krauss, Ronald J Marhefka and Ahmad S Khan,4^{th} Special Indian Edition , McGraw- Hill Education Pvt. Ltd., 2010.
Reference Books: 1. **Microwave Engineering** – David M Pozar, John Wiley India Pvt. Ltd. 3^{rd}Edn, 2008. 2. **Microwave Engineering** – Sushrut Das, Oxford Higher Education, 2^{nd}Edn, 2015. 3. **Antennas and Wave Propagation** – Harish and Sachidananda: Oxford University Press, 2007.

DIGITAL IMAGE PROCESSING

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC72	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50 (10 Hours / Module)	Exam Hours	03

CREDITS – 04

Course Objectives: The objectives of this course are to:

- Understand the fundamentals of digital image processing
- Understand the image transform used in digital image processing
- Understand the image enhancement techniques used in digital image processing
- Understand the image restoration techniques and methods used in digital image processing
- Understand the Morphological Operations and Segmentation used in digital image processing

Module-1	RBT Level
Digital Image Fundamentals: What is Digital Image Processing?, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. [Text: Chapter 1 and Chapter 2: Sections 2.1 to 2.5, 2.6.2]	L1, L2
Module-2	
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain**: Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering. [Text: Chapter 3: Sections 3.2 to 3.6 and Chapter 4: Sections 4.2, 4.5 to 4.10]	L1, L2, L3
Module-3	
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. [Text: Chapter 5: Sections 5.2, to 5.9]	L1, L2, L3
Module-4	

Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing. **Wavelets:** Background, Multiresolution Expansions. **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. [Text: Chapter 6: Sections 6.1 to 6.3, Chapter 7: Sections 7.1 and 7.2, Chapter 9: Sections 9.1 to 9.5]	L1, L2, L3
Module-5	
Segmentation: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds. **Representation and Description:** Representation, Boundary descriptors. [Text: Chapter 10: Sections 10.2, to 10.5 and Chapter 11: Sections 11.1 and 11.2]	L1, L2, L3

Course Outcomes: At the end of the course students should be able to:

- Understand image formation and the role human visual system plays in perception of gray and color image data.
- Apply image processing techniques in both the spatial and frequency (Fourier) domains.
- Design image analysis techniques in the form of image segmentation and to evaluate the Methodologies for segmentation.
- Conduct independent study and analysis of Image Enhancement techniques.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Digital Image Processing- Rafel C Gonzalez and Richard E. Woods, PHI 3rd Edition 2010.

Reference Books:

1. **Digital Image Processing**- S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata McGraw Hill 2014.
2. **Fundamentals of Digital Image Processing**-A. K. Jain, Pearson 2004.

POWER ELECTRONICS

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

POWER ELECTRONICS

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) Scheme]

Course Code	**15EC73**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours / Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Understand the construction and working of various power devices.
- Study and analysis of thyristor circuits with different triggering conditions.
- Learn the applications of power devices in controlled rectifiers, converters and inverters.
- Study of power electronics circuits under various load conditions.

Module-1

Introduction - Applications of Power Electronics, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits, Peripheral Effects.
Power Transistors: Power BJTs: Steady state characteristics. Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics, di/dt and dv/dt limitations. (Text 1) **L1, L2**

Module-2

Thyristors - Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, Two transisitor model of SCR, Gate Characteristics of SCR, Turn-ON Methods, Turn-OFF Mechanism, Turn-OFF Methods: Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit, UJT Firing Circuit. (Text 2) **L1, L2, L3**

Module-3

Controlled Rectifiers - Introduction, Principle of Phase-Controlled Converter Operation, Single-Phase Full Converter with RL Load, Single-Phase Dual Converters, Single-Phase Semi Converter with RL load.
AC Voltage Controllers - Introduction, Principles of ON-OFF Control, Principle of Phase Control, Single phase controllers with resistive and inductive loads. (Text 1) **L1, L2, L3**

Module-4

DC-DC Converters - Introduction, principle of step-down operation and it's analysis with RL load, principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators, Chopper circuit design. (Text 1) **L1, L2**

Module-5

Pulse Width Modulated Inverters- Introduction, principle of operation, performance parameters, Single phase bridge inverters, voltage control of single phase inverters, current source inverters, Variable DC-link inverter, Boost inverter, Inverter circuit design.
Static Switches: Introduction, Single phase AC switches, DC Switches, Solid state

relays, Microelectronic relays. (Text 1) **L1, L2**

Course Outcomes: At the end of the course students should be able to:

- Describe the characteristics of different power devices and identify the various applications associated with it.
- Illustrate the working of power circuit as DC-DC converter.
- Illustrate the operation of inverter circuit and static switches.
- Determine the output response of a thyristor circuit with various triggering options.
- Determine the response of controlled rectifier with resistive and inductive loads.

Evaluation of Internal Assessment Marks:

It is suggested that at least 4 experiments of Power Electronics to be conducted by the students. This activity can be considered for the evaluation of 05 marks out of 20 Internal Assessment (IA) Marks, reserved for the other activities.

Text Books:

1. Mohammad H Rashid, Power Electronics, Circuits, Devices and Applications, 3rd/4th Edition, Pearson Education Inc, 2014, ISBN: 978-93-325-1844-5.
2. M.D Singh and K B Khanchandani, Power Electronics, 2nd Edition, Tata Mc-Graw Hill, 2009, ISBN: 0070583897

Reference Books:

1. L. Umanand, Power Electronics, Essentials and Applications, John Wiley India Pvt. Ltd, 2009.
2. Dr. P. S. Bimbhra, “Power Electronics”, Khanna Publishers, Delhi, 2012.
3. P.C. Sen, “Modern Power Electronics”, S Chand & Co New Delhi, 2005.
4. Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, ePub eBook.

MULTIMEDIA COMMUNICATION

B.E., VII Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based credit System (CBCS) Scheme

Subject Code	15EC741	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to:

- Gain fundamental knowledge in understanding the basics of different multimedia networks and applications.
- Understand digitization principle techniques required to analyze different media types.
- Analyze compression techniques required to compress text and image and gain knowledge of DMS.
- Analyze compression techniques required to compress audio and video.
- Gain fundamental knowledge about multimedia communication across different networks.

Module-1	RBT Level
Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology. (Chap 1 of Text 1)	L1, L2
Module-2	
Information Representation: Introduction, Digitization principles, Text, Images, Audio and Video (Chap 2 of Text 1)	L1, L2
Module-3	
Text and image compression: Introduction, Compression principles, text compression, image Compression. (Chap 3 of Text 1) **Distributed multimedia systems:** Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems (Chap. 4 - Sections 4.1 to 4.5 of Text 2).	L1, L2, L3
Module-4	
Audio and video compression: Introduction, Audio compression, video compression, video compression principles, video compression. (Chap. 4 of Text 1).	L1, L2, L3
Module-5	
Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks (Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2).	L1, L2

Course Outcomes: After studying this course, students will be able to:
- Understand basics of different multimedia networks and applications.
- Understand different compression techniques to compress audio and video.
- Describe multimedia Communication across Networks.
- Analyse different media types to represent them in digital form.
- Compress different types of text and images using different compression techniques and analyse DMS.

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Fred Halsall, “Multimedia Communications”, Pearson education, 2001 ISBN -9788131709948.

2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “Multimedia Communication Systems”, Pearson education, 2004. ISBN -9788120321458

Reference Book:

Raifsteinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002. ISBN -9788177584417

BIOMEDICAL SIGNAL PROCESSING
B.E., VII Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC742	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: The objectives of this course are to:

- Describe the origin, properties and suitable models of important biological signals such as ECG and EEG.
- Introduce students to basic signal processing techniques in analysing biological signals.
- Develop the students mathematical and computational skills relevant to the field of biomedical signal processing.
- Develop a thorough understanding on basics of ECG signal compression algorithms.
- Increase the student's awareness of the complexity of various biological phenomena and cultivate an understanding of the promises, challenges of the biomedical engineering.

Module-1	RBT Level
Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. **Electrocardiography:** Basic electrocardiography, ECG lead systems, ECG signal characteristics. **Signal Conversion** :Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits (Text-1)	L1, L2
Module-2	
Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. **Adaptive Noise Cancelling:** Principal noise canceller model, 60-Hzadaptive cancelling using a sine wave model, other applications of adaptive filtering (Text-1)	L1, L2, L3
Module-3	
Data Compression Techniques: Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG (Text-1)	L1, L2, L3
Module-4	

Cardiological signal processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor. (Text -2)	L1, L2, L3
Module-5	
Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. **Analysis of EEG channels:** Detection of EEG rhythms, Template matching for EEG, spike and wave detection (Text-2).	L1, L2, L3

Course outcomes: At the end of the course, students will be able to:

- Possess the basic mathematical, scientific and computational skills necessary to analyse ECG and EEG signals.
- Apply classical and modern filtering and compression techniques for ECG and EEG signals
- Develop a thorough understanding on basics of ECG and EEG feature extraction.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. **Biomedical Digital Signal Processing-** Willis J. Tompkins, PHI 2001.
2. **Biomedical Signal Processing Principles and Techniques-** D C Reddy, McGraw-Hill publications 2005

Reference Book:

Biomedical Signal Analysis-Rangaraj M. Rangayyan, John Wiley & Sons 2002

REAL TIME SYSTEMS

B.E., VII Semester, Electronics & Communication Engineering /Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC743	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (08 Hours per Module)	Exam Hours	03

Credits – 03

Course Objectives: This Course will enable students to:

- Discuss the historical background of Real-time systems and its classifications.
- Describe the concepts of computer control and hardware components for Real-Time Application.
- Discuss the languages to develop software for Real-Time Applications.
- Explain the concepts of operating system and RTS development methodologies.

Modules	RBT Level
Module-1	
Introduction to Real-Time Systems: Historical background, Elements of a Computer Control System, RTS- Definition, Classification of Real-time Systems, Time Constraints, Classification of Programs. **Concepts of Computer Control:** Introduction, Sequence Control, Loop Control, Supervisory Control, Centralized Computer Control, Hierarchical Systems. (Text Book: 1.1 to 1.6 and 2.1 to 2.6)	**L1, L2**
Module-2	
Computer Hardware Requirements for Real-Time Applications: Introduction, General Purpose Computer, Single Chip Microcomputers and Microcontrollers, Specialized Processors, Process-Related Interfaces, Data Transfer Techniques, Communications, Standard Interface.(Text Book: 3.1 to 3.8)	**L1, L2**
Module-3	
Languages for Real-Time Applications: Introduction, Syntax Layout and Readability, Declaration and Initialization of Variables and Constants, Modularity and Variables, Compilation of Modular Programs, Data types, Control Structures, Exception Handling, Low-level facilities, Co-routines, Interrupts and Device Handling, Concurrency, Real-Time Support, Overview of Real-Time Languages. (Text Book: 5.1 to 5.14)	**L1, L2, L3**
Module-4	
Operating Systems: Introduction, Real-Time Multi-Tasking OS, Scheduling Strategies, Priority Structures, Task Management, Scheduler and Real-Time Clock Interrupt Handler, Memory Management, Code Sharing, Resource Control, Task Co-Operation and Communication, Mutual Exclusion.(Text Book: 6.1 to 6.11)	**L1, L2**

Module-5	
Design of RTS – General Introduction: Introduction, Specification Document, Preliminary Design, Single-Program Approach, Foreground/Background System. **RTS Development Methodologies:** Introduction, Yourdon Methodology, Ward and Mellor Method, Hately and Pirbhai Method. (Text Book: 7.1 to 7.5 and 8.1, 8.2, 8.4,8.5)	**L1, L2, L3**

Course Outcomes: At the end of the course, students should be able to:

- Understand the fundamentals of Real time systems and its classifications.
- Understand the concepts of computer control, operating system and the suitable computer hardware requirements for real-time applications.
- Develop the software languages to meet Real time applications.
- Apply suitable methodologies to design and develop Real-Time Systems.

Question Paper Pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Real-Time Computer Control, by Stuart Bennet, 2nd Edn. Pearson Education. 2008.

Reference Books:

1. C.M. Krishna, Kang G. Shin, “Real –Time Systems”, McGraw –Hill International Editions, 1997.
2. Real-Time Systems Design and Analysis, Phillip. A. Laplante, second edition, PHI, 2005.
3. Embedded Systems, Raj Kamal, Tata McGraw Hill, India, third edition, 2005.

Cryptography

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC744	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (08 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This Course will enable students to:

- Enable students to understand the basics of symmetric key and public key cryptography.
- Equip students with some basic mathematical concepts and pseudorandom number generators required for cryptography.
- Enable students to authenticate and protect the encrypted data.
- Enrich knowledge about Email, IP and Web security.

Modules	RBT Level
Module-1	
Basic Concepts of Number Theory and Finite Fields: Divisibility and the divisibility algorithm, Euclidean algorithm, Modular arithmetic, Groups, Rings and Fields, Finite fields of the form GF(p), Polynomial arithmetic, Finite fields of the form GF(2^n)(Text 1: Chapter 3)	L1, L2
Module-2	
Classical Encryption Techniques: Symmetric cipher model, Substitution techniques, Transposition techniques, Steganography (Text 1: Chapter 1) **SYMMETRIC CIPHERS:** Traditional Block Cipher structure, Data Encryption Standard (DES) (Text 1: Chapter 2: Section1, 2)	L1, L2
Module-3	
SYMMETRIC CIPHERS: The AES Cipher. (Text 1: Chapter 4: Section 2, 3, 4) **Pseudo-Random-Sequence Generators and Stream Ciphers:** Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs (Text 2: Chapter 16: Section 1, 2, 3, 4)	L1, L2, L3
Module-4	
More number theory: Prime Numbers, Fermat's and Euler's theorem, Primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7) **Principles of Public-Key Cryptosystems**: The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9: Section 1, 3, 4)	L1, L2, L3
Module-5	

One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA],One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Use basic cryptographic algorithms to encrypt the data.
- Generate some pseudorandom numbers required for cryptographic applications.
- Provide authentication and protection for encrypted data.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of Three sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. William Stallings , "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2. Bruce Schneier, "Applied Cryptography Protocols, Algorithms, and Source code in C", Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X

Reference Books:

1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003.

CAD for VLSI

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

<table>
<tr><td>Subject Code</td><td>15EC745</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam marks</td><td>80</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40
(8 Hours per Module)</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 03</td></tr>
<tr><td colspan="4">Course Objectives: This course will enable students to:
• Understand various stages of Physical design of VLSI circuits
• Know about mapping a design problem to a realizable algorithm
• Become aware of graph theoretic, heuristic and genetic algorithms
• Compare performance of different algorithms</td></tr>
</table>

<table>
<tr><th>Modules</th><th>RBT Level</th></tr>
<tr><td colspan="2">Module 1</td></tr>
<tr><td>Data Structures and Basic Algorithms:
Basic terminology, Complexity issues and NP-Hardness. Examples - Exponential, heuristic, approximation and special cases. Basic Algorithms. Graph Algorithms for Search, spanning tree, shortest path, min-cut and max-cut, Steiner tree. Computational Geometry Algorithms: Line sweep and extended line sweep methods.</td><td>L1, L2</td></tr>
<tr><td colspan="2">Module 2</td></tr>
<tr><td>Basic Data Structures. Atomic operations for layout editors, Linked list of blocks, Bin-based method, Neighbor pointers, corner-stitching, Multi-layer operations, Limitations of existing data structures. Layout specification languages.

Graph algorithms for physical design: Classes of graphs in physical design, Relationship between graph classes, Graph problems in physical design, Algorithms for Interval graphs, permutation graphs and circle graphs.</td><td>L1, L2</td></tr>
<tr><td colspan="2">Module 3</td></tr>
</table>

Partitioning: Problem formulation, Design style specific partitioning problems, Classification of Partitioning Algorithms. Group migration algorithms: Kernighan-Lin algorithm, Fiduccia-Mattheyses Algorithm, Simulated Annealing, Simulated Evolution. **Floor Planning:** Problem formulation, Constraint based floor planning, Rectangular dualization, Simulated evolution algorithms.	L1, L2,L3
Module 4	
Pin Assignment: Problem formulation. Classification of pin assignment problems, General pin assignment problem. **Placement:** Problem formulation, Classification of placement algorithms. Simulation based placement: Simulated annealing, simulated evolution, force directed placement. Partitioning based algorithms: Breur's Algorithm, Terminal propagation algorithm, Other algorithms for placement.	L1,L2,L3
Module 5	
Global Routing: Problem formulation, Classification of Global routing algorithms, Maze routing algorithms: Lee's algorithm, Soukup's algorithm and Hadlock's Algorithm, Line probe algorithms. **Detailed Routing:** Problem formulation, Routing considerations, models, channel routing and switch box routing problems. General river routing problem, Single row routing problem. Two-layer channel routing algorithms: Basic Left Edge Algorithm, Dogleg router, Symbolic router-YACR2.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Appreciate the problems related to physical design of VLSI
- Use genralized graph theoretic approach to VLSI problems
- Design Simulated Annealing and Evolutionary algorithms
- Know various approaches to write generalized algorithms

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of Three sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Algorithms for VLSI Physical Design Automation, 3rd Ed, Naveed Sherwani, 1999 Kluwer Academic Publishers, Reprint 2009 Springer (India) Private Ltd. ISBN 978-81-8128-317-7.

DSP Algorithms and Architecture

B.E., VII Semester, Electronics & Communication Engineering /Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC751	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Figure out the knowledge and concepts of digital signal processing techniques.
- Understand the computational building blocks of DSP processors and its speed issues.
- Understand the various addressing modes, peripherals, interrupts and pipelining structure of TMS320C54xx processor.
- Learn how to interface the external devices to TMS320C54xx processor in various modes.
- Understand basic DSP algorithms with their implementation.

Module-1	RBT Level
Introduction to Digital Signal Processing: Introduction, A Digital Signal – Processing System, The Sampling Process, Discrete Time Sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time-Invariant Systems, Digital Filters, Decimation and Interpolation. **Computational Accuracy in DSP Implementations:** Number Formats for Signals and Coefficients in DSP Systems, Dynamic Range and Precision, Sources of Error in DSP Implementation.	L1, L2
Module-2	
Architectures for Programmable Digital Signal – Processing Devices: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing.	L1, L2, L3
Module-3	
Programmable Digital Signal Processors: Introduction, Commercial Digital Signal-processing Devices, Data Addressing Modes of TMS32OC54XX, Memory Space of TMS32OC54xx Processors, Program Control. Detail Study of TMS320C54X & 54xx Instructions and Programming, On – Chip Peripherals, Interrupts of TMS32OC54XX Processors, Pipeline Operation of TMS32OC54xx Processor.	L1, L2, L3
Module-4	

Implementation of Basic DSP Algorithms: Introduction, The Q – notation, FIR Filters, IIR Filters, Interpolation and Decimation Filters (one example in each case). **Implementation of FFT Algorithms:** Introduction, An FFT Algorithm for DFT Computation, Overflow and Scaling, Bit – Reversed Index. Generation & Implementation on the TMS32OC54xx.	L1, L2, L3
Module-5	
Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices: Introduction, Memory Space Organization, External Bus Interfacing Signals. Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O Direct Memory Access (DMA). **Interfacing and Applications of DSP Processors:** Introduction, Synchronous Serial Interface, A CODEC Interface Circuit, DSP Based Bio-telemetry Receiver, A Speech Processing System, An Image Processing System.	L1, L2, L3
Course Outcomes: At the end of this course, students would be able to • Comprehend the knowledge and concepts of digital signal processing techniques. • Apply the knowledge of DSP computational building blocks to achieve speed in DSP architecture or processor. • Apply knowledge of various types of addressing modes, interrupts, peripherals and pipelining structure of TMS320C54xx processor. • Develop basic DSP algorithms using DSP processors. • Discuss about synchronous serial interface and multichannel buffered serial port (McBSP) of DSP device. • Demonstrate the programming of CODEC interfacing.	

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of Three sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

"Digital Signal Processing", Avatar Singh and S. Srinivasan, Thomson Learning, 2004.

Reference Books:

1. "Digital Signal Processing: A practical approach", Ifeachor E. C., Jervis B. W Pearson-Education, PHI, 2002.
2. "Digital Signal Processors", B Venkataramani and M Bhaskar, TMH, 2nd, 2010
3. "Architectures for Digital Signal Processing", Peter Pirsch John Weily, 2008

IoT & WIRELESS SENSOR NETWORKS

B.E., VII Semester, Electronics & Communication Engineering /Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC752	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Understand various sources of IoT & M2M communication protocols.
- Describe Cloud computing and design principles of IoT.
- Become aware of MQTT clients, MQTT server and its programming.
- Understand the architecture and design principles of WSNs.
- Enrich the knowledge about MAC and routing protocols in WSNs.

Module-1	RBT Level
Overview of Internet of Things: IoT Conceptual Framework, IoT Architectural View, Technology Behind IoT, Sources of IoT,M2M communication, Examples of IoT. Modified OSI Model for the IoT/M2M Systems, data enrichment, data consolidation and device management at IoT/M2M Gateway, web communication protocols used by connected IoT/M2M devices, Message communication protocols (CoAP-SMS, CoAP-MQ, MQTT,XMPP) for IoT/M2M devices.	L1, L2
Module-2	
Architecture and Design Principles for IoT: Internet connectivity, Internet-based communication,IPv4, IPv6,6LoWPAN protocol, IP Addressing in the IoT, Application layer protocols: HTTP, HTTPS,FTP,TELNET and ports. **Data Collection, Storage and Computing using a Cloud Platform:** Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service models, IoT Cloud- based data collection, storage and computing services using Nimbits.	L1, L2
Module-3	

Prototyping and Designing Software for IoT Applications: Introduction, Prototyping Embedded device software, Programming Embedded Device Arduino Platform using IDE, Reading data from sensors and devices, Devices, Gateways, Internet and Web/Cloud services software development. Programming MQTT clients and MQTT server. Introduction to IoT privacy and security. Vulnerabilities, security requirements and threat analysis, IoT Security Tomography and layered attacker model.	L1, L2, L3
Module-4	
Overview of Wireless Sensor Networks: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. **Architectures**: Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture-Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design principles for WSNs, Service interfaces of WSNs Gateway Concepts.	L1, L2, L3
Module-5	
Communication Protocols: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Contention based protocols(CSMA,PAMAS), Schedule based protocols (LEACH, SMACS, TRAMA) Address and Name Management in WSNs, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Hierarchical networks by clustering.	L1, L2, L3
Course Outcomes: At the end of the course, students will be able to: • Describe the OSI Model for the IoT/M2M Systems. • Understand the architecture and design principles for IoT. • Learn the programming for IoT Applications. • Identify the communication protocols which best suits the WSNs.	

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:
1. Raj Kamal, ”Internet of Things-Architecture and design principles”, McGraw Hill Education. 2. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005. 3. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
Reference Books:
1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, And Applications”, John Wiley, 2007. 2. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

PATTERN RECOGNITION

B.E., VII Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC753	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: The objectives of this course are to:

- Introduce mathematical tools needed for Pattern Recognition
- Impart knowledge about the fundamentals of Pattern Recognition.
- Provide knowledge of recognition, decision making and statistical learning problems
- Introduce parametric and non-parametric techniques, supervised learning and clustering concepts of pattern recognition

Modules

Module-1	**RBT Level**
Introduction: Importance of pattern recognition, Features, Feature Vectors, and Classifiers, Supervised, Unsupervised, and Semi-supervised learning, Introduction to Bayes Decision Theory, Discriminant Functions and Decision Surfaces, Gaussian PDF and Bayesian Classification for Normal Distributions.	L1, L2
Module-2	
Data Transformation and Dimensionality Reduction: Introduction, Basis Vectors, The Karhunen Loeve (KL) Transformation, Singular Value Decomposition, Independent Component Analysis (Introduction only). Nonlinear Dimensionality Reduction, Kernel PCA.	L1, L2
Module-3	
Estimation of Unknown Probability Density Functions: Maximum Likelihood Parameter Estimation, Maximum a Posteriori Probability estimation, Bayesian Interference, Maximum Entropy Estimation, Mixture Models, Naive-Bayes Classifier, The Nearest Neighbor Rule.	L1, L2, L3
Module-4	
Linear Classifiers: Introduction, Linear Discriminant Functions and Decision Hyperplanes, The Perceptron Algorithm, Mean Square Error Estimate, Stochastic Approximation of LMS Algorithm, Sum of Error Estimate.	L1, L2, L3
Module-5	
Nonlinear Classifiers: The XOR Problem, The two Layer Perceptron, Three Layer Perceptron, Back propagation Algorithm, Basic Concepts of Clustering, Introduction to Clustering , Proximity Measures.	L1, L2, L3

Course outcomes: At the end of the course, students will be able to:

- Identify areas where Pattern Recognition and Machine Learning can offer a solution.
- Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems
- Describe genetic algorithms, validation methods and sampling techniques
- Describe and model data to solve problems in regression and classification
- Implement learning algorithms for supervised tasks

Question paper pattern:

The question paper will have ten questions.

- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Pattern Recognition: Sergios Theodoridis, Konstantinos Koutroumbas, Elsevier India Pvt. Ltd (Paper Back), 4th edition.

Reference Books:

1. **The Elements of Statistical Learning:** Trevor Hastie, Springer-Verlag New York, LLC (Paper Back), 2009.
2. **Pattern Classification:** Richard O. Duda, Peter E. Hart, David G. Stork. John Wiley & Sons, 2012.
3. **Pattern Recognition and Image Analysis Earl Gose:** Richard Johnsonbaugh, Steve Jost, ePub eBook.

ADVANCED COMPUTER ARCHITECTURE

B.E., VII Semester, Electronics & Communication Engineering /Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC754	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course Objectives: This course will enable students to:

- Understand the various parallel computer models and conditions of parallelism
- Explain the control flow, dataflow and demand driven machines
- Study CISC, RISC, superscalar, VLIW and multiprocessor architectures
- Understand the concept of pipelining and memory hierarchy design
- Explain cache coherence protocols.

Module-1	RBT Level
Parallel Computer Models: The state of computing, Classification of parallel computers, Multiprocessors and multicomputer, Multivectors and SIMD computers. **Program and Network Properties:** Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism, Program partitioning and scheduling, Grain Size and latency.	L1, L2
Module-2	
Program flow mechanisms: Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms. **Principles of Scalable Performance**: Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.	L1, L2, L3
Module-3	
Speedup Performance Laws: Amdhal's law, Gustafson's law, Memory bounded speed up model, Scalability Analysis and Approaches. **Advanced Processors:** Advanced processor technology, Instruction-set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar Processors, VLIW Architectures.	L1, L2, L3
Module-4	
Pipelining: Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline Design, Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design. **Memory Hierarchy Design:** Cache basics & cache performance, reducing miss rate and miss penalty, multilevel cache hierarchies, main memory organizations, design of memory hierarchies.	L1, L2, L3

Module-5	
Multiprocessor Architectures: Symmetric shared memory architectures, distributed shared memory architectures, models of memory consistency, cache coherence protocols (MSI, MESI, MOESI), scalable cache coherence, overview of directory based approaches, design challenges of directory protocols, memory based directory protocols, cache based directory protocols.	L1, L2, L3

Course Outcomes: At the end of the course, the students will be able to:

- Explain parallel computer models and conditions of parallelism
- Differentiate control flow, dataflow, demand driven mechanisms
- Explain the principle of scalable performance
- Discuss advanced processors architectures like CISC, RISC, superscalar and VLIW
- Understand the basics of instruction pipelining and memory technologies
- Explain the issues in multiprocessor architectures

Question paper pattern:

The question paper will have ten questions.

- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Kai Hwang, “Advanced computer architecture”; TMH.

Reference Books:

1. Kai Hwang and Zu, “Scalable Parallel Computers Architecture”; MGH.
2. M.J Flynn, “Computer Architecture, Pipelined and Parallel Processor Design”; Narosa Publishing.
3. D.A.Patterson, J.L.Hennessy, “Computer Architecture :A quantitative approach”; Morgan Kauffmann Feb, 2002.

SATELLITE COMMUNICATION

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS)]

Subject Code	15EC755	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to

- Understand the basic principle of satellite orbits and trajectories.
- Study of electronic systems associated with a satellite and the earth station.
- Understand the various technologies associated with the satellite communication.
- Focus on a communication satellite and the national satellite system.
- Study of satellite applications focusing various domains services such as remote sensing, weather forecasting and navigation.

Module-1	RBT Level
Satellite Orbits and Trajectories: Definition, Basic Principles, Orbital parameters, Injection velocity and satellite trajectory, Types of Satellite orbits, Orbital perturbations, Satellite stabilization, Orbital effects on satellite's performance, Eclipses, Look angles: Azimuth angle, Elevation angle.	L1, L2
Module-2	
Satellite subsystem: Power supply subsystem, Attitude and Orbit control, Tracking, Telemetry and command subsystem, Payload. **Earth Station:** Types of earth station, Architecture, Design considerations, Testing, Earth station Hardware, Satellite tracking.	L1, L2
Module-3	
Multiple Access Techniques: Introduction, FDMA (No derivation), SCPC Systems, MCPC Systems, TDMA, CDMA, SDMA. **Satellite Link Design Fundamentals**: Transmission Equation, Satellite Link Parameters, Propagation considerations.	L1, L2, L3
Module-4	
Communication Satellites: Introduction, Related Applications, Frequency Bands, Payloads, Satellite Vs. Terrestrial Networks, Satellite Telephony, Satellite Television, Satellite radio, Regional satellite Systems, National Satellite Systems.	L1, L2
Module-5	

Remote Sensing Satellites: Classification of remote sensing systems, orbits, Payloads, Types of images: Image Classification, Interpretation, Applications. **Weather Forecasting Satellites**: Fundamentals, Images, Orbits, Payloads, Applications. **Navigation Satellites**: Development of Satellite Navigation Systems, GPS system, Applications.	L1, L2, L3

Course Outcomes: At the end of the course, the students will be able to:

- Describe the satellite orbits and its trajectories with the definitions of parameters associated with it.
- Describe the electronic hardware systems associated with the satellite subsystem and earth station.
- Describe the various applications of satellite with the focus on national satellite system.
- Compute the satellite link parameters under various propagation conditions with the illustration of multiple access techniques.

Question Paper pattern:

- The Question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full Questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The Students will have to answer 5 full Questions, selecting one full Question from each module.

Text Book:

Anil K. Maini, Varsha Agrawal, Satellite Communications, Wiley India Pvt. Ltd., 2015, ISBN: 978-81-265-2071-8.

Reference Books :

1. Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006
2. Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd Edition, Wiley India Pvt. Ltd , 2017, ISBN: 978-81-265-0833-4

ADVANCED COMMUNICATION LAB

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ECL76	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory = 03	Exam Marks	80
RBT Levels	L1, L2, L3	Exam Hours	03
CREDITS – 02			

Course objectives: This course will enable students to:

- Design and demonstrate the digital modulation techniques
- Demonstrate and measure the wave propagation in microstrip antennas
- Characteristics of microstrip devices and measurement of its parameters.
- Model an optical communication system and study its characteristics.
- Simulate the digital communication concepts and compute and display various parameters along with plots/figures.

Laboratory Experiments

PART-A: Following Experiments No. 1 to 4 has to be performed using discrete components.

1. Time Division Multiplexing and Demultiplexing of two bandlimited signals.
2. ASK generation and detection
3. FSK generation and detection
4. PSK generation and detection
5. Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench.
6. Measurement of directivity and gain of microstrip dipole and Yagi antennas.
7. Determination of
    a. Coupling and isolation characteristics of microstrip directional coupler.
    b. Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate.
    c. Power division and isolation of microstrip power divider.
8. Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.

PART-B: Simulation Experiments using SCILAB/MATLAB/Simulink or LabView

1. Simulate NRZ, RZ, half-sinusoid and raised cosine pulses and generate eye diagram for binary polar signaling.

2. Simulate the Pulse code modulation and demodulation system and display the waveforms.

3. Simulate the QPSK transmitter and receiver. Plot the signals and its constellation diagram.

4. Test the performance of a binary differential phase shift keying system by simulating the non-coherent detection of binary DPSK.

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Determine the characteristics and response of microwave devices and optical waveguide.
- Determine the characteristics of microstrip antennas and devices and compute the parameters associated with it.
- Simulate the digital modulation schemes with the display of waveforms and computation of performance parameters.
- Design and test the digital modulation circuits/systems and display the waveforms.

Conduct of Practical Examination:

- All laboratory experiments are to be considered for practical examination.
- For examination one question from **PART-A** and one question from **PART-B or** only one question from **PART-B** experiments based on the complexity, to be set.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

VLSI LAB

B.E., VII Semester, Electronics & Communication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15ECL77	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory = 03	Exam Marks	80
RBT Levels	L1, L2, L3	Exam Hours	03
CREDITS – 02			

Course objectives: This course will enable students to:

- Explore the CAD tool and understand the flow of the Full Custom IC design cycle.
- Learn DRC, LVS and Parasitic Extraction of the various designs.
- Design and simulate the various basic CMOS analog circuits and use them in higher circuits like data converters using design abstraction concepts.
- Design and simulate the various basic CMOS digital circuits and use them in higher circuits like adders and shift registers using design abstraction concepts.

Experiments can be conducted using any of the following or equivalent design tools: Cadence/Synopsis/Mentor Graphics/Microwind

Laboratory Experiments

PART - A

ASIC-DIGITAL DESIGN

1. Write Verilog Code for the following circuits and their Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints*. Do the initial timing verification with gate level simulation.
   i. An inverter
   ii. A Buffer
   iii. Transmission Gate
   iv. Basic/universal gates
   v. Flip flop -RS, D, JK, MS, T
   vi. Serial & Parallel adder
   vii. 4-bit counter [Synchronous and Asynchronous counter]
   viii. Successive approximation register [SAR]

PART - B
ANALOG DESIGN

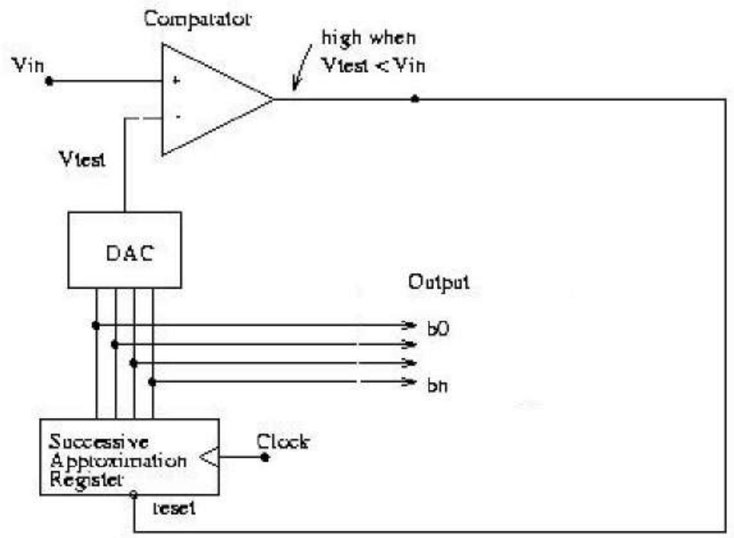
1. Design an Inverter with given specifications**, completing the design flow mentioned below:
   a. Draw the schematic and verify the following
      i) DC Analysis
      ii) Transient Analysis
   b. Draw the Layout and verify the DRC, ERC
   c. Check for LVS
   d. Extract RC and back annotate the same and verify the Design
   e. Verify & Optimize for Time, Power and Area to the given constraint*

2. Design the (i) Common source and Common Drain amplifier and (ii) A Single Stage differential amplifier, with given specifications**, completing the design flow mentioned below:
   a. Draw the schematic and verify the following
      i) DC Analysis
      ii) AC Analysis
      iii) Transient Analysis
   b. Draw the Layout and verify the DRC, ERC
   c. Check for LVS
   d. Extract RC and back annotate the same and verify the Design.

3. Design an op-amp with given specification** using given differential amplifier Common source and Common Drain amplifier in library*** and completing the design flow mentioned below:
   a. Draw the schematic and verify the following
      i) DC Analysis
      ii). AC Analysis
      iii) Transient Analysis
   b. Draw the Layout and verify the DRC, ERC
   c. Check for LVS
   d. Extract RC and back annotate the same and verify the Design.

4. Design a 4 bit R-2R based DAC for the given specification and completing the design flow mentioned using given op-amp in the library***.
   a. Draw the schematic and verify the following
      i) DC Analysis
      ii) AC Analysis
      iii) Transient Analysis
   b. Draw the Layout and verify the DRC, ERC

5. For the SAR based ADC mentioned in the figure below draw the mixed signal schematic and verify the functionality by completing ASIC Design FLOW. [Specifications to GDS-II]



*	An appropriate constraint should be given.
**	Appropriate specification should be given.
***	Applicable Library should be added & information should be given to the Designer.

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Write test bench to simulate various digital circuits.
- Interpret concepts of DC Analysis, AC Analysis and Transient Analysis in analog circuits.
- Design and simulate basic CMOS circuits like inverter, common source amplifier and differential amplifiers.
- Use basic amplifiers and further design higher level circuits like operational amplifier and analog/digital converters to meet desired parameters.
- Use transistors to design gates and further using gates realize shift registers and adders to meet desired parameters.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- For examination, one question from **PART-A** and one question from **PART-B** to be set.
- Students are allowed to pick one experiment from the lot.
- Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

B.E E&C EIGTH SEMESTER SYLLABUS

Wireless Cellular and LTE 4G Broadband

B.E., VIII Semester, Electronics &Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC81	IA Marks	20
Number of Lecture	04	Exam Marks	80
Total Number	50 (10 Hours / Module)	Exam Hours	03
CREDITS – 04			

Course Objectives: This course will enable students to:

- Understand the basics of LTE standardization phases and specifications.
- Explain the system architecture of LTE and E-UTRAN, the layer of LTE, based on the use of OFDMA and SC-FDMA principles.
- Analyze the role of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer, for transferring the EPS bearer.
- Analyze the main factors affecting LTE performance including mobile speed and transmission bandwidth.

Module – 1	RBT Level
Key Enablers for LTE features: OFDM, Single carrier FDMA, Single carrier FDE, Channel Dependent Multiuser Resource Scheduling, Multi antenna Techniques, IP based Flat network Architecture, LTE Network Architecture. (Sec 1.4- 1.5 of Text). **Wireless Fundamentals:** Cellular concept, Broadband wireless channel (BWC), Fading in BWC, Modeling BWC – Empirical and Statistical models, Mitigation of Narrow band and Broadband Fading (Sec 2.2 – 2.7of Text).	L1, L2
Module – 2	
Multicarrier Modulation: OFDM basics, OFDM in LTE, Timing and Frequency Synchronization, PAR, SC-FDE (Sec 3.2 – 3.6 of Text). **OFDMA and SC-FDMA:**OFDM with FDMA,TDMA,CDMA, OFDMA, SC-FDMA, OFDMA and SC-FDMA in LTE (Sec 4.1 – 4.3, 4.5 of Text). **Multiple Antenna Transmission and Reception:** Spatial Diversity overview, Receive Diversity, Transmit Diversity, Interference cancellation and signal enhancement, Spatial Multiplexing, Choice between Diversity, Interference suppression and Spatial Multiplexing (Sec 5.1 – 5.6 of Text).	L1, L2
Module – 3	
Overview and Channel Structure of LTE: Introduction to LTE, Channel Structure of LTE, Downlink OFDMA Radio Resource, Uplink	L1, L2

SC-FDMA Radio Resource(Sec 6.1 – 6.4 of Text). . **Downlink Transport Channel Processing:** Overview, Downlink shared channels, Downlink Control Channels, Broadcast channels, Multicast channels, Downlink physical channels, H-ARQ on Downlink(Sec 7.1 – 7.7 of Text).	
Module – 4	
Uplink Channel Transport Processing: Overview, Uplink shared channels, Uplink Control Information, Uplink Reference signals, Random Access Channels, H-ARQ on uplink (Sec 8.1 – 8.6 of Text). **Physical Layer Procedures:** Hybrid – ARQ procedures, Channel Quality Indicator CQI feedback, Precoder for closed loop MIMO Operations, Uplink channel sounding, Buffer status Reporting in uplink, Scheduling and Resource Allocation, Cell Search, Random Access Procedures, Power Control in uplink(Sec 9.1- 9.6, 9.8, 9.9, 9.10 Text).	L1, L2
Module – 5	
Radio Resource Management and Mobility Management: PDCP overview, MAC/RLC overview, RRC overview, Mobility Management, Inter-cell Interference Coordination(Sec 10.1 – 10.5 of Text).	L1, L2

Course Outcomes: At the end of the course, students will be able to:

- Understand the system architecture and the functional standard specified in LTE 4G.
- Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.
- Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
- Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Question Paper pattern:

- The Question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full Questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The Students will have to answer 5 full Questions, selecting one full Question from each module.

Text Book:

Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, ‘Fundamentals of LTE’, Prentice Hall, Communications Engg. and Emerging Technologies.

Reference Books:

1. LTE for UMTS Evolution to LTE-Advanced' Harri Holma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.
2. 'EVOLVED PACKET SYSTEM (EPS) ; THE LTE AND SAE EVOLUTION OF 3G UMTS' by Pierre Lescuyer and Thierry Lucidarme, 2008, John Wiley & Sons, Ltd. Print ISBN:978-0-470-05976-0.
3. 'LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, Issam Toufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

FIBER OPTICS and NETWORKS

B.E., VIII Semester, Electronics &Communication Engineering

[As per Choice Based Credit System (CBCS)]

Subject Code	15EC82	IA Marks	20
Number of Lecture Hours/Week	4	Exam Marks	80
Total Number of Lecture Hours	50(10 Hours / Module)	Exam Hours	03

CREDITS – 04

Course Objectives: This course will enable students to:

- Learn the basic principle of optical fiber communication with different modes of light propagation.
- Understand the transmission characteristics and losses in optical fiber.
- Study of optical components and its applications in optical communication networks.
- Learn the network standards in optical fiber and understand the network architectures along with its functionalities.

Module -1	RBT Level
Optical fiber Communications: Historical development, The general system, Advantages of optical fiber communication, Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, Photonic crystal fibers. (Text 2)	L1, L2
Module -2	
Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. **Optical Fiber Connectors:** Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers. (Text 2)	L1, L2
Module -3	
Optical sources: Energy Bands, Direct and Indirect Bandgaps, Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant frequencies, Laser Diode structures and Radiation Patterns: Single mode lasers. **Photodetectors:** Physical principles of Photodiodes, Photodetector noise, Detector response time. **Optical Receiver:** Optical Receiver Operation: Error sources,	L1, L2

Front End Amplifiers, Receiver sensitivity, Quantum Limit. (Text 1)	
Module -4	
WDM Concepts and Components: Overview of WDM: Operational Principles of WDM, WDM standards, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings, Active Optical Components, Tunable light sources, **Optical amplifiers:** Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers. (Text 1)	L1, L2
Module -5	
Optical Networks: Optical network evolution and concepts: Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, Public telecommunication network overview. Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching, Optical burst switching networks, Optical network deployment: Long-haul networks, Metropoliton area networks, Access networks, Local area networks. (Text 2)	L1, L2

Course Outcomes: At the end of the course, students will be able to:

1. Classification and working of optical fiber with different modes of signal propagation.
2. Describe the transmission characteristics and losses in optical fiber communication.
3. Describe the construction and working principle of optical connectors, multiplexers and amplifiers.
4. Describe the constructional features and the characteristics of optical sources and detectors.
5. Illustrate the networking aspects of optical fiber and describe various standards associated with it.

Question Paper pattern:

- The Question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full Questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The Students will have to answer 5 full Questions, selecting one full Question from each module.

Text Books:

1. Gerd Keiser , Optical Fiber Communication, 5th Edition, McGraw Hill

Education(India) Private Limited, 2015. ISBN:1-25-900687-5.
2. John M Senior, Optical Fiber Communications, Principles and Practice, 3rd Edition, Pearson Education, 2010, ISBN:978-81-317-3266-3

Reference Book:

Joseph C Palais, Fiber Optic Communication , Pearson Education, 2005, ISBN:0130085103

Micro Electro Mechanical Systems

B.E., VIII Semester, Electronics &Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC831	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Understand overview of microsystems, their fabrication and application areas.
- Working principles of several MEMS devices.
- Develop mathematical and analytical models of MEMS devices.
- Know methods to fabricate MEMS devices.
- Various application areas where MEMS devices can be used.

Module 1	RBT Level
Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	L1, L2
Module 2	
Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication**: Introduction, Molecular Theory of Matter and Inter-molecular Forces, Plasma Physics, Electrochemistry.	L1, L2
Module 3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	L1,L2,L3
Module 4	

Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	L1,L2,L3
Module 5	
Overview of Micromanufacturing: Introduction, Bulk Micromanufacturing, Surface Micromachining, The LIGA Process, Summary on Micromanufacturing.	L1,L2

Course Outcomes: After studying this course, students will be able to:

- Appreciate the technologies related to Micro Electro Mechanical Systems.
- Understand design and fabrication processes involved with MEMS devices.
- Analyse the MEMS devices and develop suitable mathematical models
- Know various application areas for MEMS device

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of Three sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley.

Reference Books:

1. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cenage Learning.

SPEECH PROCESSING

B.E., VIII Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC832	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course enables students to:

- Introduce the models for speech production
- Develop time and frequency domain techniques for estimating speech parameters
- Introduce a predictive technique for speech compression
- Provide fundamental knowledge required to understand and analyse speech recognition, synthesis and speaker identification systems.

Modules	
Module-1	**RBT Level**
Fundamentals of Human Speech Production: The Process of Speech Production, Short-Time Fourier Representation of Speech, The Acoustic Theory of Speech Production, Lossless Tube Models of the Vocal Tract, Digital Models for Sampled Speech Signals	L1, L2
Module-2	
Time-Domain Methods for Speech Processing: Introduction to Short-Time Analysis of Speech, Short-Time Energy and Short-Time Magnitude, Short-Time Zero-Crossing Rate, The Short-Time Autocorrelation Function, The Modified Short-Time Autocorrelation Function, The Short-Time Average Magnitude Difference Function.	L1, L2
Module-3	
Frequency Domain Representations: Discrete-Time Fourier Analysis, Short-Time Fourier Analysis, Spectrographic Displays, Overlap Addition(OLA),Method of Synthesis, Filter Bank Summation(FBS) Method of Synthesis, Time-Decimated Filter Banks, Two-Channel Filter Banks, Implementation of the FBS Method Using the FFT, OLA Revisited, Modifications of the STFT.	L1, L2
Module-4	
The Cepstrum and Homomorphic Speech Processing: Homomorphic Systems for Convolution, Homomorphic Analysis of the Speech Model, Computing the Short-Time Cepstrum and Complex Cepstrum of Speech, Homomorphic Filtering of Natural Speech, Cepstrum Analysis of All-Pole Models, Cepstrum Distance Measures.	L1, L2, L3
Module-5	
Linear Predictive Analysis of Speech Signals: Basic Principles of Linear	L1, L2,

Predictive Analysis, Computation of the Gain for the Model, Frequency Domain Interpretations of Linear Predictive Analysis, Solution of the LPC Equations, The Prediction Error Signal, Some Properties of the LPC Polynomial A(z), Relation of Linear Predictive Analysis to Lossless Tube Models, Alternative Representations of the LP Parameters.	L3
Course outcomes: Upon completion of the course, students will be able to: • Model speech production system and describe the fundamentals of speech. • Extract and compare different speech parameters. • Choose an appropriate speech model for a given application. • Analyse speech recognition, synthesis and speaker identification systems	
Question paper pattern: • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of Three sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Book: **Theory and Applications of Digital Speech Processing-**Rabiner and Schafer, Pearson Education 2011	
Reference Books: 3. **Fundamentals of Speech Recognition-** Lawrence Rabiner and Biing-Hwang Juang, Pearson Education, 2003. 4. **Speech and Language Processing–An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition-** Daniel Jurafsky and James H Martin, Pearson Prentice Hall 2009.	

Radar Engineering

B.E., VIII Semester, Electronics & Communication Engineering/
Telecommunication Engineering
[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC833	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to:

- Understand the Radar fundamentals and analyze the radar signals.
- Understand various technologies involved in the design of radar transmitters and receivers.
- Learn various radars like MTI, Doppler and tracking radars and their comparison

Modules	RBT Level
Module-1	
Basics of Radar: Introduction, Maximum Unambiguous Range, Radar Waveforms, Definitions with respect to pulse waveform - PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power. **Simple form of the Radar Equation**, Radar Block Diagram and Operation, Radar Frequencies, Applications of Radar, The Origins of Radar, Illustrative Problems. **(Chapter 1 of Text)**	L1, L2, L3
Module-2	
The Radar Equation: Prediction of Range Performance, Detection of signal in Noise, Minimum Detectable Signal, Receiver Noise, SNR, Modified Radar Range Equation, Envelope Detector — False Alarm Time and Probability, Probability of Detection, **Radar Cross Section of Targets:** simple targets – sphere, cone-sphere, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems. **(Chapter 2 of Text, Except 2.4, 2.6, 2.8 & 2.11)**	L1, L2, L3
Module-3	
MTI and Pulse Doppler Radar: Introduction, Principle, Doppler Frequency Shift, Simple CW Radar, Sweep to Sweep subtraction and Delay Line Canceler, MTI Radar with – Power Amplifier Transmitter, Delay Line Cancelers — Frequency Response of Single Delay- Line Canceler, Blind Speeds, Clutter Attenuation, MTI Improvement Factor, N- Pulse Delay-Line Canceler, **Digital MTI Processing** – Blind phases, I and Q Channels, Digital MTI Doppler signal processor, Moving Target Detector- Original MTD. **(Chapter 3: 3.1, 3.2, 3.5, 3.6 of Text)**	L1, L2, L3
Module-4	
Tracking Radar: Tracking with Radar- Types of Tracking Radar Systems, Monopulse Tracking- Amplitude Comparison Monopulse (one-and two-coordinates), Phase Comparison Monopulse. **Sequential Lobing**, Conical Scan Tracking, Block Diagram of Conical Scan	L1, L2, L3

Tracking Radar, Tracking in Range, Comparison of Trackers. **(Chapter 4: 4.1, 4.2, 4.3 of Text)**	
Module-5	
The Radar Antenna: Functions of The Radar Antenna, Antenna Parameters, Reflector Antennas and Electronically Steered Phased array Antennas. **(Chapter 9: 9.1, 9.2 9.4, 9.5 of Text)** **Radar Receiver:** The Radar Receiver, Receiver Noise Figure, Super Heterodyne Receiver, Duplexers and Receivers Protectors, Radar Displays. **(Chapter 11 of Text)**	L1, L2, L3

Course outcomes: At the end of the course, students will be able to:

- Understand the radar fundamentals and radar signals.
- Explain the working principle of pulse Doppler radars, their applications and limitations
- Describe the working of various radar transmitters and receivers.
- Analyze the range parameters of pulse radar system which affect the system performance

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Introduction to Radar Systems- Merrill I Skolink, 3e, TMH, 2001.

Reference Books:

1. Radar Principles, Technology, Applications — Byron Edde, Pearson Education, 2004.
2. Radar Principles – Peebles. Jr, P.Z. Wiley. New York, 1998.
3. Principles of Modem Radar: Basic Principles – Mark A. Rkhards, James A. Scheer, William A. HoIm. Yesdee, 2013

MACHINE LEARNING

B.E., VIII Semester, Electronics & Communication Engineering/ Telecommunication Engineering

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	15EC834	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40 (8 Hours / Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Introduce some concepts and techniques that are core to Machine Learning.
- Understand learning and decision trees.
- Acquire knowledge of neural networks, Bayesian techniques and instant based learning.
- Understand analytical learning and reinforced learning.

Modules	
Module-1	**RBT Level**
Learning: Designing Learning systems, Perspectives and Issues, Concept Learning, Version Spaces and Candidate Elimination Algorithm, Inductive bias.	L1, L2
Module-2	
Decision Tree and ANN: Decision Tree Representation, Hypothesis Space Search, Inductive bias in decision tree, issues in Decision tree. Neural Network Representation, Perceptrons, Multilayer Networks and Back Propagation Algorithms.	L1, L2
Module-3	
Bayesian and Computational Learning: Bayes Theorem, Bayes Theorem Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier.	L1, L2
Module-4	
Instant Based Learning and Learning set of rules: K- Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning. Sequential Covering Algorithms, Learning Rule Sets, Learning First Order Rules, Learning Sets of First Order Rules.	L1, L2
Module-5	
Analytical Learning and Reinforced Learning: Perfect Domain Theories, Explanation Based Learning, Inductive-Analytical Approaches, FOCL Algorithm, Reinforcement Learning.	L1, L2

Course outcomes: At the end of the course, students should be able to:

- Understand the core concepts of Machine learning.
- Appreciate the underlying mathematical relationships within and across Machine Learning algorithms.
- Explain paradigms of supervised and un-supervised learning.
- Recognize a real world problem and apply the learned techniques of Machine Learning to solve the problem.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of Three sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Machine Learning-Tom M. Mitchell, McGraw-Hill Education, (INDIAN EDITION), 2013.

Reference Books:

1. **Introduction to Machine Learning-** Ethem Alpaydin, 2nd Ed., PHI Learning Pvt. Ltd., 2013.
2. **The Elements of Statistical Learning-**T. Hastie, R. Tibshirani, J. H. Friedman, Springer; 1st edition, 2001.

NETWORK AND CYBER SECURITY

B.E., VIII Semester, Electronics & Communication Engineering

[As per Choice Based credit System (CBCS) Scheme

Subject Code	15EC835	IA Marks	20
Number of Lecture Hours/Week	03	Exam marks	80
Total Number of Lecture Hours	40 (8 Hours per Module)	Exam Hours	03
CREDITS – 03			

Course Objectives: This course will enable students to:

- Know about security concerns in Email and Internet Protocol.
- Understand cyber security concepts.
- List the problems that can arise in cyber security.
- Discuss the various cyber security frame work.

Module-1	RBT Level
Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH) (Text 1: Chapter 15)	L1, L2
Module-2	
E-mail Security: Pretty Good Privacy, S/MIME, Domain keys identified mail (Text 1: Chapter 17)	L1, L2
Module-3	
IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations Internet Key Exchange. Cryptographic Suites(Text 1: Chapter 18)	L1, L2
Module-4	
Cyber network security concepts: Security Architecture, antipattern: signature based malware detection versus polymorphic threads, document driven certification and accreditation, policy driven security certifications. Refactored solution: reputational, behavioural and entropy based malware detection. **The problems:** cyber antipatterns concept, forces in cyber antipatterns, cyber anti pattern templates, cyber security antipattern catalog (Text-2: Chapter1 & 2)	L1, L2, L3
Module-5	
Cyber network security concepts contd. : **Enterprise security using Zachman framework** Zachman framework for enterprise architecture, primitive models versus composite models, architectural problem solving patterns, enterprise workshop, matrix mining, mini patterns for problem solving meetings. **Case study:** cyber security hands on – managing administrations	L1, L2, L3

and root accounts, installing hardware, reimaging OS, installing system protection/ antimalware, configuring firewalls (Text-2: Chapter 3 & 4).	

Course Outcomes: After studying this course, students will be able to:

- Explain network security protocols
- Understand the basic concepts of cyber security
- Discuss the cyber security problems
- Explain Enterprise Security Framework
- Apply concept of cyber security framework in computer system administration

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of Three sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3.

2. Thomas J. Mowbray, "Cyber Security – Managing Systems, Conducting Testing, and Investigating Intrusions", Wiley.

Reference Books:

1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003.

Electrical and Electronics Engineering

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

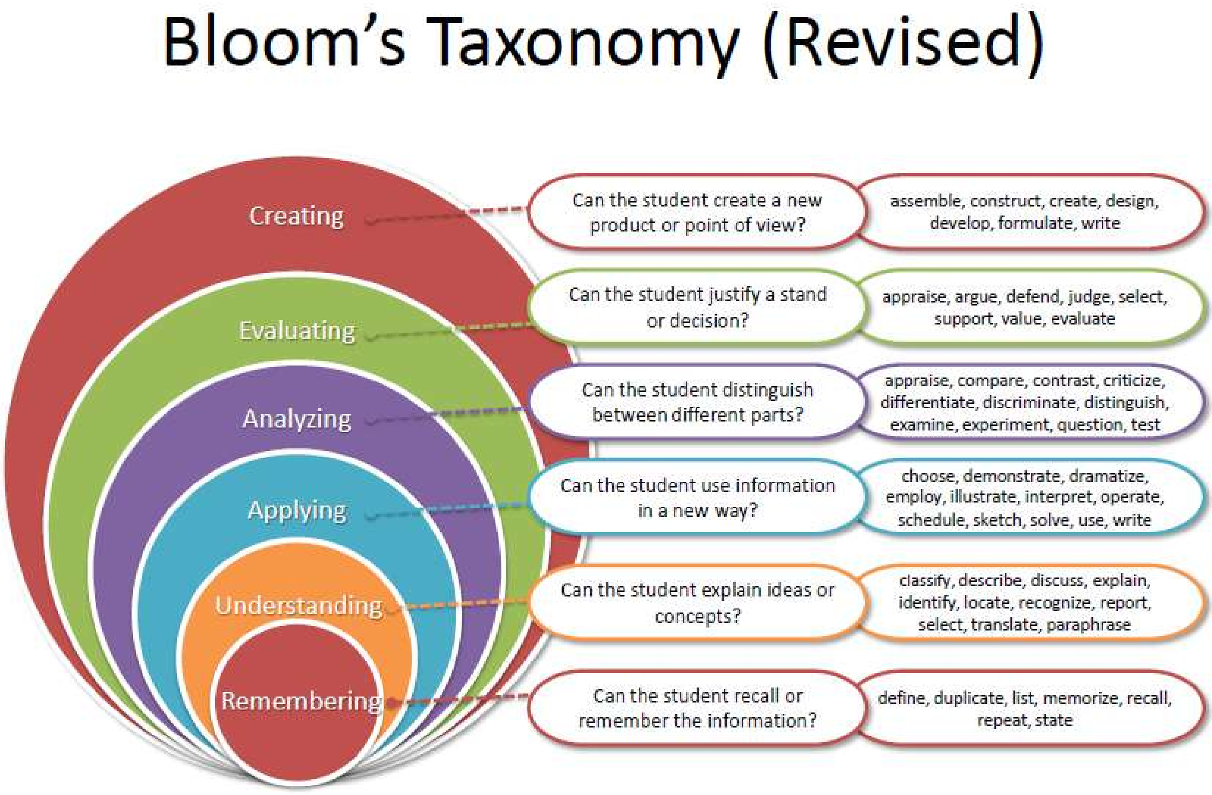
Scheme of Teaching and Examination and Syllabus

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

III TO VIII SEMESER

(Effective from Academic year 2015-16)

CATEGORIZATION FOR THE THINKING PROCESS



Bloom's Revised Taxonomy Levels, Level Definitions and attributes levels along with action verbs that can be used when developing learning outcomes.			
Level		Level Definitions and attributes	Verbs(not comprehensive)
Lower order thinking skills (LOTS)	Remembering (Knowledge) L_1	Students exhibit memory/rote memorization of previously learnt materials by recognition,recalling facts, terms, basic concepts, and simple answers. Able to remember, but not necessarily fully understanding the material.	Copy, Choose, Define, Discover, Describe, Duplicate, Enumerate, Find, How, Identify, Label, List, Locate, Listen, Memorize, Match, Name, Omit, Quote, Recall, Relate, Reproduce, Recognize, Select, Show, Spell, Tell, Tabulate, Who, When, Where etc.
	Understanding (Comprehension) L_2	Students demonstrate understanding of facts and ideas by interpreting, exemplifying, classifying, inferring, summarizing, comparing and explaining main ideas with own words.	Ask, Classify, Compare, Contrast, Demonstrate, Describe, Extend, Differentiate, Distinguish, Discuss, Express, Explain, Group, Illustrate, Infer, Interpret, Outline, Paraphrase, Rephrase, Relate, Show, Summarize, Select, Translate, Restate etc.
	Applying (Application) L_3	Students solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Calculate, Predict, Apply, Solve, Illustrate, Use, Demonstrate, Determine, Model, Build, Construct, Develop, Experiment With, Identify, Make Use Of, Organize, Plan, Select etc.
Higher order thinking skills (HOTS)	Analysing (Analysis) L_4	Students are able to examine and break information into component parts by identifying motives, causes arrangement, logic and semantics. They can make inferences and find evidence to support generalization.	Analyse, Assume, Break Down, Classify, Categorize, Conclusion, Compare, Contrast, Diagram, Discover, Dissect, Distinguish, Divide, Examine, Function, Illustrate, Inference, Inspect, List,Motive, Outline,Relationships, Simplify, Survey, Take Part In, Test For etc.
	Evaluating (Evaluation) L_5	Students are able to present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria. They can justify a decision or course of action.	Agree, Appraise, Assess, Award, Build, Create, Compose, Choose, Compare, Conclude, Criteria, Criticize, Design, Derive, Develop, Decide, Deduct, Determine, Disprove, Defend, Estimate, Formulate, Generate, Invent, Modify, Evaluate, Explain, Influence, Judge, Interpret, Justify, Mark, Measure, Perceive, Rate, Prioritize, Recommend, Rule On, Select, Support, Value etc.
	Creating (Synthesis) L_6	Students are able to compile, generate or view information,ideas or products together in a different way by combining elements in a new pattern or by proposing alternative solutions. Also, use information to form a unique product. This requires creativity and originality.	Assemble, Adapt, Anticipate, Build, Change, Choose, Combine, Collaborate, Collect, Create, Compile, Compose, Construct, Delete, Design, Develop, Discuss, Develop, Devise, Elaborate, Estimate, Formulate, Happen, Hypothesize, Imagine, Improve, Invent, Imagine, Intervene, Make Up, Maximize, Modify, Originate, Plan, Predict, Propose, Rearrange, Solve, Suppose, Substitute, Test etc.

Graduate attributes: Graduate attributes are the qualities, skills and understandings a university community agrees its students should develop during their time with the institution. These attributes include but go beyond the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future.

Bowden, Hart, King, Trigwell& Watts (2000)

Scheme of Teaching and Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

III SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT31	Core Subject	Engineering Mathematics-III	Mathematics	04	--	03	20	80	100	4
2	15EE32	Core Subject	Electric Circuit Analysis	EEE	04	--	03	20	80	100	4
3	15EE33	Core Subject	Transformers and Generators	EEE	04	--	03	20	80	100	4
4	15EE34	Core Subject	Analog Electronic Circuits	EEE	04	--	03	20	80	100	4
5	15EE35	Core Subject	Digital System Design	EEE	04	--	03	20	80	100	4
6	15EE36	Foundation Course	Electrical and Electronic Measurements	EEE	04	--	03	20	80	100	4
7	15EEL37	Laboratory	Electrical Machines Laboratory -1	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEL38	Laboratory	Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
				TOTAL	**Theory:24 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**28**

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. FoundationCourse: The courses based upon the content that leads to Knowledge enhancement.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

IV SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT41	Core Subject	Engineering Mathematics-IV	Maths	04	--	03	20	80	100	4
2	15EE42	Core Subject	Power Generation and Economics	EEE	04	--	03	20	80	100	4
3	15EE43	Core Subject	Transmission and Distribution	EEE	04	--	03	20	80	100	4
4	15EE44	Core Subject	Electric Motors	EEE	04	--	03	20	80	100	4
5	15EE45	Core Subject	Electromagnetic Field Theory	EEE	04	--	03	20	80	100	4
6	15EE46	Foundation Course	Operational Amplifiers and Linear ICs	EEE	04	--	03	20	80	100	4
7	15EEL47	Laboratory	Electrical Machines Laboratory -2	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEL48	Laboratory	Op- amp and Linear ICs Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
				TOTAL	**Theory:24 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**28**

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Foundation Course:**The courses based upon the content that leads to Knowledge enhancement.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

V SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE51	Core Subject	Management and Entrepreneurship	EEE	04	--	03	80	20	100	4
2	15EE52	Core Subject	Microcontroller	EEE	04	--	03	80	20	100	4
3	15EE53	Core Subject	Power Electronics	EEE	04	--	03	80	20	100	4
4	15EE54	Core Subject	Signals and Systems	EEE	04	--	03	80	20	100	4
5	15EE55X	Professional Elective	Professional Elective – I	EEE	03	--	03	80	20	100	3
6	15EE56Y	Open Elective	Open Elective - I	EEE	03	--	03	80	20	100	3
7	15EEL57	Laboratory	Microcontroller Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL58	Laboratory	Power Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
				TOTAL	**Theory:22hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**26**

Elective

Professional Elective		Open Elective*** Offered by the Department of Electrical and Electronics Engineering	
Courses under Code 15EE55X	**Title**	**Courses under Code 15EE55X**	**Title**
15EE551	Introduction to Nuclear Power	15EE561	Electronic Communication systems
15EE552	Electrical Engineering Materials	15EE562	Programmable Logic controllers
15EE553	Estimating and Costing	15EE563	Renewable Energy Systems
15EE554	Special Electrical Machines	15EE564	Business Communication

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided;

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Electives relevant to chosen specialization/ branch.

3. Open Elective: Electives from other technical and/ or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VI SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE61	Core Subject	Control Systems	EEE	04	--	03	80	20	100	4
2	15EE62	Core Subject	Power System Analysis – 1	EEE	04	--	03	80	20	100	4
3	15EE63	Core Subject	Digital Signal Processing	EEE	04	--	03	80	20	100	4
4	15EE64	Core Subject	Electrical Machine Design	EEE	04	--	03	80	20	100	4
5	15EE65X	Professional Elective	Professional Elective – II	EEE	03	--	03	80	20	100	3
6	15EE66Y	Open Elective	Open Elective - II	EEE	03	--	03	80	20	100	3
7	15EEL67	Laboratory	Control System Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL68	Laboratory	Digital Signal Processing Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
				TOTAL	**Theory:22 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**26**

Elective

Professional Elective		**Open Elective*** Offered by the Department of Electrical and Electronics Engineering**	
Courses under Code 15EE65X	**Title**	**Courses under Code 15EE66Y**	**Title**
15EE651	Computer Aided Electrical Drawing	15EE661	Artificial Neural Networks and Fuzzy logic
15EE652	Advanced Power Electronics	15EE662	Sensors and Transducers
15EE653	Energy Audit and Demand side Management	15EE663	Batteries and Fuel Cells for Commercial, Military and Space Applications
15EE654	Solar and Wind Energy	15EE664	Industrial Servo Control Systems

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided;

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Electives relevant to chosen specialization/ branch.

3. Open Elective: Electives from other technical and/ or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VII SEMESTER

Sl. No	Course Code	Subject (Course)	Title	Teaching Department	Teaching Hours/Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EE71	Core Subject	Power System Analysis - 2	EEE	04	--	03	20	80	100	4
2	15EE72	Core Subject	Power System Protection	EEE	04	--	03	20	80	100	4
3	15EE73	Core Subject	High Voltage Engineering	EEE	04	--	03	20	80	100	4
4	15EE74X	Professional Elective	Professional Elective – III	EEE	04	--	03	20	80	100	3
5	15EE75Y	Professional Elective	Professional Elective – IV	EEE	04	--	03	20	80	100	3
6	15EEL76	Laboratory	Power system Simulation Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
7	15EEL77	Laboratory	Rely and High Voltage Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEP78	Project Phase – I + Seminar		EEE	--		--	100	--	100	2
				TOTAL	**Theory:24 hours** **Practical: 06 hours**		**21**	**240**	**560**	**800**	**24**

Elective

Professional Elective – III		Professional Elective – IV	
Courses under Code 15EE74X	**Title**	**Courses under Code 15EE75Y**	**Title**
15EE741	Advanced Control Systems	15EE751	FACTs and HVDC Transmission
15EE742	Utilization of Electrical Power	15EE752	Testing and Commissioning of Power System Apparatus
15EE743	Carbon Capture and Storage	15EE753	Spacecraft Power Technologies
15EE744	Power System Planning	15EE754	Industrial Heating

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch.

3. Project Phase –I + Seminar: Literature Survey, Problem Identification, objectives and Methodology. Submission of synopsis and seminar.

4. Internship / Professional Practice: To be carried between the VI and VIIsemester vacation or VII and VIII semester vacation period.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VIII SEMESTER

Sl. No	Course Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EE81	Core Subject	Power System Operation and Control	EEE	04	--	03	20	80	100	4
2	15EE82	Core Subject	Industrial Drives and Applications	EEE	04	--	03	20	80	100	4
3	15EE83X	Professional Elective	Professional Elective – V	EEE	03	--	03	20	80	100	3
4	15EE84	Core Subject	Internship / Professional Practice	EEE	Industry Oriented		03	50	50	100	2
5	15EEP85	Core Subject	Project Work Phase -II	EEE	--	06	03	100	100	200	6
6	15EES86	Core Subject	Seminar	EEE	--	04	--	100	--	100	1
				TOTAL	**Theory:11 hours Practical: 10 hours**		**15**	**310**	**390**	**700**	**20**

Professional Elective – V

Courses under Code 15EE83X	Title
15EE831	Smart Grid
15EE832	Operation and Maintenance of Solar Electric Systems
15EE833	Integration of Distributed Generation
15EE834	Power System in Emergencies

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch.

3. Internship / Professional Practice: To be carried between the VI and VIIsemester vacation or VII and VIII semester vacation period.

III SEMESTER DETAILED SYLLABUS

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

ENGINEERING MATHEMATICS –III (Core Course)

Subject Code	15MAT31	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- The objectives of this course is to introduce students to the mostly used analytical and numerical methods in the different engineering fields by making them to learn Fourier series, Fourier transforms and Z-transforms, statistical methods , numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variations. ■

Module	Teaching Hours
Module-1	
Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period 2c. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from engineering field. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2	
Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transform. **Z-transform:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse z-transform. Applications of z-transforms to solve difference equations. ■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Statistical Methods: Review of measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –problems Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b, y = ax^2 + bx + c \text{ and } y = ae^{bx}$. Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula-Falsi Method and Newton-Raphson method. ■	**10**
Revised Bloom's Taxonomy Level: L_3 – Applying.	
Module-4	
Finite differences: Forward and backward differences, Newton's forward and backward interpolation formulae. Divided differences- Newton's divided difference formula. Lagrange's interpolation formula and inverse interpolation formula (all formulae without proof)-Problems. **Numerical integration:** Simpson's $(1/3)^{th}$and $(3/8)^{th}$ rules, Weddle's rule (without proof) – Problems. ■	**10**
Revised Bloom's Taxonomy Level: L_3 – Applying.	
Module-5	
Vector integration: Line integrals-definition and problems, surface and volume integrals-definition, Green's theorem in a plane, Stokes and Gauss-divergence theorem(without proof) and problems. **Calculus of Variations:** Variation of function and Functional, variational problems. Euler's equation, Geodesics, hanging chain, problems. ■	**10**
Revised Bloom's Taxonomy Level: L_3 – Applying, L_4 – Analysing. L_2 – Understanding, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
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15MAT31 ENGINEERING MATHEMATICS –III (Core Subject) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Know the use of periodic signals and Fourier series to analyze circuits and system communications.
- Explain the general linear system theory for continuous-time signals and digital signal processing using the Fourier Transform and z-transform.
- Employ appropriate numerical methods to solve algebraic and transcendental equations.
- Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems.
- Determine the extremals of functional and solve the simple problems of the calculus of variations. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Life-Long Learning, Accomplishment of Complex Problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
2	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10thEdition, 2015
Reference books				
3	A Text Book of Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publishers	7th Edition, 2010
4	Higher Engineering Mathematics	B.V.Ramana	Tata McGraw-Hill	2006
5	Higher Engineering Mathematics	H. K.DassEr. RajnishVerma	S.Chand	First Edition,2011

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://wwww.khanacademy.org/
3. http://www.class-central.com/subject/math

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - III			
ELECTRIC CIRCUIT ANALYSIS (Core Subject)			
Subject Code	15EE32	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To familiarize the basic laws, source transformations, theorems and the methods of analysing electrical circuits.
- To explain the concept of coupling in electric circuits and resonance.
- To familiarize the analysis of three-phase circuits, two port networks and networks with non-sinusoidal inputs.
- To analyze the transient response of circuits with dc and sinusoidal ac input.
- To impart basic knowledge on network analysis using Laplace transforms. ■

Module-1		**Teaching Hours**
Basic Concepts: Active and passive elements, Concept of ideal and practical sources. Source transformation and Source shifting, Concept of Super Mesh and Super node analysis. Analysis of networks by (i) Network reduction method including star – delta transformation, (ii) Mesh and Node voltage methods for ac and dc circuits with independent and dependent sources. Equilibrium equations using KCL and KVL, Duality. **Resonant Circuits:** Analysis of simple series RLC and parallel RLC circuits under resonances. Resonant frequency, Bandwidth and Quality factor at resonance. Practical RL-RC circuits.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Network Theorems: Analysis of networks, with and without dependent ac and dc sources by Thevenin's and Norton's theorems. Analysis of ac and dc circuits for maximum power transfer to resistive and complex loads. Application of Millman's theorem and Super Position theorem to multisource networks. Reciprocity theorem and its application. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Transient Analysis: Review of ordinary linear non homogeneous first and second order differential equations with constant coefficients. Transient analysis of ac and dc circuits by classical method. Transient analysis of dc and ac circuits. Behaviour of circuit elements under switching action ($t = 0$ and $t = \infty$). Evaluation of initial conditions. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
Laplace Transformation: Laplace transformation (LT), LT of Impulse, Step, Ramp, Sinusoidal signals and shifted functions. Waveform synthesis. Initial and Final value theorems. Laplace Transform of network and time domain solution for RL, RC and RLC networks for ac and dc excitations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Unbalanced Three phase systems: Analysis of three phase systems, calculation of real and reactive powers. **Two Port networks:** Definition, Open circuit impedance, Short circuit admittance and Transmission parameters and their evaluation for simple circuits. Network functions of one port and two port		**10**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

15EE32 ELECTRIC CIRCUIT ANALYSIS (Core Course) (continued)

Module-5(continued)		**Teaching Hours**
Two Port networks (continued): networks, properties of poles and zeros of network functions. **Complex Wave analysis:** Analysis of simple circuits with non-sinusoidal excitation. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Apply knowledge of mathematics, science, and engineering to the analysis and design of electrical circuits.
- Identify, formulate, and solve engineering problems in the area circuits and systems.
- Analyze the solution and infer the authenticity of it.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Engineering Circuit Analysis	William H Hayt et al	McGraw Hill	8th Edition,2014
2	Engineering Circuit Analysis	J David Irwin et al	Wiley India	10th Edition,2014
3	Fundamentals of Electric Circuits	Charles K Alexander Matthew N O Sadiku	McGraw Hill	5th Edition,2013
4	Network Analysis	M.E. Vanvalkenburg	Pearson	3rd Edition,2014
5	Electric Circuits	MahmoodNahvi	McGraw Hill	5th Edition,2009
6	Introduction to Electric Circuits	Richard C Dorf and James A Svoboda	Wiley	9th Edition,2015
7	Circuit Analysis; Theory and Practice	Allan H Robbins Wilhelm C Miller	Cengage	5th Edition,2013

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

TRANSFORMERS AND GENERATORS (Core Course)

Subject Code	15EE33	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To understand the concepts of transformers and their analysis.
- To suggest a suitable three phase transformer connection for a particular operation.
- To understand the concepts of generator and to evaluate their performance.
- To explain the requirement for the parallel operation of transformers and synchronous generators.■

Module-1	Teaching Hours
Single phase Transformers: Review of Principle of operation, constructional details of shell type and core type single-phase transformers, EMF equation, losses and commercial efficiency, conditions for maximum efficiency (No question shall be set from the review portion). Salient features of ideal transformer, operation of practical transformer under no - load and on - load with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency- commercial and all-day. Voltage regulation and its significance. **Three-phase Transformers:** Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, zigzag/star and V/V, choice of connection. Phase conversion - Scott connection for three-phase to two-phase conversion. Labelling of three-phase transformer terminals, vector groups. Equivalent circuit of three phase transformers. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2	
Parallel Operation of Transformers: Necessity of Parallel operation, conditions for parallel operation – Single phase and three phase. Load sharing in case of similar and dissimilar transformers. **Autotransformers and Tap changing transformers:** Introduction to auto transformer - copper economy, equivalent circuit, three phase auto connection and voltage regulation. Voltage regulation by tap changing – off circuit and on load. **Tertiary winding Transformers:** Necessity of tertiary winding, equivalent circuit and voltage regulation, tertiary winding in star/star transformers, rating of tertiary winding.■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Transformers (continuation): Cause and effects of harmonics, Current inrush in transformers, noise in transformers. Objects of testing transformers, polarity test, Sumpner's test. **Direct current Generator –** Review of construction, types, armature windings, relation between no load and terminal voltage (No question shall be set from the review portion). Armature reaction, Commutation and associated problems, no load and full load characteristics. Reasons for reduced dependency on dc generators. **Synchronous generators-** Review of construction and operation of salient & non-salient pole synchronous generators (No question shall be set from the review portion). Armature windings, winding factors, emf equation. Harmonics – causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit.■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4	
Synchronous generators (continuation): Generator load characteristic. Voltage regulation, excitation control for constant terminal voltage. Generator input and output. Parallel operation of	**10**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
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SEMESTER - III

15EE33 TRANSFORMERS AND GENERATORS (Core Course) (continued)

Module-4(continued)		**Teaching Hours**
Synchronous generators(continuation): generators and load sharing. Synchronous generator on infinite bus-bars – General load diagram, Electrical load diagram, mechanical load diagram, O – curves and V – curves. Power angle characteristic and synchronizing power. **Synchronous generators(continuation):** Effects of saliency, two-reaction theory, Direct and Quadrature reactance, power angle diagram, reluctance power, slip test. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Synchronous generators(continuation): Open circuit and short circuit characteristics, Assessment of reactance- short circuit ratio, synchronous reactance, adjusted synchronous reactance and Potier reactance. Voltage regulation by EMF, MMF, ZPF and ASA methods. **Performance of synchronous generators:** Capability curve for large turbo generators and salient pole generators. Starting, synchronizing and control. Hunting and dampers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the construction and operation and performance of transformers.
- Explain different connections for the three phase operations, their advantages and applications.
- Explain the construction and operation of Synchronous machines and evaluate the regulation of synchronous machines by different methods.
- Analyze the operation of the synchronous machine connected to infinite machine.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Electric Machines	D. P. Kothari, et al	McGraw Hill	4th Edition, 2011
2	Performance and Design of A.C. Machines	M. G. Say	CBS Publishers	3rd Edition, 2002
3	Principles of Electric Machines and power Electronics	P.C.Sen	Wiley	2nd Edition, 2013
4	Electric Machines	MulukuntlaS.Sarma,at el	Cengage	1st Edition, 2009
5	Electrical Machines, Drives and Power systems	Theodore Wildi	Pearson	6th Edition, 2014
6	Electrical Machines	M.V. Deshpande	PHI Learning	1st Edition, 2013
7	Electrical Machines	AbhijitChakrabarti et al	McGraw Hill	1st Edition, 2015
8	A Textbook of Electrical Machines	K.R.SiddapuraD.B.Raval	Vikas	1st Edition, 2014

<table>
<tr><td colspan="4">B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III</td></tr>
<tr><td colspan="4">ANALOG ELECTRONIC CIRCUITS (Core Course)</td></tr>
<tr><td>Subject Code</td><td>15EE34</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4">Credits - 04</td></tr>
<tr><td colspan="4">Course objectives:
• Provide the knowledge for the analysis of diode and transistor circuits.
• Develop skills to design the electronic circuits like amplifiers and oscillators.
• Highlight the importance of FET and MOSFET. ■</td></tr>
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<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Diode Circuits: Review of diodes as rectifiers (No question shall be set from review portion). Diode clipping and clamping circuits.
Transistor biasing and stabilization: Operating point, analysis and design of fixed bias circuit, self-bias circuit, Emitter stabilized bias circuit, voltage divider bias circuit, stability factor of different biasing circuits. Problems.
Transistor switching circuits: Transistor switching circuits,PNP transistors, thermal compensation techniques. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Transistor at low frequencies: BJT transistor modelling, CE fixed bias configuration, voltage divider bias, emitter follower, CB configuration, collector feedback configuration, analysis using h – parameter model, relation between h – parameters model of CE, CC and CB modes, Millers theorem and its dual.
Transistor frequency response: General frequency considerations, low frequency response, Miller effect capacitance, high frequency response, multistage frequency effects. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Multistage amplifiers: Cascade and cascode connections, Darlington circuits, analysis and design.
Feedback amplifiers: Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Power amplifiers: Amplifier types, analysis and design of different power amplifiers, distortion in power amplifiers.
Oscillators: Principle of operation, analysis and derivation of frequency of oscillation of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator and frequency stability. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-5</td></tr>
<tr><td colspan="2">FETs: Construction, working andcharacteristics of JFET and MOSFET. Biasing of JFET and MOSFET, JFET and MOSFET amplifiers, analysis and design. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
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B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

15EE34 ANALOG ELECTRONIC CIRCUITS (Core Subject) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Utilize the characteristics of transistor for different applications.
- Design and analyze biasing circuits for transistor.
- Design, analyze and test transistor circuitry as amplifiers and oscillators.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books

1	Electronic Devices and Circuit Theory	Robert L Boylestad Louis Nashelsky	Pearson	11th Edition, 2015
2	Integrated Electronics, Analysis and Digital Circuits and Systems	Jacob Millman et al	McGraw Hill	2nd Edition, 2009
3	Electronic Devices and Circuits	David A Bell	Oxford University Press	5th Edition, 2008
4	Microelectronics Circuits Analysis and Design	Muhammad Rashid	Cengage Learning	2nd Edition, 2014
5	A Text Book of Electrical Technology, Electronic Devices and Circuits	B.L. Theraja, A.K. Theraja,	S. Chand	Reprint, 2013
6	Electronic Devices and Circuits	Anil K. Maini VashaAgarval	Wiley	1st Edition, 2009
7	Electronic Devices and Circuits	S.Salivahanan N.Suresh	McGraw Hill	3rd Edition, 2013
8	Fundamentals of Analog Circuits	Thomas L Floyd	Pearson	2nd Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
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SEMESTER - III

DIGITAL SYSTEM DESIGN(Core Course)

Subject Code	15EE35	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To impart the knowledge of combinational circuit design.
- To impart the knowledge of Sequential circuit design.
- To provide the basic knowledge about VHDL & its use.■

Module-1	**Teaching Hours**
Principles of combinational logic: Definition of combinational, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 and 5 variables. Incompletely specified functions (Don’t care terms). Simplifying max - term equations. Quine -McClusky minimization technique, Quine - McClusky using don’t care terms, Reduced Prime Implicant tables, Map entered variables. ■	**10**
Revised Bloom’s Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Analysis and design of Combinational Logic: General approach, Decoders-BCD decoders, Encoders. Digital multiplexers-using multiplexers as Boolean function generators. Adders and Subtractors-Cascading full adders, Look ahead carry, Binary comparators. Design methods of building blocks of combinational logics.■	**10**
Revised Bloom’s Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Sequential Circuits: Basic Bistable element, Latches, SR latch, application of SR latch, A Switch debouncer, The SR latch, The gated SR latch. The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The master-slave SR Flip-Flops, The master-slave JK Flip-Flop, Edge Triggered Flip-flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop. Characteristic equations, Registers, Counters-Binary Ripple Counter, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters, Design of a Synchronous Mod-6 counters using clocked JK Flip-Flops Design of a Synchronous Mod-6 counter using clocked D, T, or SR Flip-Flops. ■	**10**
Revised Bloom’s Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Sequential Design: Introduction, Mealy and Moore models, State machine notation, synchronous sequential circuit analysis and design. Construction of state Diagrams, Counters Design. ■	**10**
Revised Bloom’s Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
HDL: Introduction, A brief history of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, Simulation and synthesis, Brief comparison of VHDL and Verilog. **Data-Flow Descriptions**: Highlights of Data flow descriptions, Structure of data-flow description, Data type-vectors. ■	**10**
Revised Bloom’s Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

15EE35 DIGITAL SYSTEM DESIGN (Core Course) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Design and analyze combinational & sequential circuits
- Design circuits like adder, sub tractor, code converter etc.
- Understand counters and sequence generators.

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books

1	Digital Logic Applications and	John M Yarbrough	CengageLearn	2011
2	Digital Principles and Design	Donald D Givone	McGraw Hill	1st Edition, 2002
3	Logic and computer design Fundamentals	M. Morries Mano and Charles Kime	Pearson Learning	4th Edition, 2014
4	Fundamentals of logic design	Charles H Roth, JR and Larry L. Kinney	Cengage Learning	6th Edition, 2013
5	Fundamentals of Digital Circuits	A. Anand Kumar	PHI	3rd Edition, 2014
6	Digital Logic Design and VHDL	A.A.Phadke, S.M.Deokar	Wiley India	1st Edition, 2009
7	Digital Circuits and Design	D.P.KothariJ.S.Dhillon	Pearson	First Print 2015
8	HDL Programming (VHDL and Verilog)	Nazeih M. Botros	Cengage Learning	1st Edition, 2011
9	Circuit Design and Simulation with VHDL	Volnei A Pedroni	PHI	2nd Edition,

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - III			
ELECTRICAL AND ELECTRONIC MEASUREMENTS (Foundation Course)			
Subject Code	15EE36	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To understand the concept of units and dimensions.
- To measure resistance, inductance, capacitance by use of different bridges.
- To study the construction and working of various meters used for measurement.
- To have the working knowledge of electronic instruments and display devices.■

Module-1		Teaching Hours
Units and Dimensions: Review of fundamental and derived units. SI units (No question shall be set from the review portion). Dimensional equations, problems. **Measurement of Resistance:** Wheatstone's bridge, sensitivity, limitations. Kelvin's double bridge. Earth resistance measurement by fall of potential method and by using Megger. **Measurement of Inductance and Capacitance:** Sources and detectors, Maxwell's inductance bridge, Maxwell's inductance and capacitance bridge, Hay's bridge, Anderson's bridge, Desauty's bridge, Schering bridge. Shielding of bridges. Problems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Measurement of Power, Energy, Power factor and Frequency: Review ofDynamometer wattmeter construction and operation (No question shall be set from the review portions), Torque expression, Errors and minimization, UPF and LPF wattmeters. Measurement of real and reactive power in 3 phase circuits. Review of Induction type energy meter construction and operation (No question shall be set from the review portions)]. Errors, adjustments and calibration of single and three phase energy meters, Problems. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Extension of Instrument Ranges: Desirable features of ammeters and voltmeters.Shunts and multipliers. Construction and theory of instrument transformers, Desirable characterises, Errors of CT and PT. Turns compensation, Illustrative examples, Silsbee's method of testing CT. **Magnetic measurements:** Introduction, measurement of flux/ flux density, magnetising force and leakage factor. Hopkinson permeameter. Measurement of iron loss by wattmeter method. A brief discussion on measurement of air gap flux and field strength.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Electronic and digital Instruments: Introduction. Essentials of electronic instruments, Advantages of electronic instruments. True rms reading voltmeter. Electronic multimeters. Digital voltmeters (DVM) - Ramp type DVM, Integrating type DVM, Continuous – balance DVM and Successive - approximation DVM. Q meter. Principle of working of electronic energy meter (block diagram treatment), extra features offered by present day meters and their significance in billing.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - III		
15EE36 ELECTRICAL AND ELECTRONIC MEASUREMENTS (Foundation Course) (continued)		
Module-5		**Teaching Hours**
Display Devices: Introduction, character formats, segment displays, Dot matrix displays, Bar graph displays. Cathode ray tubes, Light emitting diodes, Liquid crystal displays, Nixes, Incandescent, Fluorescent, Liquid vapour and Visual displays. Display multiplexing and zero suppression. **Recording Devices:** Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and xy recorders. Magnetic tape recorders, Direct recording, Frequency modulation recording, Pulse duration modulation recording, Digital tape recording, Ultraviolet recorders. Biomedical recorders, Electro Cardio Graph (ECG),Electroencephalograph, Electromyograph. Noise in reproduction. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the importance of units and dimensions.
- Measure resistance, inductance and capacitance by different methods.
- Explain the working of various meters used for measurement of power and energy.
- Explain the working of different electronic instruments and display devices.

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books

1	Electrical and electronic Measurements and Instrumentation	A.K. Sawhney	DhanpatRai and Co	10th Edition
2	A Course in Electronics and Electrical Measurements and Instrumentation	J. B. Gupta	Katson Books	2013 Edition
3	Electrical and electronic Measurements and Instrumentation	Er.R.K. Rajput	S Chand	5th Edition, 2012
4	Electrical Measuring Instruments and Measurements	S.C. Bhargava	BS Publications	2013
5	Modern Electronic Instrumentation and Measuring Techniques	Cooper D and A.D. Heifrick	Pearson	First Edition, 2015
6	Electronic Instrumentation and Measurements	David A Bell	Oxford University	3rd Edition, 2013
7	Electronic Instrumentation	H.S.Kalsi	McGraw Hill	3rd Edition,2010

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - III			
ELECTRICAL MACHINES LABORATORY - 1			
Subject Code	15EEL37	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80
Credits - 02			

Course objectives:

- Conducting of different tests on transformers and synchronous machines and evaluation of their performance.
- Verify the parallel operation of two single phase transformers.
- Study the connection of single phase transformers for three phase operation and phase conversion.
- Study of synchronous generator connected to infinite bus. ■

Sl. NO	Experiments
1	Open Circuit and Short circuit tests on single phase step up or step down transformer and predetermination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency.
3	Parallel operation of two dissimilar single-phase transformers of different kVA and determination of load sharing and analytical verification given the Short circuit test data.
4	Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.
5	Comparison of performance of 3 single-phase transformers in delta – delta and V – V (open delta) connection under load.
6	Scott connection with balanced and unbalanced loads.
7	Separation of hysteresis and eddy current losses in single phase transformer.
8	Voltage regulation of an alternator by EMF and MMF methods.
9	Voltage regulation of an alternator by ZPF method.
10	Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.
11	Performance of synchronous generator connected to infinite bus, under constant power and variable excitation & vice - versa.
12	Power angle curve of synchronous generator.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Conduct different tests on transformers and synchronous generators and evaluate their performance.
- Connect and operate two single phase transformers of different KVA rating in parallel.
- Connect single phase transformers for three phase operation and phase conversion.
- Assess the performance of synchronous generator connected to infinite bus.

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis, Individual and Team work,Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - III			
ELECTRONICS LABORATORY			
Subject Code	15EEL38	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80
Credits - 02			

Course objectives:

- To design and test half wave and full wave rectifier circuits.
- To design and test different amplifier and oscillator circuits using BJT.
- To study the simplification of Boolean expressions using logic gates.
- To realize different Adders and Subtractors circuits.
- To design and test counters and sequence generators.■

Sl. No	Experiments
1	Design and Testing of Full wave – centre tapped transformer type and Bridge type rectifier circuits with and without Capacitor filter. Determination of ripple factor, regulation and efficiency.
2	Static Transistor characteristics for CE, CB and CC modes and determination of h parameters.
3	Frequency response of single stage BJT and FET RC coupled amplifier and determination of half power points, bandwidth, input and output impedances.
4	Design and testing of BJT - RC phase shift oscillator for given frequency of oscillation.
5	Determination of gain, input and output impedance of BJT Darlington emitter follower with and without bootstrapping.
6	Simplification, realization of Boolean expressions using logic gates/Universal gates.
7	Realization of half/Full adder and Half/Full Subtractors using logic gates.
8	Realization of parallel adder/Subtractors using 7483 chip- BCD to Excess-3 code conversion and Vice - Versa.
9	Realization of Binary to Gray code conversion and vice versa.
10	Design and testing Ring counter/Johnson counter.
11	Design and testing of Sequence generator.
12	Realization of 3 bit counters as a sequential circuit and MOD – N counter design using 7476, 7490, 74192, 74193.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Design and test different diode circuits.
- Design and test amplifier and oscillator circuits and analyse their performance.
- Use universal gates and ICs for code conversion and arithmetic operations.
- Design and verify on of different counters.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

****** END ******

IV SEMESTER DETAILED SYLLABUS

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

ENGINEERING MATHEMATICS –IV (Core Subject)

Subject Code	15MAT41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:
The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.■

Module-1		Teaching Hours
Numerical Methods: Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae). ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying.	
Module-2		
Numerical Methods: Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne's method. **Special Functions:** Series solution-Frobenious method. Series solution of Bessel's differential equation leading to $J_n(x)$-Bessel's function of first kind. Basic properties, recurrence relations and orthogonality. Series solution of Legendre's differential equation leading to $P_n(x)$-Legendre polynomials. Rodrigue's formula, problems.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying.	
Module-3		
Complex Variables: Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula, Residue, poles, Cauchy's Residue theorem (without proof) and problems. **Transformations:** Conformal transformations, discussion of transformations: $w = z^2, w = e^z, w = z + (1/z)(z \neq 0)$and bilinear transformations-problems.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – ApplyingL_4 – Analysing.	
Module-4		
Probability Distributions: Random variables (discrete and continuous),probability mass/density functions. Binomial distribution, Poisson distribution.Exponential and normal distributions, problems. **Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying.	
Module-5		
Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **Stochastic process:** Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – ApplyingL_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

15MAT41 ENGINEERING MATHEMATICS – IV (Core Subject) (continued)

Course outcomes:

- Use appropriate single step and multi-step numerical methods to solve first and second order ordinary differential equations arising in flow data design problems.
- Explain the idea of analyticity, potential fields residues and poles of complex potentials in field theory and electromagnetic theory.
- Employ Bessel's functions and Legendre's polynomials for tackling problems arising in continuum mechanics, hydrodynamics and heat conduction.
- Describe random variables and probability distributions using rigorous statistical methods to analyze problems associated with optimization of digital circuits, information, coding theory and stability analysis of systems.
- Apply the knowledge of joint probability distributions and Markov chains in attempting engineering problems for feasible random events. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Life-Long Learning, Accomplishment of Complex Problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Text Books:

1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
2	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2015

Reference books:

3	A Text Book of Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publishers	7th Edition, 2010
4	Higher Engineering Mathematics	B.V.Ramana	McGraw-Hill	2006
5	Higher Engineerig Mathematics	H. K. Dass and Er. RajnishVerma	S.Chand publishing	First Edition, 2011

Web links and Video Lectures

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://wwww.khanacademy.org/
3. http://www.class-central.com/subject/math

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

POWER GENERATION AND ECONOMICS(Core Subject)

Subject Code	15EE42	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- Explain the arrangement and operation of hydroelectric, steam, diesel, gas turbine and nuclear power plants and working of major equipment in the plants.
- Classification of substation and explain the operation of different substation equipment.
- Explain the importance of grounding and different grounding methods used in practice.
- Explain the economics of power generation and importance of power factor.

Module-1	**Teaching Hours**
Hydroelectric Power Plants: Hydrology, run off and stream flow, hydrograph, flow duration curve, Mass curve, reservoir capacity, dam storage. Hydrological cycle, merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, elements of the plant, Classification of the plants based on water flow regulation, water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines Governing of turbines, selection of water turbines. Underground, small hydro and pumped storage plants. Choice of size and number of units, plant layout and auxiliaries. ■	**10**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.

Module-2	
Steam Power Plants: Introduction,Efficiency of steam plants, Merits and demerits of plants, selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling, Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, plant auxiliaries. **Diesel Power Plant:** Introduction, Merits and demerits, selection site, elements of diesel power plant, applications. **Gas Turbine Power Plant**: Introduction, Merits and demerits, selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants. Comparison of gas power plant with steam and diesel power plants. ■	**10**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.

Module-3	
Nuclear Power Plants: Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels, Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, shielding.■	**10**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.

Module-4	
Substations: Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments, and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation, Busbar arrangement schemes and single line diagrams of substations.	**10**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

15EE42 POWER GENERATION AND ECONOMICS(Core Subject) (continued)

Module-4 (continued)		**Teaching Hours**
Substations (continued): Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation. **Grounding:** Introduction, Difference between grounded and ungrounded system. System grounding – ungrounded, solid grounding, resistance grounding, reactance grounding, resonant grounding. Earthing transformer. Neutral grounding and neutral grounding transformer. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Economics: Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, disadvantages, causes, methods of improving power factor, Advantages of improved power factor, economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Describe the working of hydroelectric, steam, nuclear power plants and state functions of major equipment of the power plants.
- Classify various substations and explain the importance of grounding.
- Understand the economic aspects of power system operation and its effects.
- Explain the importance of power factor improvement.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Engineers and Society, Environment and Sustainability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	A Course in Power Systems	J.B. Gupta	Katson	2008
2	Generation of Electrical Energy	B.R.Gupta	S. Chand	2015
3	Electrical power Generation, Transmission and Distribution	S.N. Singh	PHI	2nd Edition, 2009
4	Power Plant Engineering	P.K. Nag	McGrawHill	4th Edition, 2014
5	Electrical Power Distribution Systems	V. Kamaraju	McGrawHill	1st Edition, 2009
6	Electrical Distribution Engineering	Anthony J. Pansini	CRC Press	3rd Edition, 2006
7	Electrical Distribution Systems	Dale R PatrickEt al	CRC Press	2nd Edition, 2009
8	A Text Book on Power System Engineering	A.Chakrabarti, et al	DhanpathRai	2nd Edition, 2010

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -IV

TRANSMISSION AND DISTRIBUTION (Core Subject)

Subject Code	15EE43	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:

- To understand the concepts of various methods of generation of power.
- To understand the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- To design insulators for a given voltage level.
- To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
- To study underground cables for power transmission and evaluate different types of distribution systems.

Module-1	Teaching Hours
Introduction to power system: Structure of electric power system: generation, transmission and distribution. Advantages of higher voltage transmission: HVAC, EHVAC, UHVAC and HVDC. Interconnection. Feeders, distributors and service mains. **Overhead transmission lines:** A brief introduction to types of supporting structures and line conductors-Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All –aluminium alloy conductor (AAAC) and All –aluminium conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI),Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires. **Overhead line Insulators:** A brief introduction to types of insulators, material used- porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Line parameters: Introduction to line parameters- resistance, inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Inductance of composite – conductors, geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of composite – conductor, geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3	
Performance of transmission lines: Classification of lines – short, medium and long. Current and voltage relations, line regulation and Ferranti effect in short length lines, medium length lines considering Nominal T and nominal π circuits, and long lines considering hyperbolic form equations. Equivalent circuit of a long line. ABCD constants in all cases. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Corona: Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.	**10**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -IV

15EE43 TRANSMISSION AND DISTRIBUTION (Core Subject) (continued)

Module-4 (continued)		**Teaching Hours**
Underground cable: Types of cables, constructional features, insulation resistance, thermal rating, charging current, grading of cables – capacitance and inter-sheath.Dielectric loss. Comparison between ac and dc cables. Limitations of cables.Specification of power cables. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Distribution: Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution, AC distributors with concentrated and uniform loads. Effect of disconnection of neutral in a 3 phase four wire system. **Reliability and Quality of Distribution system:** Introduction, definition of reliability, failure, probability concepts, limitation of distribution systems, power quality, Reliability aids. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course Outcomes:

At the end of the course the student will be able to:

- Explain the concepts of various methods of generation of power.
- Explain the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- Design and analyze overhead transmission system for a given voltage level.
- Calculate the parameters of the transmission line for different configurations and assess the performance of line.
- Explain the use of underground cables and evaluate different types of distribution systems.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design / development of solutions, Engineers and society, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books:

1	A Course in Electrical Power	Soni Gupta and Bhatnagar	DhanpatRai	-
2	Power System Analysis and Design	J. Duncan Gloverat el	Cengage Learning	4th Edition 2008
3	Principles of Power System	V.K. Mehta, Rohit Mehta	S. Chand	1st Edition 2013
4	Electrical power Generation, Transmission and Distribution	S.N. Singh	PHI	2nd Edition,2009
5	Electrical Power	S.L.Uppal	Khanna Publication	
6	Electrical power systems	C. L. Wadhwa	New Age	5th Edition, 2009
7	Electrical power systems	AshfaqHussain	CBS Publication	
8	Electric Power Distribution	A.S. Pabla	McGraw-Hill	6th Edition,2012
9	*For* High temperature conductors refer www.jpowers.co.jp/english/product/pdf/gap_c1.pdfand Power System Analysis and Design, J. Duncan Glover at el			

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -IV			
ELECTRIC MOTORS (Core Subject)			
Subject Code	15EE44	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course Objectives:

- To study the constructional features of Motors and select a suitable drive for specific application.
- To study the constructional features of Three Phase and Single phase induction Motors.
- To study different test to be conducted for the assessment of the performance characteristics of motors.
- To study the speed control of motor by a different methods.
- Explain the construction and operation of Synchronous motor and special motors.

Module-1		Teaching Hours
DC Motors: Classification, Back emf, Torque equation, and significance of back emf, Characteristics of shunt, series & compound motors. Speed control of shunt, series and compound motors. Application of motors. DC motor starters – 3 point and 4 point. **Losses and efficiency-** Losses in DC motors, power flow diagram, efficiency, condition for maximum efficiency. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Testing of dc motors: Direct & indirect methods of testing of DC motors-Brake test, Swinburne's test, Retardation test, Hopkinson's test, Field's test, merits and demerits of tests. **Three phase Induction motors:** Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring (No question shall be set from the review portion). Slip, Torque equation, torque-slip characteristic covering motoring, generating and braking regions of operation, Maximum torque, significance of slip**.** ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Performance of three-phase Induction Motor: Phasor diagram of induction motor on no-load and on load, equivalent circuit, losses, efficiency, No-load and blocked rotor tests. Performance of the motor from the circle diagram and equivalent circuit. Cogging and crawling. High torque rotors-double cage and deep rotor bars. Equivalent circuit and performance evaluation of double cage induction motor. Induction motor working as induction generator; standalone operation and grid connected operation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Starting and speed Control of Three-phase Induction Motors: Need for starter. Direct on line, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage, frequency, and rotor resistance methods **Single-phase Induction Motor:** Double revolving field theory and principle of operation. Construction and operation of split-phase, capacitor start, capacitor run, and shaded pole motors. Comparison of single phase motors and applications. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Synchronous motor: Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, V and inverted V curves. Synchronous condenser, hunting and damping. Methods of starting synchronous motors.		**10**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -IV

15EE44 ELECTRIC MOTORS (Core Subject) (continued)

Module-5 (continued)		**Teaching Hours**
Other motors: Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motors.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course Outcomes:

At the end of the course the student will be able to:

- Explain the constructional features of Motors and select a suitable drive for specific application.
- Analyze and assess the performance characteristics of DC motors by conducting suitable tests and control the speed by suitable method.
- Explain the constructional features of Three Phase and Single phase induction Motors and assess their performance.
- Control the speed of induction motor by a suitable method.
- Explain the operation of Synchronous motor and special motors.

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books:

1	Electric Machines	D. P. Kothari, I. J. Nagrath	McGraw Hill	4th edition, 2011
2	Principles of Electric Machines and power Electronics	P.C.Sen	Wiley	2nd Edition, 2013
3	Electric Machines	R.K. Srivastava	Cengage Learning	2nd Edition,2013
4	Electrical Machines, Drives and Power systems	Theodore Wildi	Pearson	6th Edition, 2014
5	Electrical Machines	M.V. Deshpande	PHI Learning	2013
6	Electric Machinery and Transformers	Bhag S Guru at el	Oxford University Press	3rd Edition, 2012
7	Electric Machinery and Transformers	Irving Kosow	Pearson	2rd Edition, 2012
8	Theory of Alternating Current Machines	Alexander Langsdorf	McGraw Hill	2nd Edition, 2001

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -IV			
ELECTROMAGNETIC FIELD THEORY (Core Subject)			
Subject Code	15EE45	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course Objectives:

- To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
- To study the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations.
- To evaluate the energy and potential due to a system of charges.
- To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- To study the magnetic fields and magnetic materials.
- To study the time varying fields and propagation of waves in different media.

Module-1		Teaching Hours
Vector Analysis: Scalars and Vectors**,** Vector algebra, Cartesian co-ordinate system, Vector components and unit vectors. Scalar field and Vector field. Dot product and Cross product, Gradient of a scalar field. Divergence and Curl of a vector field. Co – ordinate systems: cylindrical and spherical, relation between different coordinate systems. Expression for gradient, divergence and curl in rectangular, cylindrical and spherical co-ordinate systems. Problems. **Electrostatics:** Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics). Divergence theorem. Problems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Energy and Potential: Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. The dipole. Energy density in the electrostatic field. Problems. **Conductor and Dielectrics:** Current and current density. Continuity of current. Metallic conductors, conductor's properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Capacitance of two wire line. Problems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3		
Poisson's and Laplace equations: Derivations and problems, Uniqueness theorem. **Steady magnetic fields:** Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Problems.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-4		
Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Problems. **Magnetic materials and magnetism:** Nature of magnetic materials, magnetisation and permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Problems.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -IV

15EE45 ELECTROMAGNETIC FIELD THEORY (Core Subject) (continued)

Module-5		Teaching Hours
Time varying fields and Maxwell's equations: Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Problems. **Uniform plane wave:** Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Problems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course Outcomes:

At the end of the course the student will be able to:

- Use different coordinate systems to explain the concept of gradient, divergence and curl of a vector.
- Use Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations.
- Calculate the energy and potential due to a system of charges.
- Explain the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- Explain the behavior of magnetic fields and magnetic materials.
- Assess time varying fields and propagation of waves in different media.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books:

1	Engineering Electromagnetics	William H Hayt et al	McGraw Hill	8thEdition, 2014
2	Principles of Electromagnetics	Matthew N. O. Sadiku	Oxford	6th Edition, 2015
3	Fundamentals of Engineering Electromagnetics	David K. Cheng	Pearson	2014
4	Electromagnetism -Theory (Volume -1) -Applications (Volume-2)	AshutoshPramanik	PHI Learning	2014
5	Electromagnetic Field Theory Fundamentals	Bhag Guru et al	Cambridge	2005
6	Electromagnetic Field Theory	RohitKhurana	Vikas Publishing	1st Edition,2014
7	Electromagnetics	J. A. Edminister	McGraw Hill	3rd Edition, 2010
8	Electromagnetic Field Theory and Transmission Lines	GottapuSasibhushana Rao	Wiley	1st Edition, 2013

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -IV			
OPERATIONAL AMPLIFIERS AND LINEAR ICs (Foundation Course)			
Subject Code	15EE46	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course Objectives:

- To understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.
- To learn the designing of various circuits using linear ICs.
- To use these linear ICs for specific applications.
- To understand the concept and various types of converters.
- To use these ICs, in Hardware projects.

Module-1	Teaching Hours
Operational amplifiers: Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback ; voltage series feedback amplifier-gain, input resistance, output resistance, voltage shunt feedback amplifier- gain, input resistance, output resistance. **General Linear Applications:** D.C. & A.C amplifiers, peaking amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, differential configuration, instrumentation amplifier.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2	
Active Filters: First & Second order high pass & low pass Butterworth filters, higher order filters Band pass filters, Band reject filters & all pass filters. **DC Voltage Regulators:** voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Signal generators: Triangular / rectangular wave generator, phase shift oscillator, Wien bridge oscillator, oscillator amplitude stabilization, signal generator output controls. **Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Signal processing circuits: Precision half wave & full wave rectifiers limiting circuits, clamping circuits, peak detectors, sample & hold circuits. **A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC, dual slope ADC, digital ramp ADC. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
Phase Locked Loop (PLL): Basic PLL, components, performance factors, applications of PLL IC 565. **Timer:** Internal architecture of 555 timer, Mono stable, Astable multivibrators and applications. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER -IV

15EE46 OPERATIONAL AMPLIFIERS AND LINEAR ICs (Foundation Course) (continued)

Course Outcomes:

At the end of the course the student will be able to:

- Explain the basics of linear ICs.
- Design circuits using linear ICs.
- Demonstrate the application of Linear ICs.
- Use ICs in the electronic projects.

Graduate Attributes (As per NBA)

Engineering Knowledge,Design / development of solutions,Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/Reference Books:

1	Op-Amps and Linear Integrated Circuits	Ramakant A Gayakwad	Pearson	4thEdition 2015
2	Operational Amplifiers and Linear ICs	David A. Bell	Oxford	3rd Edition 2011
3	Linear Integrated Circuits; Analysis, Design and Applications	B. Somanthan Nair	Wiley India	2013
4	Linear Integrated Circuits	S. Salivahanan, et al	McGraw Hill	2nd Edition,2014
5	Operational Amplifiers and Linear Integrated Circuits	K. Lal Kishore	Pearson	1st Edition, 2012
6	Linear Integrated Circuits	Muhammad H Rashid	Cengage Learning	1st Edition,2014
7	Op-Amps and Linear Integrated Circuits, Concept and Application	James M Fiore	Cengage	2009

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - IV			
ELECTRICAL MACHINES LABORATORY -2			
Subject Code	15EEL47	IA Marks	20
Number of PracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80
Credits - 02			

Course Objectives:
- To perform tests on dc machines to determine their characteristics.
- To control the speed of dc motor.
- To conduct test for pre-determination of the performance characteristics of dc machines
- To conduct load test on single phase and three phase induction motor.
- To conduct test on induction motor to determine the performance characteristics.
- To conduct test on synchronous motor to draw the performance curves. ■

Sl. No	Experiments
1	Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics.
2	Field Test on dc series machines.
3	Speed control of dc shunt motor by armature and field control.
4	Swinburne's Test on dc motor.
5	Retardation test on dc shunt motor.
6	Regenerative test on dc shunt machines.
7	Load test on three phase induction motor.
8	No - load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii)circle diagram. Determination of performance parameters at different load conditions from (i) and (ii).
9	Load test on induction generator.
10	Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.
11	Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.
12	Conduct an experiment to draw V and Λ curves of synchronous motor at no load and load conditions.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course Outcomes:

At the end of the course the student will be able to:
- Test dc machines to determine their characteristics.
- Control the speed of dc motor.
- Pre-determine the performance characteristics of dc machines by conducting suitable tests.
- Perform load test on single phase and three phase induction motor to assess its performance.
- Conduct test on induction motor to pre-determine the performance characteristics.
- Conduct test on synchronous motor to draw the performance curves.

Graduate Attributes (As per NBA)

Engineering Knowledge, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

OP- AMP AND LINEAR ICS LABORATORY

Subject Code	15EEL48	IA Marks	20
Number of PracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course Objectives:

- To conduct different experiments using OP-Amps
- To conduct experiments using Linear IC's

<table>
<tr>
<td>
a)Study of pin details, specifications, application features of IC741 (LM741) and IC555 (Timer) through corresponding datasheets (Datasheets are instruction manuals for electronic components. They explain exactly what a component does and how to use it.).
b)Comparison of output performance quantity of an Operational Amplifier obtained by rigging up the circuit with the ideal value of
(i) A Non – Inverting Amplifier ($V_{out} = AV_{in}$) (ii) An Inverting Amplifier ($V_{out} = -AV_{in}$) (iii) A Difference Amplifier ($V_{out} = -A(V_p - V_n)$) (iv) A Difference Amplifier with floating inputs ($V_{out} = AV_{in}$) (v) A Non – Inverting Amplifier with negative feedback (ii) An Inverting Amplifier with negative feedback (vi) A Differential Amplifier with a negative feedback (vii) A Differential Amplifier with negative feedback and equalised amplifications.
(viii) A Voltage follower (ix) A differential – in differential –out amplifier (x) An instrumentation amplifier
c) Plot of input and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.
d) Testing of op – amp.
</td>
<td>To be covered in 03 Laboratory classes.</td>
</tr>
</table>

Sl. No	Experiments
1	Design and verify a precision full wave rectifier. Determine the performance parameters.
2	Design and realize to analyse the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.
3	Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4	Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5	Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.
6	Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.
7	Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.
8	Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.
9	Design and realization of R-2R ladder DAC.
10	Realization of Two bit Flash ADC
11	Design and verify an IC 555 timer based pulse generator for the specified pulse.
12	Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course Outcomes:

At the end of the course the student will be able to:

- To conduct experiment to determine the characteristic parameters of OP-Amp
- To design test the OP-Amp as Amplifier, adder, subtractor, differentiator and integrator

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

15EEL48 OP- AMP AND LINEAR ICS LABORATORY (continued)

Course Outcomes (continued):

- To design test the OP-Amp as oscillators and filters
- Design and study of Linear IC's as multivibrator power supplies.

Graduate Attributes (As per NBA)

Engineering Knowledge, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**** END ****

V SEMESTER DETAILED SYLLABUS

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

MANAGEMENT AND ENTREPRENEURSHIP (Core Course)

Subject Code	15EE51	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course objectives:

- To introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- To discuss the ways in which work is allocation, structure of organizations, modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- Toexplaintheroleandimportanceoftheentrepreneurineconomicdevelopmentandtheconceptsof entrepreneurship.
- To explain various types of entrepreneurs and their functions, the myths of entrepreneurship and the factors required for capacity building for entrepreneurs
- To discuss theimportanceofSmallScaleIndustriesandtherelatedtermsandproblemsinvolved.
- To discuss methods for generatingnewbusinessideasandbusinessopportunitiesinIndiaandtheimportance of business plan.
- To introduce the concepts of project management and discuss capitol building process.
- To explain project feasibility study and project appraisal and discuss project financing
- To discuss about different institutions at state and central levels supporting business enterprises. ■

Module-1		Teaching Hours
Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession. **Planning:** Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2		
Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Versus Decentralization of Authority and Responsibility, Span of Control (Definition only), Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling:** Meaning and Nature of Directing-Leadership Styles, Motivation Theories Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying.	

<table>
<tr><td colspan="3">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V</td></tr>
<tr><td colspan="3">15EE51 MANAGEMENT AND ENTREPRENEURSHIP (Core Course) (continued)</td></tr>
<tr><td colspan="2">Module-4</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Modern Small Business Enterprises: Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only).
Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions.■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_3 – Applying.</td></tr>
<tr><td colspan="3">Module-5</td></tr>
<tr><td colspan="2">Project Management: Meaning of Project, Project Objectives & Characteristics, Project Identification-Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation.
New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM .■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_3 – Applying, L_4 – Analysing. L_2 – Understanding, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Course outcomes:
At the end of the course the student will be able to:
• Explain the field of management, task of the manager, planning and the need of proper staff, recruitment and selection process.
• Discuss work allocation, the structure of organization, the modes of communication and importance of managerial control in business.
• To explain need of coordination between the manager and staff in exercising the authority and delegating duties.
• To explain the social responsibility of business and leadership
• Explain the concepts of entrepreneurship and the role and importance of the entrepreneur in economic development.
• Show an understanding of the role and importance of Small Scale Industries, business plan and its presentation.
• Discuss the concepts of project management, capitol building process, project feasibility study, project appraisal and project financing.
• Discuss the state /central level institutions / agencies supporting business enterprises.■</td></tr>
<tr><td colspan="3">Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Life-Long Learning, Accomplishment of Complex Problems.</td></tr>
<tr><td colspan="3">Question paper pattern:
• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
• There will be two full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub question covering all the topics under a module.
• The students will have to answer five full questions, selecting one full question from each module. ■</td></tr>
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B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – V				
15EE51 MANAGEMENT AND ENTREPRENEURSHIP (Core Course) (continued)				
Textbooks				
1	Principles of Management	P.C.Tripathi, P.N.Reddy	McGraw Hill,	6^{th}Edition, 2017
2	Entrepreneurship Development And Small Business Enterprises	Poornima M.Charanthimath	Pearson	2^{nd}Edition,2014
Reference Books				
1	Dynamics of Entrepreneurial Development and Management	Vasant Desai	Himalaya Publishing House	2007
2	Essentials of Management: An International, Innovation and Leadership perspective	Harold Koontz, Heinz Weihrich	McGraw Hill	10^{th}Edition 2016

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

MICROCONTROLLER (Core Course)

Subject Code	15EE52	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course objectives:

- To explain the internal organization and working of Computers, microcontrollers and embedded processors.
- Compare and contrast the various members of the 8051 family.
- To explain the registers of the 8051 microcontroller, manipulation of data using registers and MOV instructions.
- To explain in detail the execution of 8051 Assembly language instructions and data types
- To explain loop, conditional and unconditional jump and call, handling and manipulation of I/O instructions.
- To explain different addressing modes of 8051, arithmetic, logic instructions, and programs.
- To explain develop 8051C programs for time delay, I/O operations, I/O bit manipulation,logic, arithmetic operations and data conversion. ■

Module-1		Teaching Hours
8051 Microcontroller Basics: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM.8051 Addressing Modes. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Assembly programming and instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
8051 programming in C: Data types and time delay in 8051C, IO programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C, Data serialization using 8051C **8051 Timer programming in Assembly and C:** Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying,L_4 – Analysing, L_5 – Evaluating.	
Module-4		
8051 serial port programming in assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C. **8051 Interrupt programming in assembly and C:** 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE52 MICROCONTROLLER (Core Course) (continued)

Module-5		**Teaching Hours**
Interfacing: LCD interfacing, Keyboard interfacing. **ADC, DAC and sensor interfacing:** ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning. **Motor control: Relay, PWM, DC and stepper motor:** Relays and opt isolators, stepper motor interfacing, DC motor interfacing and PWM. **8051 interfacing with 8255:** Programming the 8255, 8255 interfacing, C programming for 8255.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the history of the 8051 and features of other 8051 family members and the internal architecture of the 8051.
- Explains the use of an 8051 assembler, the stack and the flag register, loop, jump, and call instructions.
- Discuss 8051 addressing modes, accessing data and I/O port programming, arithmetic, logic instructions, and programs.
- Develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic and arithmetic operations, data conversion and data serialization
- Discuss the hardware connection of the 8051 chip, its timers, serial data communication and its interfacing of 8051to the RS232.
- Discuss in detail 8051 interrupts and writing interrupt handler programs.
- Interface 8051 with real-world devices such as LCDs and keyboards, ADC, DAC chips and sensors.
- Interface 8031/51 with external memories, 8255 chip to add ports and relays, opt isolators and motors.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazadi	Pearson	2nd Edition, 2008.

Reference Books

1	The 8051 Microcontroller	Kenneth Ayala	Cengage Learning	3rd Edition, 2005
2	The 8051 Microcontroller and Embedded Systems	Manish K Patel	McGraw Hill	2014
3	Microcontrollers: Architecture, Programming, Interfacing and System Design	Raj Kamal	Pearson	1st Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – V			
POWER ELECTRONICS (Core Course)			
Subject Code	15EE53	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits – 04			

Course objectives:

- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and imitations.
- To explain different types of Thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.■

Module-1		Teaching Hours
Introduction: Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches. **Power Diodes:** Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Diode Switched *RL* Load, Freewheeling Diodes with Switched RLLoad. **Diode Rectifiers:**Introduction, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with RL Load, Single-Phase Full-Wave Rectifier with a Highly Inductive Load.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing	
Module-2		
Power Transistors: Introduction, Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, IGBTs, MOSFET Gate Drive, BJT Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing	
Module-3		
Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn-On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, *di/dt*Protection, *dv/dt*Protection, DIACs, Thyristor Firing Circuits, Unijunction Transistor.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing	
Module-4		
Controlled Rectifiers: Introduction, Single-Phase Full Converters, Single-Phase Dual Converters, Three- Phase Full Converters, Three-Phase Dual Converters, **AC Voltage Controllers:** Introduction, Single-Phase Full-Wave Controllers with Resistive Loads, Single-Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – V		
15EE53 POWER ELECTRONICS (Core Course) (continued)		
Module-5		**Teaching Hours**
DC-DC Converters: Introduction, principle of step down and step up chopper with RL load, performance parameters, DC-DC converter classification. **DC-AC converters**: Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain application area of power electronics, types of power electronic circuits and switches their characteristics and specifications.
- Explain types of power diodes, their characteristics, and the effects of power diodes on RL circuits.
- Explain the techniques for design, operation and analysis of single phase diode rectifier circuits.
- Explain steady state, switching characteristics and gate control requirements of different power transistors and their limitations.
- Discuss different types of Thyristors, their operation, gate characteristics and gate control requirements.
- Explain designing, analysis techniques and characteristics of thyristor controlled rectifiers.
- Discuss the principle of operation of single phase and three phase DC - DC, DC –AC converters and AC voltage controllers.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Power Electronics: Circuits Devices and Applications	Mohammad H Rashid,	Pearson	4th Edition, 2014

Reference Books

1	Power Electronics: Converters, Applications and Design	Ned Mohan et al	Wiley	3rd Edition, 2014
2	Power Electronics	Daniel W Hart	McGraw Hill	1st Edition, 2011
3	Elements of Power Electronics	Philip T Krein	Oxford	Indian Edition, 2008

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

SIGNALS AND SYSTEMS (Core Course)

Subject Code	15EE54	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course objectives:

- To discuss arising of signals in different systems.
- To classify the signals and define certain elementary signals.
- To explain basic operations on signals and properties of systems.
- To explain the use of convolution integral and convolution summation in analyzing the response of linear time invariant systems in continuous and discrete time domains.
- To explain the properties of linear time invariant systems in terms of impulse response description.
- To explain determination of response of a given linear time invariant system and to provide a block diagram representation to it.
- To explain Fourier transform representation of continuous time and discrete time non –periodic signals and the properties of Fourier Transforms.
- To explain the applications of Fourier transform representation to study signals and linear time invariant systems.
- To explain the use of Z-transform in the complex exponential representation of discrete time signals and the analysis of systems. ■

Module-1		Teaching Hours
Introduction: Definitions of signals and a system, classification of signals, basic operations on signals. Elementary signals viewed as interconnections of operations, properties of systems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L – 4 Analysing, L_5 – Evaluating.	
Module-2		
Time – Domain Representations For LTI Systems: Convolution, impulse response, properties, solution of differential and difference equations, block diagram representation.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-3		
The Continuous-Time Fourier Transform: Representation of a non -periodic signals: continuous-time Fourier transform (FT), Properties of continuous-time Fourier transform, Applications. Frequency response of LTI systems, Solutions of differential equations■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
The Discrete-Time Fourier Transform: Representations of non-periodic signals: The discrete-time Fourier transform (DTFT), Properties of DTFT and applications. Frequency response of LTI system, Solutions of differential equations.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating..	
Module-5		
Z- Transforms: Introduction, Z-transform, properties of ROC, properties of Z-transforms, inversion of Z-transform methods - power series and partial expansion, Transforms analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to solve difference equations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE54 SIGNALS AND SYSTEMS (Core Subject) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Classify the signals and systems.
- Explain basic operations on signals and properties of systems.
- Use convolution in both continuous and discrete domain for the analysis of systems given the impulse response of a system.
- Evaluate response of a given linear time invariant system.
- Provide block diagram representation of a linear time invariant system.
- Apply continuous time Fourier transform representation to study signals and linear time invariant systems.
- Apply discrete time Fourier transform representation to study signals and linear time invariant systems. Use Z-transform and properties of Z transform for the analysis of discrete time systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Signals and Systems	Simon Haykin, Berry Van Veen	Wiley	2nd Edition,2002

Reference Books

2	Fundamentals of Signals and Systems	Michael J. Roberts, Govind K Sharma	McGraw Hill	2nd Edition 2010
3	Signals and Systems	NagoorKani	McGraw Hill	1st Edition 2010
4	Signals and Systems A Primer with MATLAB	Matthew N.O. Sadiku Warsame H. Ali	CRC Press	1st Edition, 2016
5	Signals and Systems	Anand Kumar	PHI	3rd Edition, 2015

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –V

INTRODUCTION TO NUCLEAR POWER (Professional Elective)

Subject Code	15EE551	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To explain the fission process in nuclear materials and how the nuclear reactors work and the basic components of nuclear reactors and their types.
- Explanation about cooling of reactors, features of coolant, different types of coolants used in the reactors and the losses of cooling.
- Discussion on loss of cooling accidents in different reactors.
- Discussion on postulated severe accidents in water cooled reactors and other reactors and cooling of reactor during removal and processing.
- Discussion on cooling and disposing the nuclear waste and prospect of fusion energy in the future. ■

Module	Teaching Hours
Module-1	
The Earth and Nuclear Power: Sources and Resources: Introduction, Earth's Internal Heat Generation, The Earth's Energy Flow, The Fission Process, Thermal Energy Resources. **How Reactors Work:** Introduction, The Fission Process, Basic Components of a Nuclear Reactor, Thermal Reactors, Fast Reactors. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Cooling Reactors: Introduction, General Features of a Reactor Coolant, Principles of Heat Transfer, Gaseous Coolants, Liquid Coolants, Boiling Coolants. **Loss of Cooling:** Introduction, The Electric Kettle, Pressurized-Water Reactor, Boiling-Water Reactor, CANDU Reactor, Gas-Cooled Reactors, Sodium- Cooled Fast Reactor. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Loss-of-Cooling Accidents: Introduction, Incidents in light Water-Cooled Reactors, Heavy Water-Moderated Reactors, Gas-Cooled Reactors, Liquid Metal-Cooled Fast Reactors.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Postulated Severe Accidents Introduction: Introduction, Postulated Severe Accidents in Water-Cooled Reactors, Specific Phenomena relating to Severe Accidents, Severe Accidents in other Reactor Types, Fission Product Dispersion following Containment Failure. **Cooling during Fuel Removal and Processing**: Introduction, Refuelling, Spent Fuel Storage and Transport, Reprocessing Plant. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
Cooling and Disposing of the Waste: Introduction, Classification of Waste Products, Fission Products and Their Biological Significance, Options for Nuclear Waste Disposal, Long-Term Storage and Disposal of Spent Nuclear Fuel, Storage and Disposal of Fission Products from Reprocessing Plants, Disposal of other Materials. **Fusion Energy -Prospect for the Future:** Introduction, The Fusion Process, Confinement, Current Technical Position, Conclusions. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –V

15EE551INTRODUCTION TO NUCLEAR POWER (Professional Elective) (continued)

Course outcomes:
At the end of the course the student will be able to:

- Explain the fission process in nuclear materials, basic components of nuclear reactors, types of nuclear reactors and their working.
- Discuss different types of coolants, their features, and cooling of reactors,
- Discuss loss of cooling accidents in different reactors.
- Discuss postulated severe accidents in reactors and cooling of reactor during removal of spent fuel.
- Discuss cooling and disposing the nuclear waste and prospect of fusion energy in the future.■

Graduate Attributes (As per NBA)
Engineering Knowledge, Design/ Development of Solutions, The Engineer and Society, Environment and Sustainability, Ethics, Project Management and Finance.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Introduction to Nuclear Power	Geoffrey F. Hewitt	Taylor & Francis	1st Edition, 2000

Reference Books

1	Nuclear Reactor Engineering	G.Vaidyanathan	S.Chand	1st Edition, 2013
2	Introduction to Nuclear Engineering	John R Lamarsh Anthony J Baratta	Pearson	3rd Edition, 2016

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

ELECTRICAL ENGINEERING MATERIALS (Professional Elective)

Subject Code	15EE552	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To impart the knowledge of conducting, dielectric, insulating and magnetic materials and their applications.
- To impart the knowledge of superconducting materials and their applications
- To impart the knowledge of plastics and materials for Opto - Electronic devices. ■

Module-1	**Teaching Hours**
Introduction to Electrical and Electronic Materials: Importance of materials, Classification of electrical and electronic materials, Scope of electrical and electronic materials, Requirement of Engineering materials, Operational requirements of electrical and electronic materials, Classification of solids on the basis of energy gap, Products – working principle and materials, Types of engineering materials, Levels of material structure. Spintronics and Spintronic materials, Ferromagnetic semiconductors, Left handed materials. **Conductors:** Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermoelectric effect, Seebeck effect, Thomson effect, Wiedemann – Franz law and Lorentz relation, Problems .■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Conductive Materials and Applications: Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing. **Dielectrics:** Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss. Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behaviour of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Insulating Materials: Insulating materials and applications – Ceramic, Mica, Porcelain, Glass, Micanite and Glass bonded mica. Polymeric materials – Bakelite, Polyethylene. Natural and synthetic rubber. Paper. Choice of solid insulating material for different applications, Liquid insulating materials – Requirements, Transformer oil, Bubble theory, Aging of mineral insulating oils. Gaseous insulating Materials – Air, Nitrogen, Vacuum. **Magnetic Materials:** Origin of permanent magnetic dipole, Magnetic terminology, Relation between relative permeability and magnetic susceptibility. Classification of magnetic materials, Diamagnetic, Paramagnetism, Ferromagnetism, Antiferromagnetism and the corresponding materials. Ferrimagnetism and ferrites – properties and applications, Soft and hard ferrites. Curie temperature, Laws of magnetic materials. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-4	
Magnetic Materials (continued): Types of magnetic materials, Soft and hard magnetic materials, High energy magnetic materials, Commercial grade soft and hard magnetic materials. **Superconductive Materials:** Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field	**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE552 ELECTRICAL ENGINEERING MATERIALS (Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Superconductive Materials (continued): and critical temperature, Effects of Isotopic mass on critical temperature, Silsbee rule, Depth of penetration and coherence length. Ideal and Hard superconductors, Mechanism of super conduction, London's theory for Type I superconductors, GLAG theory for Type I superconductors, BCS theory, Applications and limitations. Applications of high temperature superconductors, Superconducting solenoids and magnets, MRI for medical diagnostics.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Plastics: Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic. **Materials for Opto – Electronic Devices:** Introduction, Optical phenomena, Reflection, Refraction, Transmittivity, Scattering, Optical absorption, Optical properties of non-metals, Optical properties of metals, Optical properties of semiconductors, Optical properties of insulators. Luminescence, Opto – Electronic devices, Photoconductivity, Photoconductive cell.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss electrical and electronics materials, their importance, classification and operational requirement
- Discuss conducting materials used in engineering, their properties and classification.
- Discuss dielectric materials used in engineering, their properties and classification.
- Discuss insulating materials used in engineering, their properties and classification.
- Discuss magnetic materials used in engineering, their properties and classification
- Explain the phenomenon superconductivity, super conducting materials and their application in engineering.
- Explain the plastic and its properties and applications.
- Discuss materials used for Opto electronic devices.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Advanced Electrical and Electronics Materials; Processes and Applications	K.M. Gupta Nishu Gupta	Wiley	First Edition, 2015

Reference Books

1	Electronic Engineering Materials	R.K. Shukla Archana Singh	McGraw Hill	2012
2	Electrical Properties of Materials	L Solymar et al	Oxford	9th Edition, 2014
3	Electrical Engineering Materials	A.J. Dekker	Pearson	2016
4	Principle of Electronic Materials and Devices	S.O. Kasap	McGraw Hill	3rd Edition 2010

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) **CHOICE BASED CREDIT SYSTEM (CBCS)** **SEMESTER -V**			
ELECTRICAL ESTMATION AND COSTING (Professional Elective)			
Subject Code	15EE553	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss the purpose of estimation and costing.
- To discuss market survey, estimates, purchase enquiries, tenders, comparative statement and payment of bills and Indian electricity act and some of the rules.
- To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses.
- To discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
- To discuss different types of service mains and estimation of power circuits.
- To discuss estimation of overhead transmission and distribution system and its components.
  To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation. ■

Module-1		Teaching Hours
Principles of Estimation: Introduction to Estimation and Costing, Electrical Schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, LabourConditions, Determination of Cost Material and Labour, Contingencies, Overhead Charges, Profit, Purchase System, Purchase Enquiry and Selection of Appropriate Purchase Mode, Comparative Statement, Purchase Orders, Payment Of Bills, Tender Form, General Idea about IE Rule, Indian Electricity(IE) Act and IE Rules -29,30,45,46,47,50,51,54,55,77 and79.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Wiring: Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring. Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables **Wiring (continued):** Main Switch and Distribution Board, Conduits and its accessories and Fittings. Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor. **Internal Wiring:** General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the Textbook), Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout. ..■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Service Mains: Introduction, Types, Estimation of Underground and Overhead Service Connections. **Design and Estimation of Power Circuits:** Introduction, Important Considerations Regarding Motor Installation Wiring, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Estimation of Overhead Transmission and Distribution Lines: (Review of Line Supports, Conductor Materials, Size of Conductor for Overhead Transmission Line, Types of Insulators)[No Question Shall be Set From the Review Portion]. Cross Arms, Pole Brackets and Clamps, Guys and Stays, Conductors Configuration Spacing and Clearances, Span Lengths, Lightning Arrestors, Phase Plates, Danger Plates, Anti Climbing Devices, Bird Guards, Beads of Jumpers, Muffs, Points to be Considered at the Time of Erection of Overhead Lines, Erection of Supports, Setting of Stays, Fixing of Cross Arms, Fixing of Insulators, Conductor Erection.		**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -V		
15EE553 ELECTRICAL ESTMATION AND COSTING (Professional Elective) (continued)		
Module-4 (continued)		**Teaching Hours**
Estimation of Overhead Transmission and Distribution Lines (continued): Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulators, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead Lines, Clearances of Conductor From Ground, Spacing Between Conductors, Important Specifications. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Applying, L_4 – Analysing	
Module-5		
Estimation of Substations: Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, Equipmentfor Substation, Substation Auxiliaries Supply, Substation Earthing.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the purpose of estimation and costing.
- Discuss market survey, estimates, purchase enquiries, preparation of tenders, comparative statements and payment of bills.
- Discuss Indian Electricity act and Indian Electricity rules.
- Discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses.
- Discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
- Discuss types of service mainsand estimation of service mains and power circuits.
- Discuss estimation of overhead transmission and distribution system and its components.
- Discuss main components of a substation, preparation of single line diagram of a substation and earthing of a substation.■

Graduate Attributes (As per NBA)

Engineering Knowledge,

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	A Course in Electrical Installation Estimating and Costing	J. B. Gupta	Katson Books,	9th Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – V			
SPECIAL ELECTRICAL MACHINES (Professional Elective)			
Subject Code	15EE554	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits – 03			

Course objectives:

- To impart knowledge on the Construction, principle of operation, control and performance of stepping motors.
- To impart knowledge on the Construction, principle of operation, control and performance of switched reluctance motors and permanent magnet brushless D.C. motors.
- To impart knowledge on the Construction, principle of operation and performance of permanent magnet synchronous motors and synchronous reluctance motor.
- To impart knowledge on single phase special machines and servo motors.
- To impart knowledge on Linear electrical machine and permanent magnet axial flux machines. ■

Module-1		**Teaching Hours**
Stepper Motor: Introduction, Variable Reluctance Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types of Stepper Motor, Windings in Stepper Motors, Torque Equation, Characteristics of Stepper Motor, Open – loop Control of Stepper Motor, Closed – loop Control of Stepper Motor, Microprocessor – Based Control of Stepper Motor, Applications of Stepper Motor. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Switched Reluctance Motor (SRM): Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque Equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensors, Current Regulators, Microprocessor – Based Control of SRM, Sensorless Control of SRM. **Permanent Magnet DC Motor and Brushless Permanent Magnet DC Motor:** Permanent Magnet DC (PMDC) motor, Brushless Permanent Magnet DC (BLDC) Motors. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Permanent Magnet Synchronous Motor (PMSM): Construction, Principle of Operation, EMF Equation, Torque Equation, Phasor Diagram, Circle Diagram, Comparison of Conventional and PMSM, Control of PMSM, Applications. **Synchronous Reluctance Motor (SyRM):** Constructional of SyRM, Working, Phasor Diagram and Torque Equation, Control of SyRM, Advantages and Applications. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Single Phase Special Electrical Machines: AC series Motor, Repulsion Motor, Hysteresis Motor, Single Phase Reluctance Motor, Universal Motor. **Servo Motors:** DC Servo Motors, AC Servo Motors. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Linear Electric Machines: Linear Induction Motor, Linear Synchronous Motor, DC Linear Motor, Linear Reluctance Motor, Linear Levitation Machines. **Permanent Magnet Axial Flux (PMAF) Machines:** Comparison of Permanent Radial and Axial Flux Machines, Construction of PMAF Machines, Armature Windings, torque and EMF Equations of PMAF, Phasor Diagram, Output Equation, Pulsating Torque And its Minimisation, Control and Applications of PMAF. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE554 SPECIAL ELECTRICAL MACHINES (Professional Elective) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain the performance and control of stepper motors, and their applications.
- Explain theory of operation and control of switched reluctance motor and permanent magnet brushless D.C. motors.
- Explain theory of operation and control of permanent magnet synchronous motors and synchronous reluctance motor.
- Explain operation of single phase special machines and servo motors.
- Explain operation of linear electrical machine and permanent magnet axial flux machines. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Textbook

1	Special Electrical Machines	E.G. Janardanan	PHI	1st Edition 2014.

Reference Books

1	Special Electrical Machines	K Venkataratham	University Press	2009
2	Brushless Permanent Magnet and Reluctance Motor Drives	T J E Miller	Clerendon Press, Oxford	1989
3	Permanent Magnet and Brushless DC Motors	Kenjo T and Nagamori S	Clerendon Press, Oxford	1985
4	Stepping Motors and their Microprocessor Control	KenjoT	Clerendon Press Oxford	1984
5	Switched Reluctance Motor Drives Modeling, Simulation Design and Applications	Krishan R	CRC	2001

<table>
<tr><td colspan="5">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V</td></tr>
<tr><td colspan="5">ELECTRONIC COMMUNICATION SYSTEMS(Open Elective)</td></tr>
<tr><td>Subject Code</td><td>15EE561</td><td colspan="2">IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td colspan="2">Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td colspan="2">Exam Marks</td><td>80</td></tr>
<tr><td colspan="5">Credits - 03</td></tr>
<tr><td colspan="5">Course objectives:
• To explain elements of communication system, noise and its effects.
• To describe the theory of amplitude, angle, pulse and digital modulation techniques
• To explain principles of radio communication, transmitters and receivers
• To explain basics of Television Broadcasting
• To explain basic principles of radar systems.
• To discuss multiplexing used in broadband communications.
• To explain the basic routing process used for long-distance telephony
• To explain fiber optic technology used for communication and its components and systems and their installation.
• To discuss basics of information theory, coding and data communication.</td></tr>
<tr><td colspan="4">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="4">Introduction to Communication: Elements of a Communication System, Need for Modulation, Electromagnetic Spectrum and Typical Applications, Terminologies in Communication Systems, Basics of Signal Representation and Analysis.
Noise: External Noise, internal Noise, Noise Calculations, Noise Figure, Noise Temperature.
Amplitude Modulation Techniques: Elements of Analog Communication, Theory of Amplitude Modulation Techniques, Generation of Amplitude Modulated Signals.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="5">Module-2</td></tr>
<tr><td colspan="4">Angle Modulation Techniques: Theory of Angle Modulation Techniques, Practical Issues in Frequency Modulation, Generation of Frequency Modulation.
Pulse Modulation Techniques: Introduction, Pulse Analog Modulation Techniques, Pulse Digital Modulation Techniques.
Digital Modulation Techniques: Introduction, Basic Digital Modulation Schemes, M-ary Digital Modulation Techniques.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="5">Module-3</td></tr>
<tr><td colspan="4">Radio Transmitters and Receivers: Introduction lo Radio Communication, Radio Transmitters, Receiver Types, AM Receivers, FM Receivers, Single- and Independent-Sideband Receivers.
Television Broadcasting: Requirements and Standards, Black-and-White Transmission, Black-and-White Reception, Colour Transmission and Reception.■</td><td>08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td><td></td></tr>
<tr><td colspan="5">Module-4</td></tr>
<tr><td colspan="4">Radar Systems: Basic Principles, Pulsed Systems, Other Radar Systems.
Broadband Communication Systems: Multiplexing, Short-and Medium-Haul Systems, Long-Haul Systems, Elements of Long-Distance Telephony.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing</td></tr>
<tr><td colspan="5"></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE561 ELECTRONIC COMMUNICATION SYSTEMS(Open Elective) (continued)

Module-5	**Teaching Hours**
Introduction to Fiber Optic Technology: History of Fiber Optics, Need of Optical Fibers, Introduction to Light, The Optical Fiber and Fiber Cables, Fiber Optic Components and Systems, Installation, Testing, and Repair. **Information Theory, Coding and Data Communication:** Information Theory, Digital Codes, Error Detection and Correction, Fundamentals of Data Communication System, Data Sets and Interconnection Requirements, Network and Control Considerations.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing	

Course outcomes:

At the end of the course the student will be able to:

- Understand communication systems and its terminologies.
- Explain noise, computation of noise level in communication systems.
- Describe the theory of amplitude, angle, pulse and digital modulation techniques
- Explain principles of radio communication, transmitters and receivers
- Show understanding of the basic TV system and process transmission and reception
- Explain basic principles of radar systems and multiplexing broadband communication systems.
- Show understanding of fiber optic technology.
- Show understanding of information theory, coding and data communication

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Electronic Communication Systems	George Kennedy	McGraw Hill	5th Edition, 2011

Reference Books

1	Electronic Communications Systems: Fundamentals Through Advanced	Wayne Tomasi	Pearson	5th Edition, 2009
2	Communication Systems	V. Chandrasekar	Oxford	1st Edition, 2012
3	Communication Systems	P Ramakrishna Rao	McGraw Hill	1st Edition, 2013

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V			
PROGRAMMABLE LOGIC CONTROLLERS (Open Elective)			
Subject Code	15EE562	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain advantages and disadvantages, main parts and their functions, basic sequence of operation of PLC.
- To describe the hardware components: I/O modules, CPU, memory devices, other support devices and the functions of PLC memory map.
- To describe program scan sequence, the communication of information to the PLC using different languages, internal relay instruction.
- To explain identification of common operating modes found in PLCs, writing and entering the ladder logic programs.
- To define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits and Latching Relays.
- To explain conversion of relay schematics into PLC ladder logic programs and writing PLC programs directly from narrative descriptions.
- To explain the functions of PLC counter instructions, applying combinations of counters and timers to control systems.
- To describe the function of selectable timed interrupt and fault routine files and use of temporary end instruction.
- To explain the execution of data transfer instructions, interruption of data transfer and data compare instructions.
- To explain the basic operation of PLC closed-loop control system, various forms of mechanical sequencers and their operations.
- To describe the operation of bit and word shift registers and develop programs that use shift registers.
- To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes. ■

Module-1		Teaching Hours
Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs). **Basics of PLC Programming:** Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding,	
Module-2		
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers:** Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding,.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) **CHOICE BASED CREDIT SYSTEM (CBCS)** **SEMESTER - V**		
15EE562 PROGRAMMABLE LOGIC CONTROLLERS (Open Elective) (continued)		
Module-3		**Teaching Hours**
Programming Counters: Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. **Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding,.	
Module-4		
Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. **Math Instructions:** Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Sequencer and Shift Register Instructions: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations. **Process Control, Network Systems, and SCADA:** Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA). ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss history of PLC, its sequence of operation, advantages and disadvantages, main parts and their functions.
- Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.
- Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module.
- Convert relay schematics and narrative descriptions into PLC ladder logic programs
- Analyze PLC timer and counter ladder logic programs
- Describe the operation of different program control instructions
- Discuss the execution of data transfer instructions, data compare instructions and the basic operation of PLC closed-loop control system.
- Describe the operation of mechanical sequencers, bit and word shift registers, processes and structure of control systems and communication between the processes.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V				
15EE562 PROGRAMMABLE LOGIC CONTROLLERS (Open Elective) (continued)				
Textbook				
1	Programmable Logic Controllers	Frank D Petruzella	McGraw Hill,	4^{th} Edition, 2011
Reference Book				
1	Programmable Logic Controllers an Engineer's Guide,	E A Parr	Newnes	3^{rd} Edition, 2013
2	Introduction Programmable Logic Controllers	Gary Dunning	Cengage	3^{rd} Edition, 2006

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V			
RENEWABLE ENERGY RESOURCES(Open Elective)			
Subject Code	15EE563	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- To explain sun – earth geometric relationship, Earth – Sun Angles and their Relationships
- To discuss about solar energy reaching the Earth's surface and solar thermal energy applications.
- To discuss types of solar collectors, their configurations and their applications
- To explain the components of a solar cell system, equivalent circuit of a solar cell, its characteristics and applications.
- To discus benefits of hydrogen energy, production of hydrogen energy, storage its advantages and disadvantages.
- To discuss wind turbines, wind resources, site selection for wind turbine
- To discuss geothermal systems, their classification and geothermal based electric power generation
- To discuss waste recovery management systems, advantages and disadvantages
- To discuss biomass production, types of biomass gasifiers, properties of producer gas.
- To discuss biogas, its composition, production, benefits.
- To discuss tidal energy resources, energy availability, power generation.
- To explain motion in the sea wave, power associated with sea wave and energy availability and the devices for harnessing wave energy.
- To discuss principles of ocean thermal energy conversion and production of electricity. ■

Module-1		**Teaching Hours**
Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. **Energy from Sun:** Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects ofSolar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond. **Solar Cells:** Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic Panels, Applications of Solar Cell Systems. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy. **Wind Energy:** Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. **Geothermal Energy:** Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects.		**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - V

15EE563 RENEWABLE ENERGY RESOURCES(Open Elective) (continued)

Module-3 (continued)		**Teaching Hours**
Solid waste and Agricultural Refuse: Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Biomass Energy: Biomass Production, Energy Plantation,Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers. **Biogas Energy:** Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics. **Tidal Energy:**Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. **Ocean Thermal Energy:**Introduction,Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- Discuss energy from sun, energy reaching the Earth's surface and solar thermal energy applications.
- Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications.
- Discus generation of energy from hydrogen, wind, geothermal system, solid waste and agriculture refuse.
- Discuss production of energy from biomass, biogas.
- Discuss tidal energy resources, energy availability and power generation.
- Discuss power generation sea wave energy and ocean thermal energy. ■

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V				
15EE563 RENEWABLE ENERGY RESOURCES(Open Elective) (continued)				
Textbook				
1	Nonconventional Energy Resources	ShobhNath Singh	Pearson	1st Edition, 2015
Reference Books				
1	Nonconventional Energy Resources	B.H. Khan	McGraw Hill	3rd Edition,
2	Renewable Energy; Power for a sustainable Future	Godfrey Boyle	Oxford	3rd Edition, 2012
3	Renewable Energy Sources: Their Impact on global Warming and Pollution	TasneemAbbasi S.A. Abbasi	PHI	1st Edition, 2011

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -V			
BUSINESS COMMUNICATION (Open Elective)			
Subject Code	15EE564	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss analysing audiences, and choose the most effective structure and style for delivering strategically sound written and spoken messages.
- To discuss how to organize the talk, handling audience response.
- To discuss how to communicate with managers, co-workers, customers and suppliers.
- To discuss how engineers can use written and oral skills, computer, graphics and other engineering tools to communicate with other engineers and management. ■

Module-1		Teaching Hours
Analyse Communication Purpose and Audience: How to Learn, How Engineers Are Persuaded, Speak or Write: Select the Right Communication Channel, Consider Your Communication Purpose and Audience. **Projecting the Image of the Engineering Profession:** Overcome Anxiety, Primary Impact: Nonverbal Body Language, Secondary Impact: Control Vocal Quality, Volume, And Pace, Optimize Presentation Environment. **Presentation Aids: Engineering:** The Real da Vinci Code, Speaking Visually—Guidelines for Using Presentation Aids, Choosing among Options, Creating Visuals with Impact, Delivering with Visuals. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Organize Your Talk: Planning Your Talk, Conducting an Audience Analysis: 39Questions, Organizing Your Talking Seven Easy Stages, Getting Attention and Keeping Interest, Five Minutes Early – Time Management for Your Presentation, Delivering Your Introduction, Presenting Your Conclusion. **Handling Audience Response:** Create the Environment, Handle with C.A.R.E, Deal with Hostile Questions, Deal with Other Types of Questions, Control the Q&A Session, Thinking on Your Feet. **Organizing for Emphasis:** Make our Bottom Line the Top Line, Purpose Statement and Blueprints, Open Long Reports with a Summary, Use More Topic Sentences, Develop Headings, Structure Vertical Lists. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Write As If Talking to Your Engineering Associates: Use Personal Pronouns, Relyon Everyday Words, Use Short Spoken Transitions, Keep Sentences Short, Reach Out to Your Engineering Readers by Asking Questions, 5Whys-ATechnique for Engineering Problem Solving. **Trim Your Expressions:** Introduction, Prune Wordy Expressions, Use Strong Verbs, Cut Doublings and Noun Strings, Eliminate Unnecessary Determiners and Modifiers, Change Phrases into Single Words, Change Unnecessary Clauses into Phrases or Single Words, Avoid Over using "Itis" and "Thereis", Eight Steps for Lean Writing. **Write Actively—Engineering is about Actions:** Active Voice:"Albert Einstein Wrote the Theory of Relativity", How to Recognize the Passive Voice, How to Write Actively – Use Three Cures, Write Passively for Good Reasons Only, Theory of Completed Staff Work. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Every day Engineering Communications -E-Mails, Phone Calls, and Memos: Effective E-mail Writing: Seven Things to Remember, How to Be Productive on the Phone, "Memos Solve Problems".		**08**

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<tr><td colspan="3">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
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<tr><td colspan="3">15EE564 BUSINESS COMMUNICATION (Open Elective) (continued)</td></tr>
<tr><td colspan="2">Module-4 (continued)</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Visuals for Engineering Presentation - Engineers Think in Pictures: Optimize Slide Layout, Display Engineering Data Effectively, How to Develop Effective Graphics.
Write Winning Grant Proposals: Know Your Audience, Understand Your Goal and Marketing Strategy, Select the Correct Writing Style, Organize Your Proposal around the FourPs, A Brief Checklist before Submitting Your Proposal. ■</td><td rowspan="2"></td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-5</td></tr>
<tr><td colspan="2">How to Effectively Prepare Engineering Reports: Writing an Effective Progress Report, Develop Informative Design Reports.
Listening Interactive Communication about Engineering Risk: Listening – A Forgotten Risk Communication Skill Listening – Harder Than Speaking and Writing, How to Listen to Voice of Customers about Risk, Listen Attentively: Understanding What Drives Perceived Risk, Thirteen Questions about Risk Communication. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Course outcomes:
At the end of the course the student will be able to:
Apply business communication strategies and principles to prepare effective communication for domestic and international business situations.
Utilize analytical and problem solving skills appropriate to business communication.
Participate in team activities that lead to the development of collaborative work skills.
Select appropriate organizational formats and channels used in developing and presenting business messages.
Compose and revise accurate business documents using computer technology.
Communicate via electronic mail, Internet, and other technologies.
Deliver an effective oral business presentation. ■</td></tr>
<tr><td colspan="3">Graduate Attributes (As per NBA)
Engineering Knowledge</td></tr>
<tr><td colspan="3">Question paper pattern:
The question paper will have ten questions.
Each full question is for 16 marks.
There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
Each full question with sub questions will cover the contents under a module.
Students will have to answer 5 full questions, selecting one full question from each module. ■</td></tr>
<tr><td colspan="3">Text Book</td></tr>
</table>

1	What Every Engineer Should Know AboutBusinessCommunication	John X. Wang	CRC	2008

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -V

MICROCONTROLLER LABORATORY - 1

Subject Code	15EEL57	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80

Credits - 02

Course objectives:

- To explain writing assembly language programs for data transfer, arithmetic, Boolean and logical instructions.
- To explain writing assembly language programs for code conversions.
- To explain writing assembly language programs using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
- To perform interfacing of stepper motor and dc motor for controlling the speed.
- To explain generation of different waveforms using DAC interface. ■

Sl. NO	Experiments
Note: For the experiments 1 to 6, 8051 assembly programming is to be used.	
1	Data transfer – Program for block data movement, sorting, exchanging, finding largest element in an array.
2	Arithmetic instructions: Addition, subtraction, multiplication and division. Square and cube operations for 16 bit numbers.
3	Counters
4	Boolean and logical instructions (bit manipulation).
5	Conditional call and return instructions.
6	Code conversion programs – BCD to ASCII, ASCII to BCD, ASCII to decimal, Decimal to ASCII, Hexa decimal to and Decimal to Hexa.
7	Programs to generate delay, Programs using serial port and on-chip timer/counters.
Note: Single chip solution for interfacing 8051 is to be with C Programs for the following experiments.	
8	Stepper motor interface.
9	DC motor interface for direction and speed control using PWM.
10	Alphanumerical LCD panel interface.
11	Generate different waveforms: Sine, Square, Triangular, Ramp using DAC interface.
12	External ADC and Temperature control interface.
13	Elevator interface.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating.

Course outcomes:

At the end of the course the student will be able to:

- Write assembly language programs for data transfer, arithmetic, Boolean and logical instructions.
- Write ALP for code conversions.
- Write ALP using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
- Perform interfacing of stepper motor and dc motor for controlling the speed.
- Generate different waveforms using DAC interface.
- Work with a small team to carryout experiments using microcontroller concepts and prepare reports that present lab work. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Modern tool usage, Communication.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -V

15EEL57 MICROCONTROLLER LABORATORY – 1(continued)

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Learning beyond the syllabus: To acquire a wide variety of skills and to develop society friendly applications mini projects can be practiced by referring to "Microcontroller Based Projects" Second Edition, An EFY (Electronics For You) Enterprise Pvt Ltd, 2013.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V			
POWER ELECTRONICS LABORATORY			
Subject Code	15EEL58	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80
Credits - 02			

Course objectives:

- To conduct experiments on semiconductor devices to obtain their static characteristics.
- To study different methods of triggering the SCR
- To study the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- To control the speed of a dc motor, universal motor and stepper motors.
- To study single phase full bridge inverter connected to resistive load.
- To study commutation of SCR. ■

Sl. No	Experiments
1	Static Characteristics of SCR.
2	Static Characteristics of MOSFET and IGBT.
3	Characteristic of TRIAC.
4	SCR turn on circuit using synchronized UJT relaxation oscillator.
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.
6	Single phase controlled full wave rectifier with R and R –L loads.
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.
8	Speed control of dc motor using single semi converter.
9	Speed control of stepper motor.
10	Speed control of universal motor using ac voltage regulator.
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.
12	Design of Snubber circuit.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Obtain static characteristics of semiconductor devices to discuss their performance.
- Trigger the SCR by different methods
- Verify the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- Control the speed of a dc motor, universal motor and stepper motors.
- Verify the performance of single phase full bridge inverter connected to resistive load.
- Perform commutation of SCR by different methods.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

****** END ******

VI SEMESTER DETAILED SYLLABUS

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) **CHOICE BASED CREDIT SYSTEM (CBCS)** **SEMESTER - VI**			
CONTROL SYSTEMS (Core Subject)			
Subject Code	15EE61	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To define a control system
- To explain the necessity of feedback and types of feedback control systems.
- To introduce the concept of transfer function and its application to the modeling of linear systems.
- To demonstrate mathematical modeling of control systems.
- To obtain transfer function of systems through block diagram manipulation and reduction
- To use Mason's gain formula for finding transfer function of a system
- To discuss transient and steady state time response of a simple control system.
- To discuss the stability of linear time invariant systems and Routh - Hurwitz criterion
- To investigate the trajectories of the roots of the characteristic equation when a system parameter is varied.
- To conduct the control system analysis in the frequency domain.
- To analyze stability of a control system using Nyquist plot.
- To discuss stability analysis using Bode plots.
- To determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.■

Module-1		**Teaching Hours**
Introduction to control systems: Introduction, classification of control systems. **Mathematical models of physical systems:** Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Block diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function. **Signal flow graphs:** Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems. **Routh Stability criterion:** BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
Root locus technique: Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. **Frequency Response analysis:** Co-relation between time and frequency response – 2^{nd} order systems only. **Bode plots:** Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

15EE61 CONTROL SYSTEMS (Core Subject) (continued)

Module-5		**Teaching Hours**
Nyquist plot: Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion. **Design of Control Systems:** Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the effects of feedback and types of feedback control systems.
- Evaluate the transfer function of a linear time invariant system.
- Evaluate the stability of linear time invariant systems.
- Apply block diagram manipulation and signal flow graph methods to obtain transfer function of systems.
- Demonstrate the knowledge of mathematical modeling of control systems and components
- Determine transient and steady state time response of a simple control system.
- Investigate the performance of a given system in time and frequency domains.
- Discuss stability analysis using Root locus, Bode plots and Nyquist plots.
- Determine the controller or compensator configuration and parameter values relative to how it is connec ted to the controlled process given the design specifications.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Modern Tool Usage, Life-long Learning.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Control Systems	Anand Kumar	PHI	2nd Edition, 2014

ReferenceBooks

1	Automatic Control Systems	FaridGolnaraghi, Benjamin C. Kuo	Wiley	9th Edition, 2010
2	Control Systems Engineering	Norman S. Nise	Wiley	4th Edition, 2004
3	Modern Control Systems	Richard C Dorf et al	Pearson	11th Edition, 2008
4	Control Systems, Principles and Design	M.Gopal	McGaw Hill	4th Edition, 2012
5	Control Systems Engineering	S. Salivahanan et al	Pearson	1st Edition, 2015

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

POWER SYSTEM ANALYSIS – 1 (Core Subject)

Subject Code	15EE62	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To introduce the per unit system and explain its advantages and computation.
- To explain the concept of one line diagram and its implementation in problems.
- To explain the necessity and conduction of short circuit analysis.
- To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems.
- To discuss selection of circuit breaker.
- To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits.
- To explain the concept of sequence impedance and its analysis in three phase unbalanced circuits.
- To explain the concept of sequence networks and sequence impedances of an unloaded synchronous generator, transformers and transmission lines.
- To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine
- Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.■

Module	Teaching Hours
Module-1	
Representation of Power System Components: Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU) System, Steady State Model of Synchronous Machine, Power Transformer, Transmission of electrical Power, Representation of Loads. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2	
Symmetrical Fault Analysis: Introduction, Transient on a Transmission Line, Short Circuit of a Synchronous Machine(On No Load), Short Circuit of a Loaded Synchronous Machine, Selection of Circuit Breakers.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances of Transmission Lines, Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines, Sequence Impedances and Networks of Transformers, Construction of Sequence Networks of a Power System, Measurement of sequence Impedance of Synchronous Generator. ■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4	
Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

15EE62 POWER SYSTEM ANALYSIS – 1 (Core Subject) (continued)

Module-5		**Teaching Hours**
Power System Stability: Introduction, Dynamics of a Synchronous Machine, Power Angle Equation Salient and Non – Salient pole Synchronous Machines, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Show understanding of per unit system, its advantages and computation.
- Show the concept of one line diagram and its implementation in problems
- Perform short circuit analysis on a synchronous machine and simple power system to select a circuit breaker for the system.
- Evaluate symmetrical components of voltages and currents in un-balanced three phase circuits.
- Explain the concept of sequence impedance and sequence networks of power system components and power system.
- Analyze three phase synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- Discuss the dynamics of synchronous machine, stability and types of stability.
- Discuss equal area criterion for the evaluation of stability of a simple system under different fault conditions. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, The Engineer and Society, Ethics

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1.	Modern Power System	D. P. Kothari	McGraw Hill	4th Edition, 2011

ReferenceBooks

1	Elements of Power System	William D. StevensonJr	McGraw Hill	4th Edition, 1982
2	Power System Analysis and Design	J.Duncan Glover et al	Cengage	4th Edition, 2008
3	Power System Analysis	Hadi Sadat	McGraw Hill	1st Edition, 2002

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VI			
DIGITAL SIGNAL PROCESSING (Core Subject)			
Subject Code	15EE63	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To define Discrete Fourier transform and its properties.
- To evaluate DFT of various signals using properties of DFT.
- To explain different linear filtering techniques.
- To explain the evaluation of DFT and inverse DFT using fast and efficient algorithms
- To discuss impulse invariant transformation, bilinear transformation techniques and their properties.
- To design infinite impulse response Butterworth digital filters using impulse invariant and bilinear transformation techniques.
- To design infinite impulse response Chebyshev digital filters using impulse invariant and bilinear transformation techniques.
- To discuss direct, cascade, parallel and ladder methods of realizing a digital IIR filter.
- To discuss window functions used for the design of FIR filters.
- To discuss windowing technique of designing FIR filter.
- To discuss frequency sampling technique of designing FIR filter.
- To discuss direct, cascade and linear phase form of realizing a digital FIR filter. ■

Module-1		**Teaching Hours**
Discrete Fourier Transforms: Definitions, properties-linearity, shift, symmetry Properties- circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stock ham's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing. L_5 – Evaluating	
Module-2		
Fast Fourier Transforms Algorithms: Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing. L_5– Evaluating	
Module-3		
Design of IIR Digital Filters: Introduction, impulse invariant transformation, bilinear transformations, All pole analog filters- Butterworth & Chebyshev filters, design of digital Butterworth filter by impulse invariant transformation and bilinear transformation, Frequency transformations. ■		**10**
Revised Bloom's Taxonomy Level	L1- Remembering, L2 – Understanding, L3 – Applying. L4 – Analysing. L5 – Evaluating	
Module-4		
Design of IIR Digital Filters (Continued): Design of digital Chebyshev –type 1filter by impulse invariant transformation and bilinear transformation, Frequency transformations. **Realization of IIR digital systems:** direct form, cascade form and parallel form, Ladder structures for equal degree polynomial. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5– Evaluating	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

15EE63 DIGITAL SIGNAL PROCESSING (Core Subject) (continued)

Module-5		Teaching Hours
Design of FIR Digital Filters: Introduction, windowing, rectangular, modified rectangular. Hamming, Hanning, Blackman window, **design of FIR digital filters by use of windows, Design of FIR digital filters-**frequency sampling techniques. **Realization of FIR systems:** direct form, cascade form, linear phase form■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5– Evaluating	

Course outcomes:

At the end of the course the student will be able to:

- Compute the DFT of various signals using its properties and linear filtering of two sequences.
- Apply fast and efficient algorithms for computing DFT and inverse DFT of a given sequence
- Design infinite impulse response Butterworth digital filters using impulse invariant / bilinear transformation technique.
- Design infinite impulse response Chebyshev digital filters using impulse invariant or bilinear transformation technique.
- Realize a digital IIR filter by direct, cascade, parallel and ladder methods of realization.
- Discuss different window functions and frequency sampling method used for design of FIR filters.
- Design FIR filters by use of window function or by frequency sampling method.
- Realize a digital FIR filter by direct, cascade, and linear phase form. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Design/ Development of Solutions, Modern Tool Usage.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Introduction to Digital Signal Processing	Jhonny R. Jhonson	Pearson	1st Edition, 2016

Reference Books

1.	Digital Signal Processing – Principles, Algorithms, and Applications	Jhon G. Proakis Dimitris G. Manolakis	Pearson	4th Edition, 2007.
2.	Digital Signal Processing	A.NagoorKani	McGraw Hill	2nd Edition, 2012
3	Digital Signal Processing	Shaila D. Apte	Wiley	2nd Edition, 2009
4	Digital Signal Processing	Ashok Amberdar	Cengage	1st Edition, 2007
5	Digital Signal Processing	Tarun Kumar Rawat	Oxford	1st Edition, 2015

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VI			
ELECTRICAL MACHINE DESIGN (Core Course)			
Subject Code	15EE64	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To discuss design factors, limitations in design and modern trends in design and manufacturing of electrical machines.
- To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines.
- To derive the output equation of DC machine, single phase, three phase transformers, induction motor and synchronous machines.
- To discuss the selection of specific loadings, for various machines.
- To discuss separation of main dimensions for different electrical machines
- To discuss design of field windings for DC machines and synchronous machines.
- To evaluate the performance parameters of transformer, induction motor.
- To design of cooling tubes for the transformer for a given temperature rise.
- To explain design of rotor of squirrel cage rotor and slip ring rotor.
- To define short circuit ratio and discuss its effect on machine performance.■

Module-1		Teaching Hours
Fundamental Aspects of Electrical Machine Design: Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques. **Electrical Engineering Materials:** Desirabilities of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2		
Design of DC Machines: Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Design of Transformers: Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Design of Three Phase Induction Motors: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

15EE64 ELECTRICAL MACHINE DESIGN (Core Course) (continued)

Module-5

Design of Three Phase Synchronous Machines: Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding.■ **10**

Revised Bloom's Taxonomy Level: L_3 – Applying, L_4 – Analysing. L_2 – Understanding, L_4 – Analysing.

Course outcomes: At the end of the course the student will be able to:

- Discuss design factors, limitations, modern trends in design, manufacturing of electrical machines and properties of materials used in the electrical machines.
- Derive the output equations of transformer, DC machines and AC machines.
- Discuss selection of specific loadings and magnetic circuits of different electrical machines
- Design the field windings of DC machine and Synchronous machine.
- Design stator and rotor circuits of a DC and AC machines.
- Estimate the number of cooling tubes, no load current and leakage reactance of core type transformer.
- Discuss short circuit ratio and its effects on performance of synchronous machines.
- Design salient pole and non-salient pole alternators for given specifications. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics
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Question paper pattern:

- The question paper will have ten full questions carrying equal marks.Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	A course in Electrical Machine design	A.K.Sawhney	DhanpatRai	6th Edition, 2013

Reference Books

1	Performance and Design of Alternating Current Machines	M.G. Say	CBS Publisher	3rd Edition, 2002
2	Design Data Handbook	A. Sanmugasundaram Et al	New Age International	1st Edition, 2011

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VI			
COMPUTER AIDED ELECTRICAL DRAWING (Professional Elective)			
Subject Code	15EE651	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss the terminology of DC and AC armature windings.
- To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
- To discuss the substation equipment, their location in a substation and development of a layout for substation.
- To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
- To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches.■

Suitable CAD software can be used for drawings

PART - A

Module-1		**Teaching Hours**
Winding Diagrams: (a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings. (b) Developed Winding Diagrams of A.C. Machines: (c)Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings. (d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Single Line Diagrams: Single Line Diagrams of Generating Stations and Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalised Single, Main and Transfer, Double Bus Double Breaker, Sectionalised Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main),Power Transformers, Circuit Breakers, Isolators,Earthing Switches,Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power-Line Carrier) and Line Trap.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

PART - B

Module-3		
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Transformers - Sectional Views Of Single And Three Phase Core And Shell Type Transformers. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: D.C. Machine - Sectional Views of Yoke with Poles, Armature and Commutator dealt separately.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Alternator – Sectional Views of Stator and Rotor dealt separately. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

15EE651 COMPUTER AIDED ELECTRICAL DRAWING (Professional Elective) (continued)

Course Outcomes: At the end of the course the student will be able to**:**

- Discuss the terminology and types of DC and AC armature windings.
- Develop armature winding diagram for DC and AC machines
- Develop a layout for substation using the standard symbols for substation equipment. .
- Draw sectional views of core and shell types transformers using the design data
- Draw sectional views of assembled DC machine or its parts using the design data or the sketches.
- Draw sectional views of assembled alternator or its parts using the design data or the sketches.■

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have two parts, PART – A and PART – B.
- Each part is for 40 marks.
- Part A is for Modules 1 and 2.
- Questions 1 and 2 of PART **-** A will be only on DC windings or only on AC windings. Students have to answer any one of them. The marks prescribed is 25.
- Question 3 of PART – A covering module 2 is compulsory. The marks prescribed is 15.
- Part B is for Modules 3, 4 and 5.
- Questions 4 and 5 will cover any two modules of modules 3, 4 and 5. Students have to answer any one of them. The marks prescribed is 40.■

Reference Books

1	A course in Electrical Machine design	A. K. Sawhney	DhanpatRai	6th Edition, 2013
2	Electrical Engineering Drawing	K. L. Narang	SatyaPrakashan	2014

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VI			
ADVANCED POWER ELECTRONICS (Professional Elective)			
Subject Code	15EE652	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To study switching mode regulators and Boost converters, Resonant Pulse Inverters and multilevel inverters
- To learn the techniques for design and analysis of dc –dc converters, Resonant Pulse Inverters and multilevel inverters
- To explain the operation and frequency characteristics of resonant inverters and the techniques for zero-voltage and zero-current switching
- To study the performance parameters of resonant inverters
- To explain the techniques for analyzing and design of resonant inverters
- To explain the operation and features of multilevel inverters, their advantages and disadvantages.
- To explain the control strategy to address capacitor voltage unbalancing.
- To discuss potential applications of multilevel inverters.
- To study the types and circuit topologies of power supplies and explain the operation and analysis of power supplies.
- To study the applications of power electronic devices.■

Module-1		Teaching Hours
DC–DC Converters: Switching-Mode Regulators, Comparison of Regulators, Multi-output Boost Converter, Diode Rectifier-Fed Boost Converter, Averaging Models of Converters, State–Space Analysis of Regulators, Design Considerations for Input Filter and Converters, Drive IC for Converters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2		
Resonant Pulse Inverters: Introduction. Series Resonant Inverters, Frequency Response of Series Inverters, Parallel Resonant Inverters, Voltage Controlled Resonant Inverters, Class E Resonant Inverter, Class E Resonant Rectifier, Zero – Current Switching (ZCS) Resonant Converters, Zero Voltage Switching Resonant Converters (ZVS), Comparison between ZCS and ZVS Resonant Converters, Two Quadrant ZVS Resonant Converters, Resonant DC – Link Inverters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-3		
Multilevel Inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters, Diode – Clamped Multilevel Inverter, Flying - Capacitors Multilevel Inverter. Cascaded Multilevel Inverter, Applications, Features of Multilevel Inverters, Comparison of Multilevel Converters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-4		
Power Supplies: Introduction, DC Power Supplies, AC Power Supplies, Multistage Conversions, Control Circuits, Magnetic Design Considerations.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_4 – Analysing	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

15EE652 ADVANCED POWER ELECTRONICS (Professional Elective) (continued)

Module-5		Teaching Hours
Residential and Industrial Applications: Introduction, Residential Applications, Industrial Applications. **Electrical Utility Applications:** Introduction, High Voltage DC Transmission, Static VAR Compensators, Interconnection of Renewable Energy Sources and Energy Storage systems to the Utility Grid, Active Filters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_4 – Analysing	

Course outcomes:

At the end of the course the student will be able to:

- Explain the types of switching – mode regulators, Resonant Pulse Inverters and multilevel inverters
- To discuss the techniques for design and analysis of dc –dc converters, Resonant Pulse Inverters and multilevel inverters
- Evaluate the performance parameters of resonant inverters
- Explain the techniques for zero-voltage and zero-current switching of resonant pulse inverters
- Explain the control strategy to address capacitor voltage unbalancing in multilevel inverters.
- Discuss the types, topologies operation and analysis of power supplies.
- Discuss residential, Industrial and Electrical utility applications of power electronic devices. ■ ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis Design/ Development of Solutions , Conduct investigations of complex problems, Ethics

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Power Electronics: Circuits Devices and Applications,	Mohammad H Rashid	Pearson	4th Edition, 2014
2	Power Electronics Converters, Applications and Design (For Module 5: Chapters 16 and 17)	Ned Mohan et al	Wiley	3rd Edition, 2014

Reference Books

1	Power Electronics	Daniel W Hart	McGraw Hill	1st Edition, 2011

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VI			
ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (Professional Elective)			
Subject Code	15EE653	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain the importance of energy audit, its types and energy audit methodology.
- To explain the parameters required for energy audit and the working of the instruments used in the measurement of the parameters.
- To explain the energy audit of different systems and equipment and buildings
- To explain electrical load management techniques, harmonics and their effects, electricity tariffs and power factor improvement.
- To explain the scope of demand side management, its concept and implementation issues and strategies.
- To discuss energy conservation ■

Module-1		**Teaching Hours**
Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism. **Types of Energy Audits and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis.■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing.	
Module-2		
Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. **Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency.■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing ,	
Module-3		
Energy Audit of HVAC Systems: Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE. **Electrical-Load Management:** Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses.■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing	
Module-4		
Energy Audit of Motors: Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Lighting Systems:**Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. ■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI

15EE653 ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (Professional Elective)(continued)

Module-5	Teaching Hours
Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings. **Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment. **Energy Conservation:** Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation.■	**08**
Revised Bloom's Taxonomy Level: L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing	

Course outcomes:

At the end of the course the student will be able to:

- Understand the need of energy audit and energy audit methodology.
- Explain audit parameters and working principles of measuring instruments used to measure the parameters.
- Conduct energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems.
- Conduct energy audit HVAC systems, motors, pumps, blowers and cooling towers.
- Explain load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission.
- Conduct energy audit of lighting systems and buildings.
- Show an understanding of demand side management and energy conservation.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Environment and sustainability, Ethics, Individual and Team work, Communication

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Handbook on Energy Audit	Sonal Desai	McGraw Hill	1st Edition, 2015
2.	Generation of Electrical Energy	B R Gupta	S. Chand	1stEdition, 1983

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –VI

SOLAR AND WIND ENERGY (Professional Elective)

Subject Code	15EE654	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To discuss the importance of energy in human life, relationship among economy and environment with energy use.
- To discuss the increasing role of renewable energy, energy management, energy audit, energy efficiency, energy intensity.
- To discuss energy consumption status in India, energy saving potential and energy conservation efforts in India.
- To explain the concept of energy storage and the principles of energy storage devices.
- To discuss the characteristics and distribution of solar radiation, measurement of components of solar radiation and analysis of collected solar radiation data.
- To explain availability of solar radiation at a location and the effect of tilting the surface of collector with respect to horizontal surface.
- To describe the process of harnessing solar energy in the form of heat and working of solar collectors.
- To discuss applications of solar energy including heating and cooling.
- To discuss the operation of solar cell and the environmental effects on electrical characteristics of solar cell
- To discuss sizing and design of typical solar PV systems and their applications.
- To discuss basic Principles of Wind Energy Conversion and to compute the power available in the wind.
- To discuss forces on the Blades, Wind Energy Conversion, collection of Wind Data, energy estimation and site selection.
- To discuss classification of WEC Systems, its advantages and disadvantages of WECS, and Types of Wind Machines (Wind Energy Collectors).
- To evaluate the performance of Wind-machines, Generating Systems.
- To discuss energy storage, applications of Wind Energy and Environmental Aspects. ■

Module-1	**Teaching Hours**
Fundamentals of Energy Science and Technology: Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non -conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India. **Energy Conservation and Efficiency:** Introduction, Important Terms and Definitions, Important Aspects of Energy Conservation, Global Efforts, Achievements and Future Planning, Energy Conservation/Efficiency Scenario in India, Energy Audit, Energy Conservation Opportunities. **Energy Storage:** Introduction, Necessity of Energy Storage, Specifications of Energy Storage Devices. **Solar Energy-Basic Concepts:** Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Solar Energy-Basic Concepts (continued): Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface. **Solar Thermal Systems:** Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) **CHOICE BASED CREDIT SYSTEM (CBCS)** **SEMESTER – VI**		
15EE654 SOLAR AND WIND ENERGY (Professional Elective) (continued)		
Module-3		**Teaching Hours**
Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario – World and India. The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations **Wind energy systems:** Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Basic Components of a Wind Energy Conversion(WEC) System: Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind-machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the importance of energy in human life, relationship among economy and environment with energy use and the increasing role of renewable energy.
- Explain the concept of energy storage and the principles of energy storage devices.
- To discuss solar radiation on horizontal and tilted surface, its characteristics, measurement and analysis of radiation data.
- Describe the process of harnessing solar energy and its applications in heating and cooling.
- Discuss fabrication, operation of solar cell, electrical characteristics, sizing and design of solar PV systems and their applications.
- Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection.
- Discuss the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Design/ Development of Solutions, The Engineer and Society, Environment and Sustainability, Ethics, Project Management and Finance.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – VI				
15EE654 SOLAR AND WIND ENERGY(Professional Elective) (continued)				
Textbook				
1	Non-Conventional Energy Resources	B. H. Khan	McGraw Hill	2nd Edition 2017
2	Non-Conventional Sources of Energy	Rai, G. D	Khanna Publishers	4th Edition, 2009
Reference Books				
1	Non-Conventional Energy Resources	ShobhNath Singh	Pearson	1st Edition, 2015
2	Solar Energy – Principles of Thermal Collections and Storage	S.P. Sukhatme J.K.Nayak	McGraw Hill	3rd Edition, 2008
3	Wind Turbine Technology	Ahmad Hemami	Cengage	1st Edition, 2012

<table>
<tr><td colspan="5">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VI</td></tr>
<tr><td colspan="5">ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC (Open Elective)</td></tr>
<tr><td colspan="2">Subject Code</td><td>15EE661</td><td>IA Marks</td><td>20</td></tr>
<tr><td colspan="2">Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="2">Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="5">Credits - 03</td></tr>
<tr><td colspan="5">Course objectives:
• To expose the students to the concepts of feed forward neural networks.
• To provide adequate knowledge about feedback networks.
• To teach about the concept of fuzziness involved in various systems.
• To provide adequate knowledge about fuzzy set theory. ■</td></tr>
<tr><td colspan="4">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="4">Fundamentals of Neural Networks: Basic concepts of Neural networks, Human Brain, Model of an Artificial Neuron, Neural network architectures, Characteristics of Neural Networks, Learning methods, Taxonomy of Neural Network Architectures, Early Neural Network Architectures.
Back propagation Networks: Architecture of a Back propagation network, the Perceptron Model, The solution, Single layer Artificial Neural Network, Model for Multilayer Perceptron, Back propagation Learning, Illustration, Applications.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="5">Module-2</td></tr>
<tr><td colspan="4">Back propagation Networks (continued): Effect of Tuning Parameters of the Back propagation Neural Network, Selection of Various Parameters in BPN, Variations of Standard Back propagation Algorithm.
Associative Memory: Auto correlators, Hetero correlators: Kosko's Discrete BAM, Wang et al.'s Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real-coded Pattern Pairs, Applications, Recent Trends. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="5">Module-3</td></tr>
<tr><td colspan="4">Adaptive Resonance Theory: Introduction, ART l, ART 2, Applications, Sensitivities of Ordering of Data.■</td><td>08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td><td></td></tr>
<tr><td colspan="5">Module-4</td></tr>
<tr><td colspan="4">Fuzzy Set Theory: Fuzzy versus Crisp, Crisp sets, Fuzzy Sets, Crisp Relations, FuzzyRelations. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding. L_3 – Applying.</td></tr>
<tr><td colspan="5">Module-5</td></tr>
<tr><td colspan="4">Fuzzy Logic And Inference: Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Rule based System, Defuzzification Methods, Applications.
Type – 2 Fuzzy Sets: Representation of Type – 2 Fuzzy Sets, Operations on Type – 2 Fuzzy Sets, Interval Type – 2 Fuzzy Sets.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="3">L_1 – Remembering, L_2 – Understanding. L_3 – Applying.</td></tr>
<tr><td colspan="5"></td></tr>
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B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI

15EE661 ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC (Open Elective) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Show an understanding of Organization of the Brain, Biological and Artificial Neuron Models
- Show an understanding of Back propagation network architecture, Perceptron Model, Single layer Artificial Neural Network, Model for Multilayer Perceptron, Back propagation Learning,
- Show an understanding of Back propagation training and summary of Back propagation Algorithm
- Show an understanding Bidirectional Associative Memory (BAM) Architecture
- Show an understanding adaptive resonance theory architecture and its applications
- Differentiate between crisp logic, predicate logic and fuzzy logic.
- Explain fuzzy rule based system
- Show an understanding of Defuzzification methods. ■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications.	S. Rajasekaran, G.A. VijayalakshmiPai	PHI Learning	2nd Edition, 2017

Reference Books

1	Neural Networks – A comprehensive foundation	Simon Haykin	Prentice Hall	3rd Edition, 2004.
2	Fuzzy Logic With Engineering Applications	Timothy J Ross	Wiley	3rd Edition, 2014
3.	Fuzzy sets and Fuzzy Logic: Theory and Applications	Klir, G.J. Yuan Bo	Prentice Hall	2005.

<table>
<tr><td colspan="4">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI</td></tr>
<tr><td colspan="4">SENSORS AND TRANSDUCERS(Open Elective)</td></tr>
<tr><td>Subject Code</td><td>15EE662</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4">Credits – 03</td></tr>
<tr><td colspan="4">Course objectives:
To discuss need of transducers, their classification, advantages and disadvantages.
To discuss working of different types of transducers and sensors..
To discuss recent trends in sensor technology and their selection.
To discuss basics of signal conditioning and signal conditioning equipment.
To discuss configuration of Data Acquisition System and data conversion.
To discuss the basics of Data transmission and telemetry.
To explain measurement of various non-electrical quantities.■</td></tr>
<tr><td colspan="3">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="3">Sensors and Transducers: Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="2">L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="4">Module-2</td></tr>
<tr><td colspan="3">Sensors and Transducers (continued): Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="2">L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="4">Module-3</td></tr>
<tr><td colspan="3">Signal Condition:Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers.
Data Acquisition Systems and Conversion:Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="2">L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="4">Module-4</td></tr>
<tr><td colspan="3">Data Transmission and Telemetry:Data/Signal Transmission, Telemetry.
Measurement of Non – Electrical Quantities:Pressure Measurement■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="2">L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="4">Module-5</td></tr>
<tr><td colspan="3">Measurement of Non – Electrical Quantities (continued):Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Metes, Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td colspan="2">L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="4"></td></tr>
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B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI

15EE662 SENSORS AND TRANSDUCERS(Open Elective) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Discuss need of transducers, their classification, advantages and disadvantages.
- Show an understanding of working of various transducers and sensors.
- Discuss recent trends in sensor technology and their selection.
- Discuss basics of signal conditioning and signal conditioning equipment.
- Discuss configuration of Data Acquisition System and data conversion.
- Show knowledge of data transmission and telemetry.
- Explain measurement of non-electrical quantities -temperature, flow, speed, force, torque, power and viscosity.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Electrical and Electronic Measurements and instrumentation	R.K Rajput	S. Chand	3rd Edition, 2013.

Reference Books

1	A Course in Electronics and Electrical Measurements and Instruments	J.B. Gupta	Katson Books	13th Edition, 2008
2	A Course in Electrical and Electronic Measurements and Instrumentation	A. K. Sawheny	DhanpatRai	2015

<table>
<tr><td colspan="4" align="center">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI</td></tr>
<tr><td colspan="4" align="center">BATTERIES AND FUEL CELLS FOR COMMERCIAL, MILITARY AND SPACE APPLICATIONS
(Open Elective)</td></tr>
<tr><td>Subject Code</td><td>15EE663</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 03</td></tr>
</table>

Course objectives:

- To discuss the current status of various rechargeable batteries and fuel cells for various applications.
- To discuss the performance capabilities and limitations of batteries and fuel cells.
- To discuss the performance requirements for next-generation high-power rechargeable lithium-based batteries and sealed nickel-cadmium and lead-acid batteries.
- To discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW)
- To describe the high-power batteries currently used by EVs and HEVs and various next-generation rechargeable batteries best suited for all-electric cars, EVs, and HEVs.
- To discuss low-power battery configurations that are best suited for compact commercial, industrial, and medical applications.
- To identify the design aspects and performance characteristics of micro- and nano-batteries best suited for detection, sensing, and monitoring devices. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Current Status of Rechargeable Batteries and Fuel Cells: Rechargeable Batteries, Fundamental Aspects of a Rechargeable Battery, Rechargeable Batteries Irrespective of Power Capability, Rechargeable Batteries for Commercial and Military Applications, Batteries for Low-Power Applications, Fuel Cells. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Batteries for Aerospace and Communications Satellites: Introduction, On-board Electrical Power System, Battery Power Requirements and Associated Critical Components, Cost-Effective Design Criterion for Battery-Type Power Systems for Spacecraft, Spacecraft Power System Reliability, Ideal Batteries for Aerospace and Communications Satellites, Performance Capabilities and Battery Power Requirements for the Latest Commercial and Military Satellite Systems, Military Satellites for Communications, Surveillance, Reconnaissance, and Target Tracking, Batteries Best Suited to Power Satellite Communications Satellites.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Fuel Cell Technology:Introduction, Performance Capabilities of Fuel Cells Based on Electrolytes, Low-Temperature Fuel Cells Using Various Electrolytes, Fuel Cells Using a Combination of Fuels, Fuel Cell Designs for Multiple Applications, Ion-Exchange Membrane Fuel Cells, Potential Applications of Fuel Cells, Fuel Cells for Aircraft Applications, Fuel Cells for Commercial, Military, and Space Applications, Fuel Cells Capable of Operating in Ultra-High-Temperature Environments, Fuel Cell Requirements for Electric Power Plant Applications.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Batteries for Electric and Hybrid Vehicles:Introduction, Chronological Development History of Early Electric Vehicles and Their Performance Parameters, Electric and Hybrid Electric Vehicles</td><td>08</td></tr>
<tr><td colspan="2"></td><td></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

15EE663 BATTERIES & FUEL CELLS FOR COMMERCIAL, MILITARY & SPACE APPLICATIONS(Open Elective) (continued)

Module-4(continued)	Teaching Hours
Batteries for Electric and Hybrid Vehicles (continued): Developed Earlier by Various Companies and Their Performance Specifications, Development History of the Latest Electric and Hybrid Electric Vehicle Types and Their Performance Capabilities and Limitations, Performance Requirements of Various Rechargeable Batteries, Materials for Rechargeable Batteries, Critical Role of Rare Earth Materials in the Development of EVs and HEVs. ■	
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-5	
Low-Power Rechargeable Batteries for Commercial, Space, and Medical Applications: Introduction, Low-Power Battery Configurations, Characteristics, Batteries for Miniaturized Electronic System Applications, for Embedded-System Applications, Batteries for Medical Applications, Selection Criteria for Primary and Secondary (Rechargeable) Batteries for Specific Applications. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the current status, the performance capabilities and limitations of rechargeable batteries and fuel cells for various applications.
- To discuss the performance requirements for next-generation high-power rechargeable lithium-based batteries and sealed nickel-cadmium and lead-acid batteries.
- Discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW)
- Describe the high-power batteries currently used by EVs and HEVs and various next-generation rechargeable batteries best suited for all-electric cars, EVs, and HEVs.
- Discuss low-power battery configurations that are best suited for compact commercial, industrial, and medical applications.
- Explain the design aspects and performance characteristics of micro- and nano-batteries best suited for detection, sensing, and monitoring devices. ■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook

1	Next-Generation Batteries and Fuel Cells for Commercial, Military, and Space Applications	A.R. JHA	CRC Press	1st Edition, 2012

Reference Books

1	Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors.	Vladimir S. Bagotsky	John Wiley	1st Edition,2015
2	Modelling and Control of Fuel Cells: Distributed Generation Applications	M. HashemNehrir Caisheng Wang	Wiley	1st Edition,2009

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VI			
INDUSTRIAL SERVO CONTROL SYSTEMS(Professional Elective)			
Subject Code	15EE664	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- To discuss system analogs and vectors, with a review of differential equations.
- To discuss the concept of transfer functions for the representation of differential equations.
- To discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- To determine the frequency response techniques for proper servo compensation.
- To explain perform indices and performance criteria for servo systems.
- To discuss the mechanical considerations of servo systems.■

Module-1		**Teaching Hours**
Servos: Introduction, Benefits of Servo Systems, Types of Servos - Evolution of Servo Drives, Classification of Drives, Components of Servos - Hydraulic/Electric Circuit Equations,Actuators—Electric,Actuators—Hydraulic,Amplifiers—Electric,Amplifiers—Hydraulic,Transducers (Feedback).■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Machine Servo Drives: Types of Drives, Feed Drive Performance. **Troubleshooting Techniques:** Techniques by Drive, Problems: Their Causes and Cures. **Machine Feed Drives:** Advances in Technology, Parameters for making ApplicationChoices. **Application of Industrial Servo Drives:** Introduction ,Physical System Analogs, Quantities and Vectors,Differential Equations for PhysicalSystems,Electric Servo Motor TransferFunctions and Time Constants, Transport Lag Transfer Function,Hydraulic Servo Motor Characteristics,General Transfer Characteristics.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Generalized Control Theory: Servo Block Diagrams,Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts,Nichols Charts, Servo Analysis Techniques,Servo Compensation. **Indexes of Performance:** Definition of Indexes of Performance for Servo Drives,Indexes of Performance for Electric and Hydraulic Drives.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Performance Criteria: Percent Regulation,Servo System Responses. **Servo Plant CompensationTechniques:** Dead-Zone Nonlinearity,Change-in-Gain Nonlinearity,Structural Resonances,Frequency Selective Feedback,Feedforward Control. **Machine Considerations:**Machine feed drive Considerations,Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

15EE664 INDUSTRIAL SERVO CONTROL SYSTEMS (Open Elective) (continued)

Module-5		**Teaching Hours**
Machine Considerations: Drive Stiffness, Drive Resolution,Drive Acceleration,Drive Speed Considerations,Drive Ratio Considerations,Drive Thrust/Torque And FrictionConsiderations, Drive Duty Cycles.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- Discuss system analogs and vectors, with a review of differential equations.
- Discuss the concept of transfer functions for the representation of differential equations.
- Discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- Represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- Determine the frequency response techniques for proper servo compensation.
- Explain perform indices and performance criteria for servo systems.
- Discuss the mechanical considerations of servo systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text Book

1	Industrial Servo Control SystemsFundamentals andApplications	George W. Younkin	Marcel Dekker	1st Edition, 2003

Reference Books

1	Servo Motors and Industrial Control Theory	RiazollahFiroozian	Springer	2nd Edition, 2014
2	DC SERVOS Application and Design with MATLAB	Stephen M. Tobin	CRC	1st Edition, 2011

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VI			
CONTROL SYSTEM LABORATORY			
Subject Code	15EEL67	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80
Credits - 02			

Course objectives:

- To determine the time and frequency domain reposes of a given second order system using software package or discrete components.
- To design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
- To draw the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair.
- To simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- To write a script files to plot root locus, bode plot, Nyquist plots to study the stability of the system using a software package.■

Sl. NO	Experiments
1	Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor
2	Experiment to draw synchro pair characteristics
3	Experiment to determine frequency response of a second order system
4	(a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lead compensating network.
5	(a)To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lag compensating network
6	Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.
	Experiments 7 to 11 must be done using MATLAB/SCILAB only.
7	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of additional poles and zeros on time response of second order system. (c) To evaluate the effect of pole location on stability (d) To evaluate the effect of loop gain of a negative feedback system on stability.
8	To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
9	(a) To simulate a D.C. Position control system and obtain its step response. (b) To verify the effect of input waveform, loop gain and system type on steady state errors. (c) To perform trade-off study for lead compensator. (d) To design PI controller and study its effect on steady state error.
10	(a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response (b) To study the effect of open loop gain on transient response of closed loop system using root locus.
11	(a) To study the effect of open loop poles and zeros on root locus contour (b) To estimate the effect of open loop gain on the transient response of closed loop system using root locus. (c) Comparative study of Bode, Nyquist and root locus with respect to stability.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VI
15EEL67 CONTROL SYSTEM LABORATORY(continued)
Course outcomes: At the end of the course the student will be able to: • Use software package or discrete components in assessing the time and frequency domain reposes of a given second order system. • Design and analyze Lead, Lag and Lag – Lead compensators for given specifications. • Determine the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair used in control systems. • Simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system. • Write a script files to plot root locus, bode plot, Nyquist plots to study the stability of the system using a software package. • Work with a small team to carryout experiments and prepare reports that present lab work. ■
Graduate Attributes (As per NBA) Engineering Knowledge,Problem Analysis, Individual and Team work, Modern tool usage, Communication.
Conduct of Practical Examination: 1. All laboratory experiments are to be included for practical examination. 2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners. 3. Students can pick one experiment from the questions lot prepared by the examiners. 4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VI			
DIGITAL SIGNAL PROCESSING LABORATORY			
Subject Code	15EEL68	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80
Credits - 02			

Course objectives:

- To explain the use of MATLAB software in evaluating the DFT and IDFT of given sequence
- To verify the convolution property of the DFT
- To design and implementation of IIR and FIR filters for given frequency specifications.
- To realize IIR and FIR filters.
- To help the students in developing software skills.■

Sl. No	Experiments
1	Verification of Sampling Theorem both in time and frequency domains
2	Evaluation of impulse response of a system
3	To perform linear convolution of given sequences
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.
5	Computation of N – point DFT and to plot the magnitude and phase spectrum.
6	Linear and circular convolution by DFT and IDFT method.
7	Solution of a given difference equation.
8	Calculation of DFT and IDFT by FFT
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.
12	Realization of IIR and FIR filters

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Applying, L_4 – Analysing, L_5 – Evaluating,

Course outcomes: At the end of the course the student will be able to:

- Give physical interpretation of sampling theorem in time and frequency domains.
- Evaluate the impulse response of a system.
- Perform convolution of given sequences to evaluate the response of a system.
- Compute DFT and IDFT of a given sequence using the basic definition and/or fast methods.
- Provide a solution for a given difference equation.
- Design and implement IIR and FIR filters
- Conduct experiments using software and prepare reports that present lab work■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

****** END ******

VII SEMESTER DETAILED SYLLABUS

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

POWER SYSTEM ANALYSIS – 2(Core Course)

Subject Code	15EE71	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To explain formulation of network models and bus admittance matrix for solving load flow problems.
- To discuss solution of nonlinear static load flow equations by different numerical techniques and methods to control voltage profile.
- To discuss optimal operation of generators on a bus bar, optimal unit commitment, reliability considerations and optimum generation scheduling.
- To discuss optimal power flow solution, scheduling of hydro-thermal system, power system security and reliability.
- To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.
- To explain numerical solution of swing equation for multi-machine stability. ■

Module-1		**Teaching Hours**
Load Flow Studies: Introduction, Network Model Formulation, Formation of Y_{bus} by Singular Transformation, Load Flow Problem, Gauss-Seidel Method.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-2		
Load Flow Studies (continued): Newton-Raphson Method, Decoupled Load Flow Methods, Comparison of Load Flow Methods, Control of Voltage Profile.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-3		
Optimal System Operation: Introduction, Optimal Operation of Generators on a Bus Bar, Optimal Unit Commitment, Reliability Considerations, Optimum Generation Scheduling.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-4		
Optimal System Operation (continued): Optimal Load Flow Solution, Optimal Scheduling of Hydrothermal System, Power System Security, Maintenance Scheduling, Power System Reliability.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-5		
SymmetricalFault Analysis: Algorithm for Short Circuit Studies, Z_{bus} Formulation. **Power System Stability:** Numerical Solution of Swing Equation, Multimachine Stability.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Formulate network matrices and models for solving load flow problems.
- Perform steady state power flow analysis of power systems using numerical iterative techniques.
- Suggest a method to control voltage profile.
- Show knowledge of optimal operation of generators on a bus bar, optimal unit commitment,

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
15EE71POWER SYSTEM ANALYSIS – 2(Core Subject) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes(continued):

- Discuss optimal scheduling for hydro-thermal system, power system security and reliability.
- Analyze short circuit faults in power system networks using bus impedance matrix.
- Perform numerical solution of swing equation for multi-machine stability■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Modern Power System Analysis	D. P. Kothari	McGraw Hill	4^{th} Edition, 2011

Reference Books

1	Computer Methods in Power Systems Analysis	Glenn W Stagg Ahmed H Ei - Abiad	McGraw Hill	1stEdition, 1968
2	Computer Techniques in Power System Analysis	M.A. Pai	McGraw Hill	2ndEdition, 2006
3	Power System Analysis	HadiSaadat	McGraw Hill	2ndEdition, 2002

<table>
<tr><td colspan="4" align="center">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII</td></tr>
<tr><td colspan="4" align="center">POWER SYSTEM PROTECTION(Core Subject)</td></tr>
<tr><td>Subject Code</td><td>15EE72</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 04</td></tr>
</table>

Course objectives:

- To discuss performance of protective relays, components of protection scheme and relay terminology.
- To explain relay construction and operating principles.
- To explain Overcurrent protection using electromagnetic and static relays and Overcurrent protective schemes.
- To discuss types of electromagnetic and static distance relays, effect of arc resistance, power swings, line length and source impedance on performance of distance relays.
- To discuss pilot protection; wire pilot relaying and carrier pilot relaying.
- To discuss construction, operating principles and performance of various differential relays for differential protection.
- To discuss protection of generators, motors, Transformer and Bus Zone Protection.
- To explain the principle of circuit interruption and different types of circuit breakers.
- To describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
- To discuss protection Against Overvoltages and Gas Insulated Substation (GIS). ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Introduction to Power System Protection: Need for protective schemes, Nature and Cause of Faults, Types of Fault,Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection,Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection.
Relay Construction and Operating Principles: Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.
Overcurrent Protection:Introduction, Time – current Characteristics, Current Setting, Time Setting.■</td><td>10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td><td></td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Overcurrent Protection (continued):Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.
Distance Protection: Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges(Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays.■</td><td>10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td><td></td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Pilot Relaying Schemes:Introduction, Wire Pilot Protection, Carrier Current Protection Differential Protection: Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection.
Rotating Machines Protection: Introduction, Protection of Generators.
Transformer and Buszone Protection: Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection.■</td><td>10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.</td><td></td></tr>
<tr><td colspan="3"></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE72 POWER SYSTEM PROTECTION (Core Course) (continued)

Module-4		Teaching Hours
Circuit Breakers: Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF_6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Fuses: Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination. **Protection against Overvoltages:** Causes of Overvoltages, Lightning phenomena, Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL). **Modern Trends in Power System Protection:** Introduction, gas insulated substation/switchgear (GIS).■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss performance of protective relays, components of protection scheme and relay terminology overcurrent protection.
- Explain the working of distance relays and the effects ofarc resistance, power swings, line length and source impedance on performance of distance relays.
- Discuss pilot protection; wire pilot relaying and carrier pilot relaying.
- Discuss construction, operating principles and performance of differential relays for differential protection.
- Discuss protection of generators, motors, Transformer and Bus Zone Protection.
- Explain the principle of circuit interruption in different types of circuit breakers.
- Describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
- Discuss protection against Overvoltages and Gas Insulated Substation (GIS).■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Power System Protection and Switchgear	Badri Ram, D.N. Vishwakarma	McGraw Hill	2nd Edition
2	Power System Protection and Switchgear(For additional study on gapless arrester, Refer to pages 458 to 461)	BhuvaneshOza et al	McGraw Hill	1st Edition, 2010

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII				
15EE72 POWER SYSTEM PROTECTION (Core Course) (continued)				
Reference Books				
1	Protection and Switchgear	Bhavesh et al	Oxford	1st Edition, 2011
2	Power System Switchgear and Protection	N. Veerappan S.R. Krishnamurthy	S. Chand	1st Edition, 2009
3	Fundamentals of Power System Protection	Y.G.Paithankar S.R. Bhide	PHI	1st Edition, 2009

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

HIGH VOLTAGE ENGINEERING (Core Course)

Subject Code	15EE73	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To discuss conduction and breakdown in gases, liquid dielectrics.
- To discuss breakdown in solid dielectrics.
- To discuss generation of high voltages and currents and their measurement.
- To discuss overvoltage phenomenon and insulation coordination in electric power systems.
- To discuss non-destructive testing of materials and electric apparatus.
- To discuss high-voltage testing of electric apparatus■

Module-1		Teaching Hours
Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges. **Conduction and Breakdown in Liquid Dielectrics:** Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids. **Breakdown in Solid Dielectrics:** Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Generation of High Voltages and Currents: Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents, Tripping and Control of Impulse Generators.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering , L_2 – Understanding L_3 – Applying.	
Module-3		
Measurement of High Voltages and Currents: Measurement of High Direct Current Voltages, Measurement of High AC and Impulse Voltages, Measurement of High Currents – Direct, Alternating and Impulse, Cathode Ray Oscillographs for Impulse Voltage and Current Measurements.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering , L_2 – Understanding L_3 – Applying.	
Module-4		
Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems: National Causes for Overvoltages - Lightning Phenomenon, Overvoltage due to Switching Surges, System Faults and Other Abnormal, Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Non-Destructive Testing of Materials and Electrical Apparatus: Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements.		**10**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE73 HIGH VOLTAGE ENGINEERING (Core Course) (continued)

Module-5 (continued)		**Teaching Hours**
High Voltage Testing of Electrical Apparatus: Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers, Testing of Surge Arrestors, Radio Interference Measurements, Testing of HVDC Valves and Equipment.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain conduction and breakdown phenomenon in gases, liquid dielectrics.
- Explain breakdown phenomenon in solid dielectrics.
- Explain generation of high voltages and currents
- Discuss measurement techniques for high voltages and currents.
- Discuss overvoltage phenomenon and insulation coordination in electric power systems.
- Discuss non-destructive testing of materials and electric apparatus andhigh-voltage testing of electric apparatus■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	High Voltage Engineering	M.S. Naidu, V.Kamaraju	McGraw Hill	5th Edition, 2013.

Reference Books

1	High Voltage Engineering Fundamentals	E. Kuffel, W.S. Zaengl, J. Kuffel	Newnes	2nd Edition, 2000
2	High Voltage Engineering	Wadhwa C.L.	New Age International	3rd Edition, 2012
3	High-Voltage Test and Measuring Techniques	Wolfgang Hauschild • Eberhard Lemke	Springer	1st Edition2014
4	High Voltage Engineering	Farouk A.M. Rizk	CRC Press	1st Edition2014

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

ADVANCED CONTROL SYSTEMS(Professional Elective)

Subject Code	15EE741	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To introduce state variable approach for linear time invariant systems in both the continuous and discrete time systems
- To explain development of state models for linear continuous – time and discrete – time systems
- To explain application of vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems
- To define controllability and observability of a system and testing techniques for controllability and observability of a given system
- To explain design techniques of pole assignment and state observer using state feedback.
- To explain about inherent and intentional nonlinearities that can occur in control system and developing the describing function for the nonlinearities.
- To explain stability analysis of nonlinear systems using describing function analysis.
- To explain the analysis of nonlinear systems using Lyapunov function and design of Lyapunov function for stable systems.■

Module	Teaching Hours
Module-1	
State Variable Analysis and Design: Introduction, Concept of State, State Variables and State Model, State Modelsfor Linear Continuous – Time Systems, State Variables and Linear Discrete – Time Systems.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-2	
State Variable Analysis and Design (continued): Diagonalization, Solution of State Equations, Concepts of Controllability and Observability. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-3	
Pole Placement Design and State Observers: Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer, Compensator Design by the Separation Principle. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-4	
Non-linear systems Analysis: Introduction, Common Nonlinear System Behaviours, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-5	
Non-linear systems Analysis (continued): Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE741 ADVANCED CONTROL SYSTEMS(Professional Elective) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.
- Develop of state models for linear continuous – time and discrete – time systems.
- Apply vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.
- Define controllability and observability of a system and test for controllability and observability of a given system.
- Design pole assignment and state observer using state feedback.
- Develop the describing function for the nonlinearity present to assess the stability of the system.
- Develop Lyapunov function for the stability analysis of nonlinear systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Textbook

1	Control Systems Engineering (For the Modules 1 and 2)	I.J. Nagarath and M.Gopal	New Age	5^{th} Edition, 2007
2	Digital Control and State Variable Methods: Conventional and Intelligent Control Systems (For the Modules 3,4 and 5)	M.Gopal	McGraw Hill	3^{rd}Edition, 2008

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VII			
UTILIZATION OF ELECTRICAL POWER(Professional Elective)			
Subject Code	15EE742	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss electric heating, air-conditioning and electric welding.
- To explain laws of electrolysis, extraction and refining of metals and electro deposition.
- To explain the terminology of illumination, laws of illumination, construction and working of electric lamps.
- To explain design of interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting
- To discuss systems of electric traction, speed time curves and mechanics of train movement.
- To discuss motors used for electric traction and their control.
- To discuss braking of electric motors, traction systems and power supply and other traction systems.
- Give awareness of technology of electric and hybrid electric vehicles.■

Module-1		**Teaching Hours**
Heating and welding: Electric Heating, Resistance ovens, Radiant Heating, Induction Heating, High frequency Eddy Current Heating, Dielectric Heating, The Arc Furnace, Heating of Buildings, Air – Conditioning, Electric Welding, Modern Welding Techniques. **Electrolytic Electro – Metallurgical Process:**Ionization, Faraday's Laws of Electrolysis, Definitions, Extraction of Metals, Refining of Metals, Electro Deposition.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Illumination: Introduction, Radiant Energy, Definitions, Laws of Illumination, Polar Curves, Photometry, Measurement of Mean Spherical Candle Power by Integrating Sphere, Illumination Photometer, Energy Radiation and luminous Efficiency, electric Lamps, Cold Cathode Lamp, Lighting Fittings, Illumination for Different Purposes, Requirements of Good Lighting.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Electric Traction Speed - Time Curves and Mechanics of Train Movement: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for Train Movement,Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion. **Motors for Electric traction:**Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor. **Control of motors:** Control of DC Motors,Tapped Field Control or Control by Field Weakening, Multiple Unit Control, Control of Single Phase Motors, Control of Three Phase Motors. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes. **Electric Traction Systems and Power Supply:** System of Electric Traction, AC Electrification, Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC		**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE742 UTILIZATION OF ELECTRICAL POWER(Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Traction,Feeding and Distribution System for Dc Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires. **Trams, Trolley Buses and Diesel – Electric Traction:** Tramways, The Trolley – Bus, Diesel Electric Traction.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving, Energy Consumption. **Hybrid Electric Vehicles:** Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss electric heating, air-conditioning and electric welding.
- Explain laws of electrolysis, extraction and refining of metals and electro deposition.
- Explain the terminology of illumination, laws of illumination, construction and working of electric lamps.
- Design interior and exterior lighting systems- illumination levels for factory lighting- flood lighting-street lighting.
- Discuss systems of electric traction, speed time curves and mechanics of train movement.
- Explain the motors used for electric traction and their control.
- Discuss braking of electric motors, traction systems and power supply and other traction systems.
- Explain the working of electric and hybrid electric vehicles. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, The Engineer and Society, Ethics, Individual and Team Work.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	A Textbook on Power System Engineering	A. Chakrabarti et al	DhanpatRai and Co	2nd Edition, 2010
2	Modern Electric,Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design (Chapters 04 and 05 for module 5)	MehrdadEhsani et al	CRC Press	1stEdition, 2005

Reference Books

1	Utilization, Generation and Conservation of Electrical Energy	Sunil S Rao	Khanna Publishers	1stEdition, 2011
2	Utilization of Electric Power and Electric Traction	G.C. Garg	Khanna Publishers	9thEdition, 2014

<table>
<tr><td colspan="4" align="center">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
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SEMESTER - VII</td></tr>
<tr><td colspan="4" align="center">CARBON CAPTURE AND STORAGE(Professional Elective)</td></tr>
<tr><td>Subject Code</td><td>15EE743</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 03</td></tr>
</table>

Course objectives:

- To provide an overview of carbon capture and carbon storage and explain the fundamentals of power generation.
- To explain carbon capture from power generation, industrial processes, using solvent absorption and other technologies including membranes, adsorbents, chemical looping, cryogenics and gas hydrate technology.
- To explain different geological storage methods including storage in coal seams, depleted gas reservoirs and saline formations.
- To explain Carbon dioxide compression and pipeline transport.■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Introduction: The Carbon Cycle, Mitigating Growth of The Atmospheric Carbon Inventory, The Process of Technology Innovation.
Overview of carbon capture and storage: Carbon Capture, Carbon Storage.
Power generation fundamentals: Physical and Chemical Fundamentals, Fossil-Fueled Power Plant, Combined Cycle Power Generation, Future Developments in Power-Generation Technology.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Carbon capture from power generation: Introduction, Pre-combustion Capture, Post-combustion Capture, Oxy- fuel Combustion Capture, Chemical Looping Capture Systems, Capture-Ready and Retrofit Power Plant, Approaches to Zero-Emission Power Generation.
Carbon capture from industrial processes:Cement Production, Steel Production, Oil Refining, Natural Gas Processing.
Absorption capture systems:Chemical and Physical Fundamentals, Absorption Applications in Post Combustion Capture, Absorption Technology RD&D Status.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Adsorption capture systems: Physical and Chemical Fundamentals, Adsorption Process Applications, Adsorption Technology RD&D Status. References and Resources.
Membrane separation systems:Physical and Chemical Fundamentals, Membrane Configuration and Preparation and Module Construction, Membrane Technology RD&D Status, Membrane Applications in Pre-combustion Capture, Membrane and Molecular Sieve Applications in Oxy-fuel Combustion, Membrane Applications in Post-combustion CO_2 Separation, Membrane Applications in Natural Gas Processing.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Cryogenic and distillation systems: Physical Fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan–Holmes process for CO_2 – CH_4 separation, RD&D in cryogenic and distillation technologies.
Mineral carbonation: Physical and chemical fundamentals, Current state of technology development, Demonstration and deployment outlook.
Geological storage: Introduction, Geological and engineering fundamentals, Enhanced oil recovery, Saline aquifer storage, Other geological storage options.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE743 CARBON CAPTURE AND STORAGE(Professional Elective) (continued)

Module-5		**Teaching Hours**
Ocean storage: Introduction, Physical, chemical, and biological fundamentals, Direct CO_2 injection, Chemical sequestration, Biological sequestration, **Storage in terrestrial ecosystems:** Introduction, Biological and chemical fundamentals, Terrestrial carbon storage options, Full GHG accounting for terrestrial storage, Current R&D focus in terrestrial storage. **Other sequestration and use options:** Enhanced industrial usage, Algal biofuel production.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the impacts of climate change and the measures that can be taken to reduce emissions.
- Discuss carbon capture and carbon storage.
- Explain the fundamentals of power generation.
- Explain methods of carbon capture from power generation and industrial processes.
- Explain different carbon storage methods: storage in coal seams, depleted gas reservoirs and saline formations.
- Explain Carbon dioxide compression and pipeline transport. ■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Carbon Capture and Storage	Stephen A. Rackley	Elsevier	2010

<table>
<tr><td colspan="4">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
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<tr><td colspan="4">POWER SYSTEM PLANNING (Professional Elective)</td></tr>
<tr><td>Subject Code</td><td>15EE744</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4">Credits - 03</td></tr>
</table>

Course objectives:

- To discuss primary components of power system planning namely load furcating, evaluation of energy resources, provisions of electricity Act and Energy Conservation Act.
- To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution
- To explain forecasting of anticipated future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- To discuss methods to mobilize resources to meet the investment requirement for the power sector
- To perform economic appraisal to allocate the resources efficiently and take proper investment decisions
- To discuss expansion of power generation and planning for system energy in the country
- To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions
- To discuss principles of distribution planning, supply rules, network development and the system studies
- To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.
- To discuss grid reliability, voltage disturbances and their remedies.
- To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity.
- To discuss market principles and the norms framed by CERC for online trading and exchange in the interstate power market. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Power System: Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organisation, Regulation, Scenario Planning.
Electricity Forecasting: Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Power-System Economics: Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment, Optimum Investment, Tariffs.
Generation Expansion: Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies. ■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Generation Expansion (continued): Distributed Power Generation, Renovation and Modernisation of Power Plants.
Transmission Planning: Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Distribution: Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity,</td><td>08</td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE744 POWER SYSTEM PLANNING (Professional Elective) (continued)

Module-4(continued)		**Teaching Hours**
Distribution(continued): Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification, Villages Self – Sufficiency in Energy, Community Power, Self – Generation. **Reliability and Quality:** Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Quality of Supply, Reliability and Quality Roadmap.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Demand-Side Planning: Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit. **Electricity Market:** Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Locational Marginal Pricing, Transmission Charges, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution.
- Show knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- Discuss methods to mobilize resources to meet the investment requirement for the power sector
- Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions
- Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.
- Discuss principles of distribution planning, supply rules, network development and the system studies
- Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies
- Discuss planning and implementation of electric –utility activities, market principles and the norms framed by CERC for online trading and exchange in the interstate power market.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, The Engineer and Society, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Electric Power Planning	A. S. Pabla	McGraw Hill,	2nd Edition, 2016

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VII			
FACTS AND HVDC TRANSMISSION (Professional Elective)			
Subject Code	15EE751	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- To explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- To describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- To describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- To explain advantages of HVDC power transmission, overview and organization of HVDC system.
- To describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions.■

Module-1		**Teaching Hours**
FACTS Concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What Limits the Loading Capability? Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability. Methods of Controllable Var Generation –Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC).Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches. Static VAR Compensators: SVC and STATCOM, the Regulation Slope. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Static Series Compensators: Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator, Transmitted Power Versus Transmission AngleCharacteristic.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Development of HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. **Power Conversion:**3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII		
15EE751 FACTS AND HVDC TRANSMISSION (Professional Elective) (continued)		
Module-5		**Teaching Hours**
Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- Describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- Explain advantages of HVDC power transmission, overview and organization of HVDC system.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbooks

1	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems	Narain G Hingorani, Laszlo Gyugyi	Wiley	1st Edition, 2000
2	HVDC Transmission: Power Conversion Applicationsin Power Systems	Chan-Ki Kim et al	Wiley	1st Edition, 2009

Reference Books

1	Thyristor Based FACTS Controllers for Electrical Transmission Systems	R. Mohan Mathur, Rajiv K. Varma	Wiley	1st Edition, 2002

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS(Professional Elective)

Subject Code	15EE752	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- Describe the process to plan, control and implement commissioning of electrical equipment's.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Identification of tools and equipment's used for installation and maintenance of electrical equipment.
- Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgears.■

Module-1		Teaching Hours
Electrical Tools, accessories: Tools, Accessories and Instruments required for Installation, Maintenance and Repair Work, India Electricity Rules, Safely Codes Causes and Prevention of Accidents, Artificial Respiration, Workmen's Safety Devices. **Transformers:** Installation, Location Site Selection, Foundation Details, Code of Practice for Terminal Plates, Polarity and Phase Sequence, Oil Tanks, Drying of Winding sand General Inspection. Commissioning Tests As Per National and International Standards - Volts Ratio Earth Resistance, Oil Strength, Insulation Tests, Impulse Tests Polarizing Index, Load Temperature Rise Tests. Specific Tests for Determination of Performance Curves like Efficiencies, Regulation Etc., Determination Mechanical Stress Under Normal and Abnormal Conditions.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Synchronous Machines: Specifications as per BIS Standards. Installation - Physical Inspection, Foundation Details, Alignments, Excitation Systems, Cooling and Control Gear, Drying Out. Commissioning Tests - Insulation, Resistance Measurement of Armature and Field Windings, Wave Form and Telephone Interference Tests, Line Charging Capacitance. Performance Tests -Various Tests to Estimate the Performance of Generator Operations, Slip Test, Maximum Lagging Current, Maximum Reluctance Power Tests, Sudden Short Circuit Tests, Transient Sub Transient Parameters, Measurement of Sequence Impedances, Capacitive Reactance, and Separation Of Losses, Temperature Rise Test, and Retardation Tests. Factory Tests -Gap Length, Magnetic Eccentricity, Balancing Vibrations, Bearing Performance.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3		
Induction Motor: Specifications. Installation- Location of Motors and its Control Apparatus, Shaft Alignment for Various Coupling, Fitting of Pulleys and Coupling, Drying of Windings. Commissioning Tests -Mechanical Tests For Alignment, Air Gap Symmetry, Tests for Bearings, Vibrations and Balancing. Specific Tests -Performance and Temperature Raise Tests, Stray Load Losses, Shaft Alignment, Re-Writing and Special Duty Capability, Site Test■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-4		
Laying of Underground Cables: Inspection, Storage, Transportation and Handling of Cables, Cable Handing Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning. Location of Faults using Megger, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System, Causes and Dim, and Flickering Lights■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE752 TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS
(Professional Elective) (continued)

Module-5	**Teaching Hours**
Switchgear and Protective Devices: Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests. **Domestic Installation:** Introduction, Testing of Electrical Installation of a Building, Testing of Insulation Resistance to Earth, Testing of Insulation and Resistance between Conductors Continuity or Open Circuit Test, Short Circuit Test, Testing of Earthing Continuity, Location of Faults, IE Rules for Domestic Installation■	**08**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.

Course outcomes:

At the end of the course the student will be able to:

- Describe the process to plan, control and implement commissioning of electrical equipment's.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Describe corrective and preventive maintenance of electrical equipment's.
- Explain the operation of an electrical equipment's such as isolators, circuit breakers, induction motor and synchronous machines.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Text/ Reference Books

1	Testing, Commissioning, Operation and Maintenance of Electrical Equipment	S. Rao	Khanna Publishers	6th Edition, 19th Reprint, 2015
2	Testing and Commissioning of Electrical Equipment	R.L.Chakrasali	Prism Books Pvt Ltd	1st Edition,2014
3	Preventive Maintenance of Electrical Apparatus	S.K.Sharotri	Katson Publishing House	1st Edition, 1980
4	Handbook of Switchgears	BHEL	McGraw Hill	1st Edition, 2005
5	Transformers	BHEL	McGraw Hill	1st Edition, 2003
6	TheJ&P Transformer Book	Martin J. Heathcote	Newnes	12th Edition, 1998

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

SPACECRAFT POWER TECHNOLOGIES(Professional Elective)

Subject Code	15EE753	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.
- To discuss near – earth environmental factors that will affect the design of space craft power systems.
- To describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.
- To discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.
- To discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.
- To describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations. ■

Module		Teaching Hours
Module-1		
Spacecraft: Introduction, the Beginnings, the Electrical Power System. **Environmental Factors:** Introduction, Orbital Considerations, The Near-earth Space Environment. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Solar Energy Conversion: Introduction, Solar Cell Fundamentals, Space Solar Cell Calibration and Performance Measurements, Silicon Space Solar Cells, III-V Compound Semiconductor Solar Cells, Thin Film Solar Cells. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Solar Energy Conversion (continued): Space Solar Cell Arrays, Space Thermo photovoltaic Power Systems. **Chemical Storage and Generation Systems:** Introduction, Inventions, Evolution of Batteries in Space, Fundamentals of Electrochemistry, Cell and Battery Mechanical Design, Performance Metrics. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Chemical Storage and Generation Systems (continued): Electrochemical Cell Types, Fuel Cell Systems. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Power Management and Distribution (PMAD): Introduction, Functions of PMAD, Components and Packaging, System Examples. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.
- Discuss near – earth environmental factors that will affect the design of space craft power systems.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE753 SPACECRAFT POWER TECHNOLOGIES(Professional Elective)(continued)

Course outcomes(continued):

- Describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.
- Discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.
- Discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.
- Describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Spacecraft Power Technologies	A.K. Hyder et al	Imperial College Press	1st Edition, 2000

Reference Books

1	Spacecraft Power Systems	Mukund R. Patel	CRC Press	1st Edition, 2004

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

INDUSTRIAL HEATING (Professional Elective)

Subject Code	15EE754	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:
- To explain construction, classification of industrial furnaces and the methods of heat transfer in them
- To discuss heating capacity of batch furnaces
- To discuss heating capacity of continuous furnaces
- To discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.
- To explain operation and control of industrial furnaces.■

Module-1	Teaching Hours
Industrial Heating Processes: Industrial Process Heating Furnaces, Classifications of Furnaces, Elements of Furnace Construction. **Heat Transfer in Industrial Furnaces:** Heat Required for Load and Furnace, Flow of Heat Within the Charged Load, Heat Transfer to the Charged Load Surface, Determining Furnace Gas Exit Temperature, Thermal Interaction in Furnaces, Temperature Uniformity, Turndown.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Heating Capacity of Batch Furnaces: Definition of Heating Capacity, Effect of Rate of Heat Liberation, Effect of Rate of Heat Absorption by the Load, Effect of Load Arrangement, Effect of Load Thickness, Vertical Heating, Batch Indirect-Fired Furnaces, Batch Furnace Heating Capacity Practice, Controlled Cooling in or After Batch Furnaces.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Heating Capacity of Continuous Furnaces: Continuous Furnaces Compared to Batch Furnaces, Continuous Dryers, Ovens, and Furnaces for <1400 F (<760 C), Continuous Midrange Furnaces, 1200 to 1800 F (650 to 980 C), Sintering and Pelletizing Furnaces, Axial Continuous Furnaces for Above 2000 F (1260 C), Continuous Furnaces for 1900 to 2500 F (1038 to 1370 C), Continuous Liquid Heating Furnaces.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Saving Energy in Industrial Furnace Systems: Furnace Efficiency, Methods for Saving Heat, Heat Distribution in a Furnace, Furnace, Kiln, and Oven Heat Losses, Heat Saving in Direct-Fired Low-Temperature Ovens, Saving Fuel in Batch Furnaces, Saving Fuel in Continuous Furnaces, Effect of Load Thickness on Fuel Economy, Saving Fuel in Reheat Furnaces, Fuel Consumption Calculation, Fuel Consumption Data for Various Furnace Types, Energy Conservation by Heat Recovery from Flue Gases, Energy Costs of Pollution Control.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	**08**
Operation and Control of Industrial Furnaces: Burner and Flame Types, Location, Flame Fitting, Unwanted NOx Formation, Controls and Sensors- Care, Location, Zones, Air/Fuel Ratio Control, Furnace Pressure Control Turndown Ratio, Furnace Control Data Needs, Soaking Pit Heating Control, Uniformity Control in Forge Furnaces, Continuous Reheat Furnace Control. ■	
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

15EE754 INDUSTRIAL HEATING (Professional Elective) (continued)

Course outcomes:

At the end of the course the student will be able to:

- Explain construction, classification of industrial furnaces
- Discuss the methods of heat transfer in industrial furnaces.
- Discuss heating capacity of batch furnaces and continuous furnaces
- Discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.
- Explain operation and control of industrial furnaces.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Industrial Furnaces	W. Trinks	Wiley	6^{th} Edition, 2004

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII			
POWER SYSTEM SIMULATION LABORATORY			
Subject Code	15EEL76	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80
Credits - 02			

Course objectives:

- To explain the use of MATLAB package to assess the performance of medium and long transmission lines.
- To explain the use of MATLAB package to obtain the power angle characteristics of salient and non-salient pole alternator.
- To explain the use of MATLAB package to study transient stability of radial power systems under three phase fault conditions.
- To explain the use of MATLAB package to develop admittance and impedance matrices of interconnected power systems.
- To explain the use of Mi-Power package to solve power flow problem for simple power systems.
- To explain the use of Mi-Power package to perform fault studies for simple radial power systems.
- To explain the use of Mi-Power package to study optimal generation scheduling problems for thermal power plants. ■

Sl. No		Experiments
1	Use of MATLAB package	Formation for symmetric π /T configuration for Verification of $AD - BC = 1$, Determination of Efficiency and Regulation.
2		Determination of Power Angle Diagrams, Reluctance Power, Excitation, Emf and Regulation for Salient and Non-Salient Pole Synchronous Machines.
3		To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.
4		Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular Transformation and Inspection Method.
5		Formation of Z Bus(without mutual coupling) using Z-Bus Building Algorithm.
6		Determination of Bus Currents, Bus Power and Line Flow for a Specified System Voltage (Bus) Profile.
7	Use of Mi-Power package	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinates.
8		Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled Method for Both PQand PV Buses.
9		To Determine Fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults by simulation.
10		Optimal Generation Scheduling for Thermal power plants by simulation.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating.

Course outcomes:

At the end of the course the student will be able to:

- Develop a program in MATLAB to assess the performance of medium and long transmission lines.
- Develop a program in MATLAB to obtain the power angle characteristics of salient and non-salient pole alternator.
- Develop a program in MATLAB to assess the transient stability under three phase fault at different locations in a of radial power systems.
- Develop programs in MATLAB to formulate bus admittance and bus impedance matrices of interconnected power systems.
- Use Mi-Power package to solve power flow problem for simple power systems.
- Use Mi-Power package to study unsymmetrical faults at different locations in radial power systems
- Use of Mi-Power package to study optimal generation scheduling problems for thermal power plants. ■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII
15EEL76POWER SYSTEM SIMULATION LABORATORY (continued)
Graduate Attributes (As per NBA) Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.
Conduct of Practical Examination: 1. All laboratory experiments are to be included for practical examination. 2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners. 3. Students can pick one experiment from the questions lot prepared by the examiners. 4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

<table>
<tr><td colspan="4">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII</td></tr>
<tr><td colspan="4">RELY AND HIGH VOLTAGE LABORATORY</td></tr>
<tr><td>Subject Code</td><td>15EEL77</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number ofPracticalHours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of PracticalHours</td><td>42</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4">Credits - 02</td></tr>
<tr><td colspan="4">Course objectives:
To conduct experiments to verify the characteristics of over current, over voltage, under voltage relays both electromagnetic and static type.
To verify the operation of negative sequence relay.
To conduct experiments to verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
To conduct experiments on generator, motor and feeder protection.
To conduct experiments to study the sparkover characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
To measure high AC and DC voltages
To experimentally measure the breakdown strength of transformer oil.
To experimentally measure the capacitance of different electrode configuration models using Electrolytic Tank. To generate standard lightning impulse voltage and determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.■
</td></tr>
</table>

<table>
<tr><th>Sl. NO</th><th colspan="2">Experiments</th></tr>
<tr><td colspan="3">Total of Six experiments are to be conducted by selecting Two experiments from each Part – A, Part – B and Part – C. The experiments under Part – D is compulsory.</td></tr>
<tr><td>1</td><td rowspan="3">Part - A</td><td>Over Current Relay: (a)Inverse Definite Minimum Time(IDMT)Non-Directional Characteristics (b) Directional Features (c) IDMT Directional.</td></tr>
<tr><td>2</td><td>IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type).</td></tr>
<tr><td>3</td><td>Operation of Negative Sequence Relay.</td></tr>
<tr><td>4</td><td rowspan="3">Part - B</td><td>Operating Characteristics of Microprocessor Based (Numeric) Over –Current Relay.</td></tr>
<tr><td>5</td><td>Operating Characteristics of Microprocessor Based (Numeric) Distance Relay.</td></tr>
<tr><td>6</td><td>Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage Relay.</td></tr>
<tr><td>7</td><td rowspan="3">Part - C</td><td>Generation Protection: Merz Price Scheme.</td></tr>
<tr><td>8</td><td>Feeder Protection against Faults.</td></tr>
<tr><td>9</td><td>Motor Protection against Faults.</td></tr>
<tr><td>10</td><td rowspan="6">Part - D</td><td>Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected to Standard Temperature and Pressure for Uniform [as per IS1876: 2005]and Non-uniform [as per IS2071(Part 1) : 1993] Configurations: Sphere – Sphere, Point –Plane, Point – Point and Plane – Plane.</td></tr>
<tr><td>11</td><td>Spark Over Characteristics of Air subjected to High voltage DC.</td></tr>
<tr><td>12</td><td>Measurement of HVAC and HVDC using Standard Spheres as per IS 1876 :2005</td></tr>
<tr><td>13</td><td>Measurement of Breakdown Strength of Transformer Oil as per IS 1876 :2005</td></tr>
<tr><td>14</td><td>Field Mapping using Electrolytic Tank for any one of the following Models: Cable/ Capacitor/ Transmission Line/ Sphere Gap.</td></tr>
<tr><td>15</td><td>(a) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator. (b) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage.</td></tr>
<tr><td colspan="2">Revised Bloom's Taxonomy Level</td><td>L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating</td></tr>
<tr><td colspan="3"></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

15EEL77 RELY AND HIGH VOLTAGE LABORATORY (continued)

Course outcomes:

At the end of the course the student will be able to:

- Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays both electromagnetic and static type.
- Experimentally verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
- Show knowledge of protecting generator, motor and feeders.
- Analyze the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
- Measure high AC and DC voltages and breakdown strength of transformer oil**.**
- **Draw electric field and** measure the capacitance of different electrode configuration models.
- Show knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) **CHOICE BASED CREDIT SYSTEM (CBCS)** **SEMESTER - VII**			
PROJECT PHASE – I AND SEMINAR			
Subject Code	15EEP78	IA Marks	100
Number ofPracticalHours/Week	--	Exam Hours	--
Total Number of PracticalHours	--	Exam Marks	--
Credits - 02			

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Continuous Internal Evaluation

CIE marks for the project report (50 marks)and seminar (50 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman. ■

****** END ******

VIII SEMESTER DETAILED SYLLABUS

<table>
<tr><td colspan="4" align="center">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VIII</td></tr>
<tr><td colspan="4" align="center">POWER SYSTEM OPERATION AND CONTROL(Core Course)</td></tr>
<tr><td>Subject Code</td><td>15EE81</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>04</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 04</td></tr>
</table>

Course objectives:

- To describe various levels of controls in power systems and the vulnerability of the system.
- To explain components, architecture and configuration of SCADA.
- To define unit commitment and explain various constraints in unit commitment and the solution methods
- To explain issues of hydrothermal scheduling and solutions to hydro thermal problems
- To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
- To explain automatic generation control, voltage and reactive power control in an interconnected power system.
- To explain reliability and contingency analysis, state estimation and related issues. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Introduction: Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centres.
Supervisory Control and Data acquisition (SCADA): Introduction to SCADA and its Components, Standard SCADA Configurations, Users of Power Systems SCADA, Remote Terminal Unit for Power System SCADA, Common Communication Channels for SCADA in Power Systems, Challenges for Implementation of SCADA.
Unit Commitment: Introduction, SimpleEnumeration Constraints, Priority List Method, DynamicProgramming Method for Unit Commitment.■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Hydro-thermal Scheduling: Introduction, Scheduling Hydro Systems, Discrete Time Interval Method, Short Term Hydro Thermal Scheduling Using $\gamma - \lambda$ Iterations, Short Term Hydro Thermal Scheduling Using Penalty Factors.
Automatic Generation Control (AGC): Introductions, Basic Generator Control Loops, Commonly used Terms in AGC, Functions of AGC, Speed Governors.■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Automatic Generation Control (continued): Mathematical Model of Automatic Load Frequency Control, AGC Controller, Proportional Integral Controller.
Automatic Generation Control in interconnected Power system: Introductions, Tie - Line Control with Primary Speed Control, Frequency Bias Tie - Line Control, State-Space Models.■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_3 – Applying.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Automatic Generation Control in interconnected Power system (continued): State-Space Model for Two - Area System, Tie-Line Oscillations, Related Issues in Implementation of AGC.
Voltage and Reactive Power Control: Introduction, Production and Absorption of Reactive Power, Methods of Voltage Control, Dependence of Voltage on Reactive Power , Sensitivity of Voltage to Changes in P And Q, Cost Saving, Methods of Voltage Control by Reactive Power Injection, Voltage Control Using Transformers, Voltage Stability. ■</td><td rowspan="2">10</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_3 – Applying.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

15EE81POWER SYSTEM OPERATION AND CONTROL(Core Course) (continued)

Module-5		Teaching Hours
Power System Reliability and Security: Introduction, Security Levels of System, Reliability Cost, Adequacy Indices, Functions of System Security, Contingency Analysis, Linear Sensitivity Factors, Contingency Selection and Ranking. **State estimation of Power Systems:** Introduction, Linear Least Square Estimation, DC State Estimator, Other Issues in State Estimation.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Describe various levels of controls in power systems, the vulnerability of the system,components, architecture and configuration of SCADA.
- Solve unit commitment problems
- Explain issues of hydrothermal scheduling and solutions to hydro thermal problems
- Explain basic generator control loops, functions of Automatic generation control, speed governors
- Develop and analyze mathematical models of Automatic Load Frequency Control
- Explain automatic generation control, voltage and reactive power control in an interconnected power system.
- Explain reliability, security, contingency analysis, state estimation and related issues of power systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Power System Operation and Control	K. Uma Rao	Wiley	1^{st} Edition, 2012

Reference Books

1	Power Generation Operation and Control	Allen J Wood etal	Wiley	2nd Edition,2003
2	Power System Stability and Control	Kundur	McGraw Hill	8^{th} Reprint, 2009

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VIII

INDUSTRIAL DRIVES AND APPLICATIONS(Core Course)

Subject Code	15EE82	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To define electric drive, its parts, advantages and explain choice of electric drive.
- To explain dynamics and modes of operation of electric drives.
- To explain selection of motor power ratings and control of dc motor using rectifiers.
- To analyze the performance of induction motor drives under different conditions.
- To explain the control of induction motor, synchronous motor and stepper motor drives.
- To discuss typical applications electrical drives in the industry. ■

Module-1		Teaching Hours
Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives. **Dynamics of Electrical Drives:** Fundamental Torque Equations, Speed TorqueConventions and Multiquadrant Operation. Equivalent Values of DriveParameters, Components of Load Torques, Nature and Classification of LoadTorques, Calculation of Time and Energy Loss in Transient Operations, SteadyState Stability, Load Equalization. **Control Electrical Drives:**Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **Direct Current Motor Drives:**Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor,SinglePhase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor,Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multiquadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier,Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current,Chopper Control of Separately Excited dcMotor, Chopper Control of Series Motor.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Induction Motor Drives: Analysis and Performance ofThree Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing,Operation with Unbalanced Rotor Impedances,Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply,Starting, Braking, Transient Analysis.Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
Induction Motor Drives (continued): Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control,current regulated voltage source inverter control, speed control of single phase induction motors. **Synchronous Motor Drives:**Operation from fixed frequency supply-starting, synchronous motor		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VIII

15EE82 INDUSTRIAL DRIVES AND APPLICATIONS(Core Course) (continued)

Module-5	**Teaching Hours**
Synchronous Motor Drives (continued): Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Stepper Motor Drives**: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:**Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Explain the advantages and choice of electric drive.
- Explain dynamics and different modes of operation of electric drives.
- Suggest a motor for a drive and control of dc motor using controlled rectifiers.
- Analyze the performance of induction motor drives under different conditions.
- Control induction motor, synchronous motor and stepper motor drives.
- Suggest a suitable electrical drive for specific application in the industry. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Fundamentals of Electrical Drives	Gopal K. Dubey	Narosa Publishing House	2nd Edition, 2001
2	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives under module 5.)	VedumSubrahmanyam	McGraw Hill	2nd Edition, 2011

Reference Books

1	Electric Drives	N.K De,P.K. Sen	PHI Learning	1st Edition, 2009

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –VIII

SMART GRID(Professional Elective)

Subject Code	15EE831	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To define smart grid and discuss the progress made by different stakeholders in the design and development of smart grid.
- To explain the measurement techniques using PMUs and smart meters.
- To discuss tools for the analysis of smart grid and design, operation and performance.
- To discuss incorporating performance tools such as voltage and angle stability and state estimation into smart grid.
- To discuss classical optimization techniques and computational methods for smart grid design, planning and operation.
- To discuss the development of predictive grid management and control technology for enhancing the smart grid performance.
- To discuss development of cleaner, more environmentally responsible technologies for the electric system.
- To discuss the fundamental tools and techniques essential to the design of the smart grid.
- To describe methods to promote smart grid awareness and enhancement.
- To discuss methods to make the existing transmission system smarter by investing in new technology.■

Module-1	Teaching Hours
Smart Grid Architectural Designs: Introduction, Today's Grid versus the Smart Grid, Energy Independence and Security Act of 2007: Rationale for the Smart Grid, Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Working Definition of the Smart Grid Based on Performance Measures, Representative Architecture, Functions of Smart Grid Components. **Smart Grid Communications and Measurement Technology:** Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Microgrid and Smart Grid Comparison. **Performance Analysis Tools for Smart Grid Design:** Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, DSOPF Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingencies and Their Classification, Contingency Studies for the Smart Grid.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Stability Analysis Tools for Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Computational Tools for Smart Grid Design: Introduction to Computational Tools, Decision Support Tools, Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto	**08**

<table>
<tr><td colspan="3">B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –VIII</td></tr>
<tr><td colspan="3">15EE831 SMART GRID(Professional Elective) (continued)</td></tr>
<tr><td colspan="2">Module-3 (continued)</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges.
Pathway for Designing Smart Grid: Introduction to Smart Grid Pathway Design, Barriers and Solutions to Smart Grid Development, Solution Pathways for Designing Smart Grid Using Advanced Optimization and Control Techniques for Selection Functions, General Level Automation, Bulk Power Systems Automation of the Smart Grid at Transmission Level, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid, Applications for Adaptive Control and Optimization.■</td><td rowspan="2"></td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><td colspan="3">Module-4</td></tr>
<tr><td colspan="2">Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Penetration and Variability Issues Associated with Sustainable Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits.
Interoperability, Standards, and Cyber Security: Introduction, Interoperability, Standards, Smart Grid Cyber Security, Cyber Security and Possible Operation for Improving Methodology for Other Users.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3">Module-5</td></tr>
<tr><td colspan="2">Research, Education, and Training for the Smart Grid: Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development.
Case Studies and Test beds for the Smart Grid: Introduction, Demonstration Projects, Advanced Metering, Microgrid with Renewable Energy, Power System Unit Commitment (UC) Problem,ADP for Optimal Network Reconfiguration in Distribution Automation, Case Study of RER Integration,Testbeds and Benchmark Systems, Challenges of Smart Transmission,Benefits of Smart Transmission.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Course outcomes:
At the end of the course the student will be able to:
Discuss the progress made by different stakeholders in the design and development of smart grid.
Explain measurement techniques using Phasor Measurement Units and smart meters
Discuss tools for the analysis of smart grid and design, operation and performance
Discuss classical optimization techniques and computational methods for smart grid design, planning and operation.
Explain predictive grid management and control technology for enhancing the smart grid performance
Develop cleaner, more environmentally responsible technologies for the electric system.
Discuss the computational techniques, communication, measurement, and monitoring technology tools essential to the design of the smart grid.
Explain methods to promote smart grid awareness and making the existing transmission system smarter by investing in new technology.■</td></tr>
<tr><td colspan="3">Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, The Engineer and Society, , Ethics, Individual and Team Work, Communication, Life-long Learning.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER –VIII				
15EE831 SMART GRID(Professional Elective) (continued)				
Question paper pattern: • The question paper will have ten questions. • Each full question is for 16 marks. • There will be 2full questions (with a maximum of four sub questions in one full question) from each module. • Each full question with sub questions will cover the contents under a module. • Students will have to answer 5 full questions, selecting one full question from each module.■				
Textbook				
1	Smart Grid, Fundamentals of Design and Analysis	James Momoh	Wiley	1st Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VIII			
OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS (Professional Elective)			
Subject Code	15EE832	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss basics of solar resource data, its acquisition and usage.
- To discuss PV technology, buying the PV modules and connecting the modules to form arrays.
- To discuss inverters, system components, cabling used to connect the components and mounting methods of the PV system.
- To explain site assessment, design process of the grid connected system and its sizing.
- To explain installation, commissioning, operation and maintenance of PV systems.
- To explain the types of financial incentives available, calculation of payback time. ■

Module-1		Teaching Hours
Solar Resource and Radiation: Solar resources, Quantifying solar radiation, The effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays. **PV Industry and Technology:**Semiconductor devices,Mainstream technologies,Monocrystalline silicon,Multicrystalline/polycrystalline silicon,Thin film solar cells,Contacts,Buying solar modules,Standards,Certifications,Warranties,Emerging technologies,Dye-sensitized solar cells,Sliver cells,Heterojunction with intrinsic thin layer (HIT) photovoltaic cells,III-V Semiconductors,Solar concentrators. **PV Cells, Modules and Arrays:**Characteristics of PV cells,Graphic representations of PV cell performance,Connecting PV cells to create a module,Specification sheets,Creating a string of modules,Creating an array,Photovoltaic array performance,Irradiance,Temperature,Shading.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Inverters and Other System Components: Introduction, Inverters,Battery inverters,Grid-interactive inverters,Transformers,Mainstream inverter technologies,String inverters,Multi-string inverter,Central inverter,Modular inverters,Inverter protection systems,Self-protection,Grid protection,Balance of system equipment: System equipment excluding the PV array and inverter,Cabling,PV combiner box,Module junction box,Circuit breakers and fuses,PV main disconnects/isolators,Lightning and surge protection,System monitoring,Metering,Net metering,Gross metering. Mounting Systems:Roof mounting systems,Pitched roof mounts,Pitched roof mounts for tiled roofs,Pitched roof mounts for metal roofs,Rack mounts,Direct mounts,Building-integrated systems,Ground mounting systems,Ground rack mounts,Pole mounts,Sun-tracking systems,Wind loading,Lightning protection.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Site Assessment: Location of the PV array,Roof specifications,Is the site shade-free?,Solar Pathfinder,SolmetricSuneye,HORIcatcher,iPhone apps,Software packages,Available area,Portrait installation,Landscape installation,Energy efficiency initiatives,Health, safety and environment (HSE) risks,Local environment,Locating balance of system equipment,Site plan. **Designing Grid-connected PV Systems:**Design brief,Existing system evaluation,Choosing system components,Modules,Mounting structure,Inverters,Cabling,Voltage sizing,Current sizing,Monitoring,System protection,Over-current protection,Fault-current protection,Lightning and surge protection,Grounding/earthing,Mechanical protection,Array protection,Sub-array protection,Extra low voltage (ELV) segmentation. **Sizing a PV System:**Introduction, Matching voltage specifications,Calculating maximum voltage,Calculating minimum voltage,Calculating the minimum number of modules in a string,Calculating the maximum voltage,Calculating the maximum number of modules in a string,Calculating the		**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII		
15EE832 OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS (Professional Elective)(continued)		
Module-3 (continued)		**Teaching Hours**
minimum voltage,Calculating the minimum number of modules in a string,Matching current specifications,Matching modules to the inverter's power rating,Losses in utility-interactive PV systems,Temperature of the PV module,Dirt and soiling,Manufacturer's tolerance,Shading,Orientation and module tilt angle,Voltage drop,Inverter efficiency,Calculating system yield.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Installing Grid-connected PV Systems:PV array installation, DC wiring, Cabling routes and required lengths,Cable sizing, PV combiner box,System grounding/earthing, Inverter installation, Installation checklist,Interconnection with the utility grid,Required information for installation,Safety. **System Commissioning:**Introduction, Final inspection of system installation,Testing,Commissioning, System documentation. **System Operation and Maintenance:**System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems,Troubleshooting inverters,Other common problems. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Marketing and Economics of Grid-connected PV Systems:Introduction, PV system costing,Valuing a PV system,Simple payback and financial incentives,Simple payback,Feed-in tariffs,Rebates,Tax incentives,Loans,Renewable portfolio standards and renewable energy certificates,Marketing,Insurance. **Case Studies:**Case studies A to G.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss basics of solar resource data, its acquisition and usage.
- Explain PV technology, buying the PV modules and connecting the modules to form arrays.
- Explain the use of inverters, other system components, cabling used to connect the components and mounting methods of the PV system.
- Assess the site for PV system installation.
- Design a grid connected system and compute its size.
- Explain installation, commissioning, operation and maintenance of PV systems.
- Explain the types of financial incentives available, calculation of payback time■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, The Engineer and Society, Environment and Sustainability, Ethics, Individual and Team Work, Communication, Project Management and Finance, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII				
15EE832 OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS (Professional Elective)(continued)				
Textbook				
1	Grid-connected Solar Electric Systems, The Earthscan Expert Handbook for Planning, Design and Installation	Geoff Stapleton and Susan Neill	Earthscan	1st Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VIII

INTEGRATION OF DISTRIBUTED GENERATION(Professional Elective)

Subject Code	15EE833	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain power generation by alternate energy source like wind power and solar power.
- To explain selection of size of units and location for wind and solar systems.
- Discuss the effects of integration of distributed generation on the performance the system.
- To provide practical and useful information about grid integration of distributed generation.■

<table>
<tr><th colspan="2">Module-1</th><th>Teaching Hours</th></tr>
<tr><td colspan="2">Distributed Generation: Introduction,Sources of Energy - Wind Power, Solar Power, Combined Heat-and-Power, Hydropower, Tidal Power, Wave Power, Geothermal Power, Thermal Power Plants.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying.</td></tr>
<tr><th colspan="3">Module-2</th></tr>
<tr><td colspan="2">Distributed Generation (continued): Interface with the Grid.
Power System Performance: Impact of Distributed Generation on the Power System, Aims of the Power System, Hosting Capacity Approach, Power Quality, Voltage Quality and Design of Distributed Generation, Hosting Capacity Approach for Events, Increasing the Hosting Capacity.
Overloading and Losses: Impact of Distributed Generation, Overloading: Radial Distribution Networks, Overloading: Redundancy and Meshed Operation, Losses.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><th colspan="3">Module-3</th></tr>
<tr><td colspan="2">Overloading and Losses(continued):Increasing the Hosting Capacity.
Voltage Magnitude Variations: Impact of Distributed Generation, Voltage Margin and Hosting Capacity, Design of Distribution Feeders, A Numerical Approach to Voltage Variations, Tap Changers with Line-Drop Compensation, Probabilistic Methods for Design of Distribution Feeders.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.</td></tr>
<tr><th colspan="3">Module-4</th></tr>
<tr><td colspan="2">Voltage Magnitude Variations (continued): Statistical Approach to Hosting Capacity, Increasing the Hosting Capacity.
Power Quality Disturbances: Impact of Distributed Generation, Fast Voltage Fluctuations, Voltage Unbalance.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
<tr><th colspan="3">Module-5</th></tr>
<tr><td colspan="2">Power Quality Disturbances (continued):Low-Frequency Harmonics, High-Frequency Distortion, Voltage Dips, Increasing the Hosting Capacity.■</td><td rowspan="2">08</td></tr>
<tr><td>Revised Bloom’s Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td></tr>
</table>

Course outcomes:

At the end of the course the student will be able to:

- Explain energy generation by wind power and solar power.
- Discuss the variation in production capacity at different timescales, the size of individual units, and the flexibility in choosing locations with respect to of wind and solar systems.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

15EE833 INTEGRATION OF DISTRIBUTED GENERATION(Professional Elective)(continued)

Course outcomes (continued):

- Explain the performance of the system when distributed generation is integrated to the system.
- Discuss effects of the integration of DG: the increased risk of overload and increased losses.
- Discuss effects of the integration of DG: increased risk of overvoltages, increased levels of power quality disturbances.
- Discuss effects of the integration of DG: incorrect operation of the protection
- Discuss the impact the integration of DG on power system stability and operation. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions,Conduct investigations of complex problems, Modern Tool Usage, The Engineer and Society, Ethics, Individual and Team Work, Communication,Project Management and Finance, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Integration ofDistributedGeneration in thePower System	Math Bollen	Wiley	2011

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII			
POWER SYSTEM IN EMERGENCIES(Professional Elective)			
Subject Code	15EE834	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss the disturbances that may occur in a power system and the impact of them on its viable operation.
- To give the definitions, concepts and standard terminology used in the literature on emergency control and to discuss the effect of system structure on the form of emergency control.
- To discuss the structure, function and alternatives for main transmission.
- To discuss standards of security and quality of supply in planning and operation,timescales and tasks in system operation and control.
- To discuss SCADA facilities - functions, structure, performance criteria, data and human - computer interface.
- To discuss energy management systems, communications, telemetry, telecommand and distributed generation.
- To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk.
- To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration.
- To discuss different simulators that can be used in training.
- To discuss facilities and characteristics for emergency control, qualitative and quantitative benefits of emergency control and emergency control in the future. ■

Module-1		**Teaching Hours**
Disturbances in Power Systems and their Effects: Sudden Disturbance, Predictable Disturbances, Forms of System Failure, Analysis Techniques, Trends in the Development of Analytical Techniques. **Some General Aspects of Emergency Control:** Definitions and Concepts used in Emergency Control, Some Standard Terminology, The Effects of Various Types of Fault or Disturbance on System Performance, Typical Pattern of the Development of a Sudden Disturbance, Conceptual Forms of Emergency Control, Effect of System Structure on the Need for and Implementation of Emergency Control, Design Criteria for Emergency Control Facilities.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
The Power System and its Operational and Control Infrastructure: Structure, The Functions of Interconnection, The Alternatives for Main Transmission, Security and Quality of Supply in Planning and Operation, Timescales in System Operation and Control, SCADA, Energy Management Systems, Communications and Telemetry,Telecommand, Distributed Generation, Flexible AC Transmission Systems (FACTS).■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Measures to Minimize the Impact of Disturbances: Factors in Onset, Severity and Propagation of a Disturbance, Measures in the Planning Timescale to Minimize the Risk of a Disturbance, Measures in the Operational Timescale to Minimize the Risk and Impact of a Disturbance, Special Protection Schemes, Reduction in the Spread of Disturbances, Measures to Minimize the Impact of Predictable Disturbances, An Approach to Managing Resources, The Control Centre.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
The Natural Environment - Some Disturbances Reviewed: Introduction, Useful Sources of Information, Extreme Environmental Conditions, Noteworthy Disturbances,Incidents.		**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

15EE834 POWER SYSTEM IN EMERGENCIES(Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Restoration: Introduction, The Range of Disturbed System Conditions, Some General Issues in Restoration, Recovery from an Abnormal Operating Situation, Local Islanding or Localized Loss of Demand, The 'Black Start' Situation,Strategies for Restoration of the Whole System, Aides in Restoration Process, Problems Found in Restoration, Analysis, Simulation and Modelling in Blackstart, Restoration from a Foreseen Disturbance. **Training and Simulators for Emergency Control:** Introduction, Training in General, The Need for Operator Training, The Content of Training, Forms of Training, Training Simulators, The Use of Dispatch Training Simulators in Practice.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Plant Characteristics and Control Facilities for Emergency Control and Benefits to be Obtained: Introduction, The Characteristics and Facilities Required for Emergency Control, The System and Demand, System Control Costs for Emergencies, Indirect Costs, The Benefits of Emergency Control, Quantitative Aspects,Is Emergency Control Worthwhile? **Systems and Emergency Control in the Future:** Introduction, Changes in Organization, Restructuring, Unbundling and Emergency Control, Facilities for Emergency Control in the Future, Superconductivity, Contingency Planning and Crisis.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

At the end of the course the student will be able to:

- Explain disturbances that may occur in a power system and the impact of them on its operation.
- Give the definitions, concepts and standard terminology used in the literature on emergency control and discuss the effect of system structure on the form of emergency control
- Discuss the structure, function and alternatives for main transmission
- To discuss standards of security and quality of supply in planning and operation,timescales, tasks in system operation and control, SCADA facilities - functions, structure, performance criteria, data and human - computer interface
- To discuss energy management systems, communications, telemetry, telecommand and distributed generation.
- To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk
- To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration
- To discuss different simulators used in training, facilities and characteristics for emergency control, and benefits of emergency control and emergency control in the future. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions,Conduct investigations of complex problems, Modern Tool Usage, The Engineer and Society, Ethics, Individual and Team Work, Communication,Project Management and Finance, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.■

Textbook

1	Power Systems in Emergencies: From Contingency Planning to Crisis Management	U. G. Knight	Wiley	1st Edition, 2001

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

INTERNSHIP / PROFESSIONAL PRACTICE

Subject Code	15EE84	IA Marks	50
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	50

Credits - 02

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance ofinternal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

15EE84INTERNSHIP / PROFESSIONAL PRACTICE(continued)

Continuous Internal Evaluation

CIE marks for the Internship/Professional practicereport (25 marks)and seminar (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman. ■

Semester End Examination

SEE marks for the project report (25 marks)and seminar (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII

PROJECT WORK PHASE -II

Subject Code	15EEP85	IA Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	100

Credits - 06

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

Evaluation Procedure:
The Internal marks evaluation shall be based on project report and presentation of the same in a seminar.
Project Report:50 marks. The basis for awarding the marks shall be the involvement of individual student of the project batch in carrying the project and preparation of project report. To be awarded by the internal guide in consultation with external guide if any.
Project Presentation:50 marks. Each student of the project batch shall present the topic of Project Work Phase -II orally and/or through power point slides.
The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman.
The student shall be evaluated based on:
Presentation skill for 30 marks and ability in the Question and Answer session for 20 marks.■

Semester End Examination

SEE marks for the project (100 marks)shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) as per the University norms by the examiners appointed VTU.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII			
SEMINAR			
Subject Code	15EES86	IA Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	--
Credits - 01			

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.

- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

At the end of the course the student will be able to:

- Attain, use and develop knowledge in the field of electrical and electronics engineering and other disciplines through independent learning and collaborative study.
- Identify, understand and discuss current, real-time issues
- Improve oral and written communication skills
- Explore an appreciation of the self in relation to its larger diverse social and academic contexts.
- Apply principles of ethics and respect in interaction with others.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman.

Marks distribution for internal assessment of the course 15EES86 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks.■

Mechanical Engineering

B.E. Mechanical Engineering

III SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	Engineering Mathematics – III	04			03	80	20	100	4
2	15ME32	Materials Science	04			03	80	20	100	4
3	15ME33	Basic Thermodynamics	03	02		03	80	20	100	4
4	15ME34	Mechanics of Materials	03	02		03	80	20	100	4
5	15ME35A/ 15ME35B	Metal Casting and Welding / Machine Tools and Operations	04			03	80	20	100	4
6	15ME36 A/ 15ME36B	Computer Aided Machine Drawing	02		4	03	80	20	100	3
		Mechanical Measurements and Metrology	04							
7	15MEL37A/ 15MEL37B	Materials Testing Lab/ Mechanical Measurements and Metrology Lab	1		2	03	80	20	100	2
8	15MEL38A/ 15MEL38B	Foundry and Forging Lab / Machine Shop/	1		2	03	80	20	100	2
TOTAL			**22/24**	**04**	**08/04**		**640**	**160**	**800**	**27**

MATERIAL SCIENCE

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Material Science	15ME32	04	4-0-0	80	20	3Hrs

COURSE OBJECTIVES:

This course provides

1. The foundation for understanding the structure and various modes of failure in materials common in mechanical engineering.
2. Topics are designed to explore the mechanical properties of metals and their alloys, polymers, ceramics ,smart materials and composites.
3. The means of modifying such properties, as well as the processing and failure of materials.
4. Concepts of use of materials for various applications are highlighted.

MODULE 1

Basics, Mechanical Behavior, Failure of Materials

Introduction to Crystal Structure – Coordination number, atomic packing factor, Simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections – point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion;Factors affecting diffusion.

Mechanical Behavior:

Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering and true strains, Linear and non-linear elastic behavior and properties, Mechanical properties in plastic range. Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness, Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals

Fracture: Type I, Type II and Type III,

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing. **Creep:** Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness, numerical on diffusion, strain and stress relaxation

10 Hours

MODULE 2

Alloys, Steels, Solidification

Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic, and Eutectoid systems, Lever rule, Substitutional and interstitial solid solutions, Intermediate phases, Gibbs phase rule Effect of non- equilibrium cooling, Coring and Homogenization Iron-Carbon (Cementite) diagram: description of phases, Effect of common alloying elements in steel, Common alloy steels, Stainless steel, Tool steel, Specifications of steels. Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, Crystal growth, Cast metal structures Solidification of Steels and Cast irons. Numerical on lever rule

10 Hours

MODULE 3

Heat Treatment, Ferrous and Non-Ferrous Alloys

Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminum-copper alloys and PH steels. Ferrous materials: Properties, Compositions and uses of Grey cast iron, Malleable iron, SG iron and steel,

10 Hours

MODULE 4

Other Materials, Material Selection

Ceramics: Structure types and properties and applications of ceramics. Mechanical / Electrical behavior and processing of Ceramics.

Plastics: Various types of polymers/plastics and their applications. Mechanical behaviors and processing of plastics, Failure of plastics.

Other materials: Brief description of other materials such as optical and thermal materials Smart materials – fiber optic materials, piezo-electrics, shape memory alloys Shape Memory Alloys – Nitinol, superelasticity, Biological applications of smart materials - materials used as implants in human Body, Selection of Materials, Performance of materials in service Residual life assessment – use of non-destructive testing, Economics, Environment and Sustainability

10 Hours

MODULE 5

Composite Materials

Composite materials - Definition, classification, types of matrix materials & reinforcements,Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber-reinforced composites, Fundamentals of production of composites, Processes for production of composites, Characterization of composites, Constitutive relations of composites, Determination of composite properties from component properties, Hybrid composites, Applications of composite materials, Numericals on determining properties of composites

10 Hours

COURSE OUTCOMES:

The student shall be able to

1. Describe the mechanical properties of metals, their alloys and various modes of failure.
2. Understand the microstructures of ferrous and non-ferrous materials to mechanical properties.
3. Explain the processes of heat treatment of various alloys.
4. Understand the properties and potentialities of various materials available and material selection procedures.
5. Know about composite materials and their processing as well as applications.

TEXT BOOKS:

1. Smith, Foundations of Materials Science and Engineering, 4th Edition, McGraw Hill, 2009.
2. William D. Callister, Material science and Engineering and Introduction, Wiley, 2006.

REFERENCE BOOKS

1. V.Raghavan, Materials Science and Engineering, , PHI, 2002
2. Donald R. Askland and Pradeep.P. Phule, The Science and Engineering of Materials, Cengage Learning, 4lh Ed., 2003.
3. George Ellwood Dieter, Mechanical Metallurgy, McGraw-Hill.
4. ASM Handbooks, American Society of Metals.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

BASIC THERMODYNAMICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Basic Thermodynamics	15ME33	04	3-2-0	80	20	3Hrs

COURSE OBJECTIVES

1. Learn about thermodynamic systems and boundaries
2. Study the basic laws of thermodynamics including, conservation of mass, conservation of energy or first law , second law and Zeroth law.
3. Understand various forms of energy including heat transfer and work
4. Identify various types of properties (e.g., extensive and intensive properties)
5. Use tables, equations, and charts, in evaluation of thermodynamic properties
6. Apply conservation of mass, first law, and second law in thermodynamic analysis of systems (e.g., turbines, pumps, compressors, heat exchangers, etc.)
7. Enhance their problem solving skills in thermal engineering

MODULE 1

Fundamental Concepts & Definitions: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive , extensive properties, specific properties, pressure, specific volume Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes;Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems 10 Hours

MODULE 2

First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Extension of the First law to control volume; steady flow energy equation(SFEE), important applications.

Second Law of Thermodynamics: limitations of first law of thermodynamics Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir, Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems

10 Hours

MODULE 3

Reversibility: Definitions of a reversible process, reversible heat engine, importance and superiority of a reversible heat engine and irreversible processes; factors that make a process irreversible, reversible heat engines. Unresisted expansion, remarks on Carnot's engine, internal and external reversibility, Definition of the thermodynamic temperature scale. Problems

Entropy: Clasius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, , calculation of entropy using Tds relations, entropy as a coordinate.

10 Hours

MODULE 4

Availability, Irreversibility and General Thermodynamic relations. Introduction**,** Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility, second law efficiency (effectiveness). Gibbs and Helmholtz functions, Maxwell relations, Clapeyron equation, Joule Thomson coefficient, general relations for change in entropy, enthalpy , internal energy and specific heats.

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter.

10 Hours

MODULE 5

Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases,
Air- Water mixtures and related properties, Psychrometric properties, Construction and use of Psychrometric chart.

Real gases – Introduction , Air water mixture and related properties, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Redlich and Kwong equation of state Beattie-Bridgeman equation , Law of corresponding states, compressibility factor; compressibility chart.Difference between Ideal and real gases. 10 Hours

COURSE OUTCOMES

The student will be able to

	Course Outcomes	**PO's**	**Course Level**
CO 1	Explain thermodynamic systems, properties, Zeroth law of thermodynamics, temperature scales and energy interactions.	PO1	U
CO 2	Determine heat, work, internal energy, enthalpy for flow &non flow process using First and Second Law of Thermodynamics.	P01, PO2	Ap
CO3	Interpret behavior of pure substances and its applications to practical problems.	PO1,PO2	U
CO4	Determine change in internal energy, change in enthalpy and change in entropy using TD relations for ideal gases.	PO1,PO2	Ap
CO 5	Calculate Thermodynamics properties of real gases at all ranges of pressure, temperatures using modified equation of state including Vander Waals equation, Redlich Wong equation and Beattie-Bridgeman equation.	PO1,PO2	Ap
Total Number Lecture hours		**50**	

TEXT BOOKS:

1. Basic Engineering Thermodynamics, A.Venkatesh, Universities Press, 2008
2. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002

REFERENCE BOOKS:

1. Thermodynamics, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
2. Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, John Wiley and Sons..
3. Fundamentals of Classical Thermodynamics, G.J.VanWylen and R.E.Sonntag, Wiley Eastern.
4. An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993,
5. B.K Venkanna, Swati B. Wadavadagi “Basic Thermodynamics, PHI, New Delhi, 2010

Scheme of Examination: Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MECHANICS OF MATERIALS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanics of Materials	15ME34	04	3-2-0	80	20	3Hrs

COURSE OBJECTIVES:

1. Classify the stresses into various categories and define elastic properties of materials and compute stress and strain intensities caused by applied loads in simple and compound sections and temperature changes.
2. Derive the equations for principal stress and maximum in-plane shear stress and calculate their magnitude and direction. Draw Mohr circle for plane stress system and interpret this circle.
3. Determine the shear force, bending moment and draw shear force and bending moment diagrams, describe behavior of beams under lateral loads.
4. Explain the structural behavior of members subjected to torque, Calculate twist and stress induced in shafts subjected to bending and torsion.
5. Understand the concept of stability and derive crippling loads for columns.
6. Understand the concept of strain energy and compute strain energy for applied loads.

MODULE 1

Stress and Strain: Introduction, Hooke's law, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.

10 Hours

MODULE 2

Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions.

Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.

10 Hours

MODULE 3

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.

Stress in Beams: Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular,'I' and 'T' cross sections, Flexure Formula, Bending Stresses, Deflection of beams (Curvature).

10 Hours

MODULE 4

Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections

Columns: Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, Secant formula for columns.

10 Hours

MODULE 5

Strain Energy: Castigliano's theorem I and II, Load deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.

Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory. 10 Hours

COURSE OUTCOMES:

The student shall be able to

	Course Outcomes	POs	CL
CO1	Understand simple, compound, thermal stresses and strains their relations, Poisson's ratio, Hooke's law, mechanical properties including elastic constants and their relations	PO1	U
CO2	Determine stresses, strains and deformations in bars with varying circular and rectangular cross-sections subjected to normal and temperature loads	PO1,	Ap
CO3	Determine plane stress, principal stress, maximum shear stress and their orientations using analytical method and Mohr's circle	PO1,	Ap
CO4	Determine the dimensions of structural members including beams, bars and rods using Energy methods and also stress distribution in thick and thin cylinders	PO1,	Ap
CO5	Draw SFD and BMD for different beams including cantilever beams, simply supported beams and overhanging beams subjected to UDL, UVL, Point loads and couples	PO1,	Ap
CO6	Determine dimensions, bending stress, shear stress and its distribution in beams of circular, rectangular, symmetrical I and T sections subjected to point loads and UDL	PO1,	Ap
CO7	Determine slopes and deflections at various points on beams subjected to UDL, UVL, Point loads and couples	PO1,	Ap
CO8	Determine the dimensions of shafts based on torsional strength, rigidity and flexibility and also elastic stability of columns using Rankin's and Euler's theory	PO1,	Ap
	Total Hours of instruction	**50**	

TEXT BOOKS:

1. James M Gere, Barry J Goodno, Strength of Materials, Indian Edition, Cengage Learning, 2009.
2. R Subramanian, Strength of Materials, Oxford, 2005.

REFERENCE BOOKS:

1. S S Rattan, Strength of Materials, Second Edition, McGraw Hill, 2011.
2. Ferdinand Beer and Russell Johston, Mechanics of materials, Tata McGraw Hill, 2003.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

METAL CASTING AND WELDING

<table>
<tr><td rowspan="2">Course</td><td rowspan="2">Code</td><td rowspan="2">Credits</td><td rowspan="2">L-T-P</td><td colspan="2">Assessment</td><td rowspan="2">Exam Duration</td></tr>
<tr><td>SEE</td><td>CIA</td></tr>
<tr><td>Metal Casting and Welding</td><td>15ME35 A /45A</td><td>04</td><td>4-0-0</td><td>80</td><td>20</td><td>3Hrs</td></tr>
</table>

COURSE OBJECTIVE

- To provide detailed information about the moulding processes.
- To provide knowledge of various casting process in manufacturing.
- To impart knowledge of various joining process used in manufacturing.
- To provide adequate knowledge of quality test methods conducted on welded and casted components.

MODULE -1

INTRODUCTION & BASIC MATERIALS USED IN FOUNDRY

Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.

Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types

Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger. Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold.Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and risering (open, blind) Functions and types

10 Hours

MODULE -2

MELTING & METAL MOLD CASTING METHODS

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

Casting using metal molds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes

10 Hours

MODULE -3

SOLIDIFICATION & NON FERROUS FOUNDRY PRACTICE

Solidification: Definition, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods.

Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process

Nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.

10 Hours

MODULE -4

WELDING PROCESS

Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).

Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and electron beam welding.

10 Hours

MODULE -5

SOLDERING , BRAZING AND METALLURGICAL ASPECTS IN WELDING

Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy.

Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.

Inspection methods: Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection.

10 Hours

COURSE OUTCOMES

CO No.	Course Outcomes	Blooms level	PO
CO1	Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds.	U	PO1
CO2	Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.	U	PO1
CO3	Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.	U	PO1
CO4	Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.	U	PO1
CO5	Explain the Solidification process and Casting of Non-Ferrous Metals.	U	PO1
CO6	Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing.	U	PO1
CO7	Explain the Resistance spot, Seam, Butt , Projection, Friction, Explosive, Thermit, Laser and Electron Beam Special type of welding process used in manufacturing.	U	PO1
CO8	Describe the Metallurgical aspects in Welding and inspection methods for the quality assurance of components made of casting and joining process.	U	PO1
Total Hours of instruction		**50**	

TEXT BOOKS:

1. **"Manufacturing Process-I",** Dr.K.Radhakrishna, Sapna Book House,5th Revised Edition 2009.
2. **"Manufacturing & Technology**: Foundry Forming and Welding",P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

REFERENCE BOOKS:

1. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4th Ed.Pearson Edu. 2006.
2. **"Manufacturing Technology**", SeropeKalpakjian, Steuen. R. Sechmid,Pearson Education Asia, 5th Ed. 2006.
3. **"Principles of metal casting"**, Rechard W. Heine, Carl R. LoperJr.,Philip C. Rosenthal, Tata McGraw Hill Education Private Limited Ed.1976.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consisting of 16 marks.
- There will be **2** full questions (with a **maximum** of **4** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

MACHINE TOOLS AND OPERATIONS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Machine Tools and Operations	15ME35 B / 45B	04	4-0-0	80	20	3Hrs

COURSE OBJECTIVES:

- To introduce students to different machine tools in order to produce components having different shapes and sizes.
- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

COURSE OUTCOMES:

- Explain the construction & specification of various machine tools.
- Describe various machining processes pertaining to relative motions between tool & work piece.
- Discuss different cutting tool materials, tool nomenclature & surface finish.
- Apply mechanics of machining process to evaluate machining time.
- Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

MODULE 1
MACHINE TOOLS

Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planing machine, grinding machine [**Simple sketches showing major parts of the machines**]

10 hours

MODULE 2
MACHINING PROCESSES

Introduction, Types of motions in machining, turning and Boring, Shaping, Planing and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.

[Sketches pertaining to relative motions between tool and work piece only] 10 Hours

MODULE 3
CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.

Machining equations for cutting operations: Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, Numerical Problems

10 Hours

MODULE 4

MECHANICS OF MACHINING PROCESSES

Introduction, Chip formation, Orthogonal cutting, Merchants model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process, Numerical problems. 10 Hours

MODULE 5

TOOL WEAR, TOOL LIFE: Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems

ECONOMICS OF MACHNING PROCESSES: Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency, Numerical problems 10 Hours

COURSE OUTCOMES:

- Explain the construction & specification of various machine tools.
- Describe various machining processes pertaining to relative motions between tool & work piece.
- Discuss different cutting tool materials, tool nomenclature & surface finish.
- Apply mechanics of machining process to evaluate machining time.
- Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

TEXT BOOKS:

1. Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2nd Edition, 2003
2. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006

REFERENCE BOOKS:

1. Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor& Francis, Third Edition.
2. Metal cutting principles, Milton C. Shaw, Oxford University Press, Second Edition,2005.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

COMPUTER AIDED MACHINE DRAWING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Computer Aided Machine Drawing	15ME36 A / 46A	04	2-4-0	80	20	3Hrs

COURSE OBJECTIVES

- To acquire the knowledge of CAD software and its features.
- To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views
- To familiarize the students with Indian Standards on drawing practices.
- To impart knowledge of thread forms, fasteners, keys ,joints and couplings.
- To make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using CAD packages.
- To acquire the knowledge of limits fits and tolerance pertaining to machine drawings.

INTRODUCTION TO COMPUTER AIDED SKETCHING

Review of graphic interface of the software. Review of basic sketching commands and navigational commands.

02 Hours

PART A

UNIT I

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids), True shape of section. 04 Hours

Orthographic views: Conversion of pictorial views into orthographic projections of simple machine partswith or without section. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines.

04 Hours

UNIT II

Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External), square, Acme and Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

08Hours

PART B

UNIT III

Keys and Joints: Parallel, Taper, Feather Key, Gib head key and Woodruff key

Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).

Joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods. 08 Hours

UNIT IV

Couplings: Split muff coupling, Protected type flange coupling, Pin (bush) type flexible coupling, Oldham's coupling and Universal coupling (Hook's Joint).

06 Hours

PART C

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry.

03 Hours

Assembly Drawings: (Part drawings shall be given)

1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Lathe square tool post

15 Hours

COURSE OUTCOMES

Having successfully completed this course, the student will be able to draw and use modelling software's to generate

	Course Outcome	Cognitive Level	POs
CO1	Sections of pyramids, prisms, cubes, cones and cylinders resting on their bases in 2D	U	PO1, PO5,
CO2	Orthographic views of machine parts with and without sectioning in 2D.	U	PO1, PO5,
CO3	Sectional views for threads with terminologies of ISO Metric, BSW, square and acme, sellers and American standard threads in 2D.	U	PO1, PO5,
CO4	Hexagonal and square headed bolt and nut with washer, stud bolts with nut and lock nut, flanged nut, slotted nut, taper and split pin for locking counter sunk head screw, grub screw, Allen screw assemblies in 2D	U	PO1, PO5,
CO5	Parallel key, Taper key, and Woodruff Key as per the ISO standards in 2D	U	PO1, PO5,
CO6	single and double riveted lap joints, butt joints with single/double cover straps, cotter and knuckle joint for two rods in 2D	U	PO1, PO5,
CO7	Sketch split muff, protected type flanged, pin type flexible, Oldham's and universal couplings in 2D	U	PO1, PO5,
CO8	assemblies from the part drawings with limits ,fits and tolerance given for Plummer block, Ram bottom safety valve, I.C. Engine connecting rod, Screw Jack, Tailstock of lathe, Machine Vice and Lathe square tool post in 2D and 3D	U	PO1, PO5, PO12
Total Hours of instruction		**50**	

TEXT BOOKS:

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. 'Machine Drawing', N.D.Bhat&V.M.Panchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.

REFERENCE BOOK:

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Note:

Internal Assessment: 20 Marks

Sketches shall be in sketch books and drawing shall through use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.

Scheme of Evaluation for Internal Assessment (20 Marks)

(a) Class work (Sketching and Computer Aided Machine drawing printouts in A4/A3 size sheets): 10Marks.

(b) Internal Assessment test in the same pattern as that of the main examination(Better of the two Tests): 10 marks.

Scheme of Examination:

Two questions to be set from each Part A, part B and Part C.

Student has to answer one question each from Part A , Part B for 15 marks each and one question from Part C for 50 marks.

Part A 1 x 15	=	15 Marks
Part B 1 x 15	=	15 Marks
Part C 1 x 50	=	50 Marks
Total	=	80 Marks

INSTRUCTION FOR COMPUTER AIDED MACHINE DRAWING (15ME36A/46A) EXAMINATION

1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Part A and Part B 2D drafting environment should be used.
5. For Part C 3D part environment should be used for parts assembly drawing and extract 2D views.

MECHANICAL MEASUREMENTS AND METROLOGY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Measurements and Metrology	15ME36 B / 46B	03	3-0-0	80	20	3Hrs

COURSE OBJECTIVES

Students are expected to –

- Understand metrology, its advancements & measuring instruments,
- Acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements, Screw thread and gear measurement & comparators.
- Equip with knowledge of limits, fits, tolerances and gauging.
- Acquire knowledge of measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.
- Understand the measurement of Force, Torque, Pressure, Temperature and Strain.

MODULE -1

Introduction to Metrology: Definition, objectives and concept of metrology, Need of inspection, Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in measurement.

System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars(Numericals), standardization.

Linear Measurement and angular measurements:

Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112).

Measurement of angles- sine bar, sine center, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness. **10 Hours**

MODULE -2

System of Limits, Fits, Tolerance and Gauging:

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. Classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Comparators:

Functional requirements, classification, mechanical- Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, solex comparators and optical comparators- Zeiss ultra-optimeter.

10 Hours

MODULE -3

Measurement of screw thread and gear:

Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges,Tool maker's microscope.

Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.

Advances in metrology:

Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications. **10 Hours**

MODULE -4

Measurement systems and basic concepts of measurement methods:

Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.

Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

10 Hours

MODULE -5

Force, Torque and Pressure Measurement:

Direct methods and indirect method, force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments.Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

Measurement of strain and temperature:

Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors. Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer.

10 Hours

COURSE OUTCOMES

At the end of the course students will be able to –

	Description	CL	POs
CO1	Understand the objectives of metrology, methods of measurement, selection of measuring instruments, standards of measurement and calibration of end bars.	U	PO1, PO6
CO2	Describe slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine center, angle gauges, optical instruments and straightness measurement using Autocollimator.	U	PO1, PO6
CO3	Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.	U	PO1, PO6
CO4	Understand the principle of Johnson Mikrokator, sigma comparator, dial indicator, LVDT, back pressure gauges, Solex comparators and Zeiss Ultra Optimeter	U	PO1, PO6
CO5	Describe measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2 – wire, 3 – wire methods, screw thread gauges and tool maker's microscope.	U	PO1, PO6
CO6	Explain measurement of tooth thickness using constant chord method, addendum comparator methods and base tangent method, composite error using gear roll tester and measurement of pitch, concentricity, run out and involute profile.	U	PO1, PO6
CO7	Understand laser interferometers and Coordinate measuring machines.	U	PO1, PO6
CO8	Explain measurement systems, transducers, intermediate modifying devices and terminating devices.	U	PO1, PO6
CO9	Describe functioning of force, torque, pressure, strain and temperature measuring devices.	U	PO1, PO6

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, Delhi, 2009.

REFERENCE BOOKS:

1. **Engineering Metrology and Measurements,** Bentley, Pearson Education.
2. **Theory and Design for Mechanical Measurements,III edition,** Richard S Figliola, Donald E Beasley, WILEY India Publishers.
3. **Engineering Metrology,** Gupta I.C., Dhanpat Rai Publications.
4. **Deoblin's Measurement system**, Ernest Deoblin, Dhanesh manick, McGraw –Hill.
5. **Engineering Metrology and Measurements,**N.V.Raghavendra and L.Krishnamurthy, Oxford University Press.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MATERIALS TESTING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Materials Testing Lab	15MEL37 A / 47A	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES

Students are expected-

1. To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
2. To understand mechanical behavior of various engineering materials by conducting standard tests.
3. To learn material failure modes and the different loads causing failure.
4. To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

PART – A

1. Preparation of specimen for Metallographic examination of different engineering materials.
   To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.

2. Heat treatment: Annealing, normalizing, hardening and tempering of steel.
   Metallographic specimens of heat treated components to be supplied and students should report microstructures of furnace cooled,water cooled, air cooled, tempered steel.
   Students should be able to distinguish the phase changes in a heat treated specimen compared to untreated specimen.
3. Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens.
4. To study the defects of Cast and Welded components using
   Non-destructive tests like:
   a) Ultrasonic flaw detection
   b) Magnetic crack detection
   c) Dye penetration testing.

PART – B

5. Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine
6. Torsion Test on steel bar.
7. Bending Test on steel and wood specimens.
8. Izod and Charpy Tests on Mild steel and C.I Specimen.
9. To study the wear characteristics of ferrous and non-ferrous materials under different parameters.
10. Fatigue Test (demonstration only).

COURSE OUTCOMES

At the end of the course, the students will be able to:

1. Acquire experimentation skills in the field of material testing.
2. 2.Develop theoretical understanding of the mechanical properties of materials by performing experiments.
3. Apply the knowledge to analyze a material failure and determine the failure inducing agent/s.
4. Apply the knowledge of testing methods in related areas.
5. Know how to improve structure/behavior of materials for various industrial applications.

Students should make observations on nature of failure and manifestations of failure in each of the experiments apart from reporting values of mechanical properties determined after conducting the tests.

Scheme of Examination:

ONE question from part -A:	**25 Marks**
ONE question from part -B:	**40 Marks**
Viva -Voice:	**15 Marks**
Total :	**80 Marks**

MECHANICAL MEASUREMENTS AND METROLOGY LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Measurements and Metrology Lab	15MEL37 B / 47B	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES:

1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
2. To illustrate the use of various measuring tools measuring techniques.
3. To understand calibration techniques of various measuring devices.

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
   a) Lathe tool Dynamometer OR
   b) Drill tool Dynamometer.
5. Measurements of Screw thread Parameters using two wire or Three-wire methods.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

COURSE OUTCOMES

At the end of the course, the students will be able to

	Description	CL	POs
CO1	To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.	U	PO1, PO6
CO2	To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.	U	PO1, PO6
CO3	To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.	U	PO1, PO6
CO4	To measure cutting tool forces using Lathe/Drill tool dynamometer.	U	PO1, PO6
CO5	To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.	U	PO1, PO6
CO6	To measure surface roughness using Tally Surf/ Mechanical Comparator.	U	PO1, PO6

Scheme of Examination:

ONE question from part -A:	**25 Marks**
ONE question from part -B:	**40 Marks**
Viva -Voice:	**15 Marks**
Total :	**80 Marks**

FOUNDRY AND FORGING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Foundry and Forging Lab	15MEL38A / 48A	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES:

- To provide an insight into different sand preparation and foundry equipment's.
- To provide an insight into different forging tools and equipment's.
- To provide training to students to enhance their practical skills.
- To practically demonstrate precautions to be taken during casting and hot working.
- To develop team qualities and ethical principles.

PART A

1. **Testing of Molding sand and Core sand**

   Preparation of sand specimens and conduction of the following tests:
   1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
   2. Permeability test
   3. Sieve Analysis to find Grain Fineness Number(GFN) of Base Sand
   4. Clay content determination in Base Sand.

PART B

2. **Foundry Practice**
   1. Use of foundry tools and other equipment's.
   2. Preparation of molding sand mixture.
   3. Preparation of green sand molds using two molding boxes kept ready for pouring.
      - Using patterns (Single piece pattern and Split pattern)
      - Without patterns.
      - Incorporating core in the mold. (Core boxes).
      - Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART C

3. **Forging Operations :**

   Use of forging tools and other equipment's
   - Calculation of length of the raw material required to prepare the model considering scale loss.
   - Preparing minimum three forged models involving upsetting, drawing and bending operations.
   - Demonstration of forging model using Power Hammer.

COURSE OUTCOMES

Students will be able to

- Demonstrate various skills of sand preparation, molding.
- Demonstrate various skills of forging operations.
- Work as a team keeping up ethical principles.

Question paper pattern:

One question is to be set from Part-A	15 Marks
One question is to be set from either Part-B or Part-C	35 Marks

Calculation of length of the raw material required for forging model is compulsory irrespective of the student preparing part-B or part-C model

Calculation of length for Forging	10 Marks
Viva – Voce	20 Marks
Total	20 Marks

MACHINE SHOP

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Machine Shop	15MEL38B / 48B	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES

- To provide an insight to different machine tools, accessories and attachments
- To train students into machining operations to enrich their practical skills
- To inculcate team qualities and expose students to shop floor activities
- To educate students about ethical , environmental and safety standards

PART – A

Preparation of three models on lathe involving
Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper
Cutting of Gear Teeth using Milling Machine

PART –C

For demonstration

Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling

COURSE OUTCOMES

At the end of the course, the students will be able to

COs	Description	CL	POs
CO1	Perform turning , facing , knurling , thread cutting, tapering , eccentric turning and allied operations	A	PO1, PO6, PO9
CO2	Perform keyways / slots , grooves etc using shaper	A	PO1, PO6, PO9
CO3	Perform gear tooth cutting using milling machine	A	PO1, PO6, PO9
CO4	Understand the formation of cutting tool parameters of single point cutting tool using bench grinder / tool and cutter grinder	U	PO1, PO6
CO5	Understand Surface Milling/Slot Milling	U	PO1, PO6
CO6	Demonstrate precautions and safety norms followed in Machine Shop	U	PO8
CO7	Exhibit interpersonal skills towards working in a team	U	PO9

One Model from Part – A	40 Marks
One Model from Part – B	20 Marks
Viva – Voce	20 Marks
Total	80 Marks

B.E. Mechanical Engineering

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT41	Engineering Mathematics – III	04			03	80	20	100	04
2	15ME42	Kinematics of Machinery	03	02		03	80	20	100	04
3	15ME43	Applied Thermodynamics	03	02		03	80	20	100	04
4	15ME44	Fluid mechanics	03	02		03	80	20	100	04
5	15ME45A/ 15ME45B	Metal Casting and Welding / Machine Tools and Operations	04			03	80	20	100	04
6	15ME46 A/ 15ME46B	Computer Aided Machine Drawing	02		4	03	80	20	100	03
		Mechanical Measurements and Metrology	04							
7	15MEL47A / 15MEL47B	Materials Testing Lab/ Mechanical Measurements and Metrology Lab	1		2	03	80	20	100	02
8	15MEL48A / 15MEL48B	Foundry and Forging Lab / Machine Shop/	1		2	03	80	20	100	02
TOTAL			**19/21**	**06**	**08/04**		**640**	**160**	**800**	**27**

KINEMATICS OF MACHINES

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Kinematics of Machines	15ME42	04	3-2-0	80	20	3Hrs

Course objectives

Students will

1. Familiarize with mechanisms and motion analysis of mechanisms.
2. Understand methods of mechanism motion analysis and their characteristics.
3. Analyse motion of planar mechanisms, gears, gear trains and cams.

MODULE - 1

Introduction: Definitions: Link, kinematic pairs,kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classifiction of pairs based on type of relative motion,Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's chain.

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms:Geneva wheel mechanism, Ratchet and Pawl mechanism,toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.

10 Hours

MODULE -2

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.

10 Hours

MODULE – 3

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

Freudenstein's equation for four bar mechanism and slider crank mechanism.

Function Generation for four bar mechanism.

10 Hours

Module – 4

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, back lash,condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact

Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains:aAlgebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

10 Hours

Cams: Types of cams, types of followers. displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration Retradation, Cycloidal motion. Cam profiles: disc cam with reciprocating / oscillating follower having knife-edge, roller and flat-face follower inline and offset.

Analysis of Cams: Analysis of arc cam with flat faced follower.

10 Hours

Graphical Solutions may be obtained either on the Graph Sheets or in the Answer Book itself.

Course outcomes

Students will be able to

1. Identify mechanisms with basic understanding of motion.
2. Comprehend motion analysis of planar mechanisms, gears, gear trains and cams.
3. Carry out motion analysis of planar mechanisms, gears, gear trains and cams.

TEXT BOOKS:

1. Rattan S.S, Theory of Machines,Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
2. Ambekar A. G., Mechanism and Machine Theory, PHI, 2009.

REFERENCE BOOKS:

1. Michael M Stanisic, Mechanisms and Machines-Kinematics, Dynamics and Synthesis, Cengage Learning, 2016.
2. Sadhu Singh, **Theory of Machines,** Pearson Education (Singapore)Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.

APPLIED THERMODYNAMICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Applied Thermodynamics	15ME43	04	3-2-0	80	20	3Hrs

Courselearning objectives:

- To have a working knowledge of basic performance of Gas power cycles.
- To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy
- To understand and evaluate the performance of steam power cycles their various Engineering applications
- To know how fuel burns and their thermodymic properties.
- To Understand mechanism of power transfer through belt, rope, chain and gear drives in I C Engines
- To determine performance parameters of refrigeration and air-conditioning systems.
- Evaluate the performance parameters of reciprocating air compressor as a function of receiver pressure.

Module - I

Gas Power Cycles : Air standard cycles; Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles. Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles.

Jet propulsion: Introduction to the principles of jet propulsion, turbojet, turboprop, Ramjet and turbofan engines and their processes . Principles of rocket propulsion, Introduction to rocket engine.10 Hours

Module –II

Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-s diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in Vapour power cycles, Binary Vapour cycles
10 Hours

Module –III

Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions.

I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, IC Engine fuels, Ratings and Alternate Fuels. Automotive Pollutions and its effects on environment.

10 Hours

Module –IV

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Steam jet refrigeration.

Pscychrometrics and Air-conditioning Systems: Properties ofAtmospheric air, and Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of twomoist air streams. Cooling towers.

10 Hours

Module –V

Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.

Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow.

10 Hours

Course outcomes

Students will be able to

- Apply thermodynamic concepts to analyze the performance of gas power cycles including propulsion systems.
- Evaluate the performance of steam turbine components.
- Understand combustion of fuels and combustion processes in I C engines including alternate fuels and pollution effect on environment.
- Apply thermodynamic concepts to analyze turbo machines.
- Determine performance parameters of refrigeration and air-conditioning systems.
- Understand the principles and applications of refrigeration systems.
- Analyze air-conditioning processes using the principles of psychrometry and Evaluate cooling and heating loads in an air-conditioning system.
- Understand the working, applications, relevance of air and identify methods for performance improvement.

Text Books:

1. Thermodynamics an engineering approach, by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub. Sixth edition, 2008.

2. Basic and Applied Thermodynamics" by P .K. Nag, Tata McGraw Hill, 2nd Edi. 2009
3. Fundamentals of Thermodynamics by G.J. Van Wylen and R.E. Sonntag, Wiley Eastern. Fourth edition 19993.

Reference Books:

1. Thermodynamics for engineers, Kenneth A. Kroos and Merle C. Potter, Cengage Learning, 2016
2. Principles of Engineering Thermodynamics, Michael J,Moran, Howard N. Shapiro, Wiley, 8th Edition
3. An Introduction to Thermo Dynamics by Y.V.C.Rao, Wiley Eastern Ltd, 2003.
4. Thermodynamics by Radhakrishnan. PHI, 2nd revised edition.
5. I.C Engines by Ganeshan.V. Tata McGraw Hill, 4rth Edi. 2012.
6. I.C.Engines by M.L.Mathur & Sharma. Dhanpat Rai& sons- India

E- Learning

- Nptel.ac.in
- VTU, E- learning
- MOOCS
- Open courseware

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

FLUID MECHANICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Fluid Mechanics	15ME44	04	3-2-0	80	20	3Hrs

Course objectives:

- To have a working knowledge of the basic properties of fluids and understand the continuum approximation
- To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy
- To understand the flow characteristic and dynamics of flow field for various Engineering applications
- To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modeling
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows

MODULE -1

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc,pressure at a point in the static mass of fluid, variation of pressure, Pascal's law,Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges.

Fluid Statics: Totalpressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid.Buoyancy, center of buoyancy, meta center and meta centric heightits application in shipping, stability of floating bodies.

10Hrs

MODULE -2

Fluid Kinematics and Dynamics:

Fluid Kinematics: Types of Flow-steady , unsteady, uniform, non-uniform, laminar, turbulent, one,two and three dimensional, compressible, incompressible, rotational, irrotational, stram lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

Fluid Dynamics:

Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numericals.Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals.

12 Hrs

MODULE -3

Laminar and turbulent flow: Reynods Number, Entrance flow and Developed flow, Navier-Stokes Equation (no derivation), Laminar flow between parallel plates, Poiseuille equation – velocity profile, Couette flow, Fully developed laminar flow in circular pipes, Hagen - Poiseuille equation, related numericals.

Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, Darcy Weishach formula, major and minor losses in pipes, Commercial pipe, Colebrook equation, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe, Related Numericals and simple pipe design problems.

10 Hrs

MODULE -4

Flow over bodies: Development of boundary layer**,** Prandtl's boundary layer equations, Blasius solution, laminar layer over a flat plate, boundary layer separation and its control.

Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift,streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil, Numericals.

Dimensional analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Similitude and Model studies. Numericals.

10 Hrs

MODULE -5

Compressible Flows: Introduction, thermodynamicrelations of perfect gases, internal energy andenthalpy, speed of sound, pressure field due to a moving source, basic Equations for one-dimensional flow, stagnation and sonic Properties, normal and oblique shocks.

Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications.

08 Hrs

Course outcomes:

Students will be able to

- CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior.
- CO2: Understand and apply the principles of pressure, buoyancy and floatation
- CO3:Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical and chemical engineering.
- CO4:Understand and apply the principles of fluid kinematics and dynamics.
- CO5:Understand the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.
- CO6: Understand the basic concept of compressible flow and CFD

Text Books:

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Cimbala, 3rd Ed., Tata McGraw Hill, 2014.
2. Fluid Mechanics, F M White, McGraw Hill Publications Eighth edition. 2016
3. Mechanics of Fluids, Merle C. Potter, Devid C. Wiggerrt, Bassem H. Ramadan, Cengage learning, Fourth editions 2016.

Reference Books:

1. Fundamentals of Fluid Mechanics by Munson, Young, Okiishi& Huebsch, John Wiley Publications.7th edition.
2. Fluid Mechanics, Pijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
3. Fluid Mechanics, John F.Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006.
4. Introduction to Fluid Mechanics by Fox, McDonald, John Wiley Publications,8th edition.

E- Learning

- Nptel.ac.in
- VTU, E- learning
- MOOCS
- Open courseware

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

METAL CASTING AND WELDING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Metal Casting And Welding	15ME35A / 45A	04	4-0-0	80	20	3Hrs

COURSE OBJECTIVE

- To provide detailed information about the moulding processes.
- To provide knowledge of various casting process in manufacturing.
- To impart knowledge of various joining process used in manufacturing.
- To provide adequate knowledge of quality test methods conducted on welded and casted components.

MODULE -1

INTRODUCTION & BASIC MATERIALS USED IN FOUNDRY

Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.

Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types

Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger. Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold.Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and risering (open, blind) Functions and types

10 Hours

MODULE -2

MELTING & METAL MOLD CASTING METHODS

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

Casting using metal molds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes

10 Hours

MODULE -3

SOLIDIFICATION & NON FERROUS FOUNDRY PRACTICE

Solidification: Definition, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods.

Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process

Nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.

10 Hours

MODULE -4

WELDING PROCESS

Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).

Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and electron beam welding.

10 Hours

MODULE -5

SOLDERING , BRAZING AND METALLURGICAL ASPECTS IN WELDING

Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy.

Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.

Inspection methods: Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection.

10 Hours

COURSE OUTCOMES

CO No.	Course Outcomes	Blooms level	PO
CO1	Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds.	U	PO1
CO2	Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.	U	PO1
CO3	Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.	U	PO1
CO4	Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.	U	PO1
CO5	Explain the Solidification process and Casting of Non-Ferrous Metals.	U	PO1
CO6	Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing.	U	PO1
CO7	Explain the Resistance spot, Seam, Butt , Projection, Friction, Explosive, Thermit, Laser and Electron Beam Special type of welding process used in manufacturing.	U	PO1
CO8	Describe the Metallurgical aspects in Welding and inspection methods for the quality assurance of components made of casting and joining process.	U	PO1

TEXT BOOKS:

1. **“Manufacturing Process-I”,** Dr.K.Radhakrishna, Sapna Book House,5th Revised Edition 2009.
2. **“Manufacturing & Technology**: Foundry Forming and Welding”,P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
3. **“ Introduction to Manufacturing Process**” – John A.Schey , 3rd Edition ,McGraw Hills Education.

REFERENCE BOOKS:

1. **“Machining And Machine Tools”** – A.B.Chattopadhyay, FNA (E) Wiley.
2. **“Process and Materials of Manufacturing**”, Roy A Lindberg, 4th Ed.Pearson Edu. 2006.
3. **“Manufacturing Technology,** Vol 1, P N Rao, McGraw Hill Education, 4th Edition
4. **“Principles of metal casting”**, Rechard W. Heine, Carl R. LoperJr.,Philip C. Rosenthal, Tata McGraw Hill Education Private Limited

Ed.1976.

MACHINE TOOLS AND OPERATIONS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Machine Tools and Operations	15ME35B / 45B	04	4-0-0	80	20	3Hrs

COURSE OBJECTIVES:

- To introduce students to different machine tools in order to produce components having different shapes and sizes.
- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

MODULE 1
MACHINE TOOLS
Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planing machine, grinding machine [**Simple sketches showing major parts of the machines**]
10 hours

MODULE 2
MACHINING PROCESSES
Introduction, Types of motions in machining, turning and Boring, Shaping, Planing and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.
[Sketches pertaining to relative motions between tool and work piece only] 10 Hours

MODULE 3
CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH
Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.
Machining equations for cutting operations: Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, Numerical Problems 10
Hours

MODULE 4
MECHANICS OF MACHINING PROCESSES
Introduction, Chip formation, Orthogonal cutting, Merchants model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process, Numerical problems. 10 Hours

MODULE 5
TOOL WEAR, TOOL LIFE: Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems
ECONOMICS OF MACHNING PROCESSES: Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency, Numerical problems 10 Hours

COURSE OUTCOMES:

- Explain the construction & specification of various machine tools.
- Describe various machining processes pertaining to relative motions between tool & work piece.
- Discuss different cutting tool materials, tool nomenclature & surface finish.
- Apply mechanics of machining process to evaluate machining time.

Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

TEXT BOOKS:

1. Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2nd Edition, 2003
2. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006

REFERENCE BOOKS:

1. Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor & Francis, Third Edition.
2. **"Manufacturing Technology,** Vol 2, P N Rao, McGraw Hill Education, 3rd Edition
3. Metal cutting principles, Milton C. Shaw, Oxford University Press, Second Edition,2005.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

COMPUTER AIDED MACHINE DRAWING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Computer Aided Machine Drawing	15ME36A / 46A	03	2-0-4	80	20	3Hrs

Course Objectives:

1. To improve the visualisation skills and understand the conventions used in engineering drawing.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.
3. To impart fundamental knowledge of drawing of different machine parts.
4. To enable the students with concepts of dimensioning and standards related to drawings.
5. To enable the students draw the assembly of various machine components.
6. Recognize to use engineering tools, software for drawing and engage in life long learning.

Introduction to Computer Aided Sketching
Review of graphic interface of the software. Review of basic sketching commands and navigational commands.

02 Hours

PART A

Unit I
Sections of Solids : Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids), True shape of section.

04 Hours

Orthographic views : Conversion of pictorial views into orthographic projections of simple machine partswith or without section. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines.

04 Hours

Unit II
Thread forms : Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External), square, Acme and Sellers thread, American Standard thread.
Fasteners : Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assemly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

08Hours

PART B

Unit III
Keys and Joints: Parallel, Taper, Feather Key, Gibhead key and Woodruff key
Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).
Joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods.

08 Hours

Unit |IV

Couplings : Split muff coupling, Protected type flange coupling, Pin (bush) type flexible coupling, Oldham's coupling and Universal coupling (Hook's Joint).

06 Hours

PART C

Limits, Fits and Tolerances : Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry.

03 Hours

Assembly Drawings: (Part drawings shall be given)
1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Lathe square tool post

17 Hours

Course Outcomes: Students will be able to

1. Improve their visualization skills.
2. Understand the theory of projection.
3. Make component drawings.
4. Produce the assembly drawings using part drawings.
5. Engage in life long learning using sketching and drawing as communication tool.

Text Books :

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.

Reference Book :

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Note :

Internal Assessment: 20 Marks
Sketches shall be in sketch books and drawing shall through use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.
Scheme of Evaluation for Internal Assessment (20 Marks)
(a) Class work (Sketching and Computer Aided Machine drawing printouts in A4/A3 size sheets): 10Marks.
(b) Internal Assessment test in the same pattern as that of the main examination(Better of the two Tests): 10 marks.

Scheme of Examination:

Two questions to be set from each PartA, partB and PartC.
Student has to answer one question each from PartA , PartB for 15 marks each and one question from Part C for 50 marks.

Part A1X15	=	15 Marks
Part B 1X15	=	15 Marks
Part C 1X50	=	50 Marks
Total	=	80 Marks

INSTRUCTION
FOR
COMPUTER AIDED MACHINE DRAWING (15ME36A/46A) EXAMINATION

1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Part A and Part B 2D drafting environment should be used.
5. For Part C 3D part environment should be used for parts assembly drawing and extract 2D views.

MECHANICAL MEASUREMENTS AND METROLOGY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Measurements and Metrology	15ME36B / 46B	03	3-0-0	80	20	3Hrs

COURSE OBJECTIVES

Students are expected to –

- Understand metrology, its advancements & measuring instruments,
- Acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements, Screw thread and gear measurement & comparators.
- Equip with knowledge of limits, fits, tolerances and gauging.
- Acquire knowledge of measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.
- Understand the measurement of Force, Torque, Pressure, Temperature and Strain.

MODULE -1

Introduction to Metrology: Definition, objectives and concept of metrology, Need of inspection, Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in measurement.

System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars(Numericals), standardization.

Linear Measurement and angular measurements:

Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112).

Measurement of angles- sine bar, sine center, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness. **10 Hours**

MODULE -2

System of Limits, Fits, Tolerance and Gauging:

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances.

Classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Comparators:

Functional requirements, classification, mechanical- Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, solex comparators and optical comparators- Zeiss ultra-optimeter.

10 Hours

MODULE -3

Measurement of screw thread and gear:

Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges,Tool maker's microscope.

Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.

Advances in metrology:

Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines- constructional features, applications.

10 Hours

MODULE -4

Measurement systems and basic concepts of measurement methods:

Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.

Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

10 Hours

MODULE -5

Force, Torque and Pressure Measurement:

Direct methods and indirect method, force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments.Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

Measurement of strain and temperature:

Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors.

Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer.

10 Hours

COURSE OUTCOMES

At the end of the course students will be able to –

	Description	CL	POs
CO1	Understand the objectives of metrology, methods of measurement, selection of measuring instruments, standards of measurement and calibration of end bars.	U	PO1, PO6
CO2	Describe slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine center, angle gauges, optical instruments and straightness measurement using Autocollimator.	U	PO1, PO6
CO3	Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.	U	PO1, PO6
CO4	Understand the principle of Johnson Mikrokator, sigma comparator, dial indicator, LVDT, back pressure gauges, Solex comparators and Zeiss Ultra Optimeter	U	PO1, PO6
CO5	Describe measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2 – wire, 3 – wire methods, screw thread gauges and tool maker's microscope.	U	PO1, PO6
CO6	Explain measurement of tooth thickness using constant chord method, addendum comparator methods and base tangent method, composite error using gear roll tester and measurement of pitch, concentricity, run out and involute profile.	U	PO1, PO6
CO7	Understand laser interferometers and Coordinate measuring machines.	U	PO1, PO6
CO8	Explain measurement systems, transducers, intermediate modifying devices and terminating devices.	U	PO1, PO6
CO9	Describe functioning of force, torque, pressure, strain and temperature measuring devices.	U	PO1, PO6

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. **Instrumentation, Measurement and Analysis,** B C Nakra, K K Chaudhry, 4th Edition**,** McGraw –Hill
3. **Engineering Metrology,** R.K. Jain, Khanna Publishers, Delhi, 2009.

REFERENCE BOOKS:

1. **Engineering Metrology and Measurements,** Bentley, Pearson Education.
2. **Theory and Design for Mechanical Measurements,III edition,** Richard S Figliola, Donald E Beasley, WILEY India Publishers.
3. **Engineering Metrology,** Gupta I.C., Dhanpat Rai Publications.
4. **Deoblin's Measurement system**, Ernest Deoblin, Dhanesh manick, McGraw –Hill.
5. **Engineering Metrology and Measurements,** N.V.Raghavendra and L.Krishnamurthy, Oxford University Press.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MATERIALS TESTING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Material Testing Lab	15MEL47A / 47B	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES

Students are expected-

1. To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
2. To understand mechanical behavior of various engineering materials by conducting standard tests.
3. To learn material failure modes and the different loads causing failure.
4. To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

PART – A

1. Preparation of specimen for Metallographic examination of different engineering materials.
   To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.

2. Heat treatment: Annealing, normalizing, hardening and tempering of steel.
   Metallographic specimens of heat treated components to be supplied and students should report microstructures of furnace cooled,water cooled, air cooled, tempered steel.
   Students should be able to distinguish the phase changes in a heat treated specimen compared to untreated specimen.
3. Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens.
4. To study the defects of Cast and Welded components using
   Non-destructive tests like:
   a) Ultrasonic flaw detection
   b) Magnetic crack detection
   c) Dye penetration testing.

PART – B

5. Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine
6. Torsion Test on steel bar.
7. Bending Test on steel and wood specimens.
8. Izod and Charpy Tests on Mild steel and C.I Specimen.
9. To study the wear characteristics of ferrous and non-ferrous materials under different parameters.
10. Fatigue Test (demonstration only).

COURSE OUTCOMES
At the end of the course, the students will be able to:

1. Acquire experimentation skills in the field of material testing.
2. 2.Develop theoretical understanding of the mechanical properties of materials by performing experiments.
3. Apply the knowledge to analyze a material failure and determine the failure inducing agent/s.
4. Apply the knowledge of testing methods in related areas.
5. Know how to improve structure/behavior of materials for various industrial applications.

Students should make observations on nature of failure and manifestations of failure in each of the experiments apart from reporting values of mechanical properties determined after conducting the tests.

Scheme of Examination:

ONE question from part -A:	**25 Marks**
ONE question from part -B:	**40 Marks**
Viva -Voice:	**15 Marks**
Total :	**80 Marks**

MECHANICAL MEASUREMENTS AND METROLOGY LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Measurements and Metrology Lab	15MEL37B / 47B	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES:

1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
2. To illustrate the use of various measuring tools measuring techniques.
3. To understand calibration techniques of various measuring devices.

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
   a) Lathe tool Dynamometer OR
   b) Drill tool Dynamometer.
5. Measurements of Screw thread Parameters using two wire or Three-wire methods.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

COURSE OUTCOMES

At the end of the course, the students will be able to

	Description	CL	POs
CO1	To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.	U	PO1, PO6
CO2	To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.	U	PO1, PO6
CO3	To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.	U	PO1, PO6
CO4	To measure cutting tool forces using Lathe/Drill tool dynamometer.	U	PO1, PO6
CO5	To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.	U	PO1, PO6
CO6	To measure surface roughness using Tally Surf/ Mechanical Comparator.	U	PO1, PO6

Scheme of Examination:

ONE question from part -A:	**25 Marks**
ONE question from part -B:	**40 Marks**
Viva -Voice:	**15 Marks**
Total :	**80 Marks**

FOUNDRY AND FORGING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Foundry And Forging Lab	15MEL38A / 48A	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES:

- To provide an insight into different sand preparation and foundry equipment's.
- To provide an insight into different forging tools and equipment's.
- To provide training to students to enhance their practical skills.
- To practically demonstrate precautions to be taken during casting and hot working.
- To develop team qualities and ethical principles.

PART A

1. **Testing of Molding sand and Core sand**
   Preparation of sand specimens and conduction of the following tests:
   1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
   2. Permeability test
   3. Sieve Analysis to find Grain Fineness Number(GFN) of Base Sand
   4. Clay content determination in Base Sand.

PART B

2. **Foundry Practice**
   1. Use of foundry tools and other equipment's.
   2. Preparation of molding sand mixture.
   3. Preparation of green sand molds using two molding boxes kept ready for pouring.
      - Using patterns (Single piece pattern and Split pattern)
      - Without patterns.
      - Incorporating core in the mold. (Core boxes).
      - Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART C

3. **Forging Operations :**
   Use of forging tools and other equipment's
      - Calculation of length of the raw material required to prepare the model considering scale loss.
      - Preparing minimum three forged models involving upsetting, drawing and bending operations.
      - Demonstration of forging model using Power Hammer.

COURSE OUTCOMES

Students will be able to

- Demonstrate various skills of sand preparation, molding.
- Demonstrate various skills of forging operations.
- Work as a team keeping up ethical principles.

Question paper pattern:

One question is to be set from Part-A	15 Marks
One question is to be set from either Part-B or Part-C	35 Marks

Calculation of length of the raw material required for forging model is compulsory irrespective of the student preparing part-B or part-C model

Calculation of length for Forging	10 Marks
Viva – Voce	20 Marks
Total	20 Marks

MACHINE SHOP

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Machine Shop	15MEL38b / 48B	02	1-0-2	80	20	3Hrs

COURSE OBJECTIVES

- To provide an insight to different machine tools, accessories and attachments
- To train students into machining operations to enrich their practical skills
- To inculcate team qualities and expose students to shop floor activities
- To educate students about ethical , environmental and safety standards

PART – A

Preparation of three models on lathe involving

Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper

Cutting of Gear Teeth using Milling Machine

PART –C

For demonstration

Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling

COURSE OUTCOMES

At the end of the course, the students will be able to

COs	Description	CL	POs
CO1	Perform turning , facing , knurling , thread cutting, tapering , eccentric turning and allied operations	A	PO1, PO6, PO9
CO2	Perform keyways / slots , grooves etc using shaper	A	PO1, PO6, PO9
CO3	Perform gear tooth cutting using milling machine	A	PO1, PO6, PO9
CO4	Understand the formation of cutting tool parameters of single point cutting tool using bench grinder / tool and cutter grinder	U	PO1, PO6
CO5	Understand Surface Milling/Slot Milling	U	PO1, PO6
CO6	Demonstrate precautions and safety norms followed in Machine Shop	U	PO8
CO7	Exhibit interpersonal skills towards working in a team	U	PO9

One Model from Part – A	40 Marks
One Model from Part – B	20 Marks
Viva – Voce	20 Marks
Total	80 Marks

B.E. Mechanical Engineering

V SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME51	Management and Engineering Economics	3	2	0	03	80	20	100	4
2	15ME52	Dynamics of Machinery	3	2	0	03	80	20	100	4
3	15ME53	Turbo Machines	3	2	0	03	80	20	100	4
4	15ME54	Design of Machine Elements - I	3	2	0	03	80	20	100	4
5	15ME55X	Professional Elective-I	3	0	0	03	80	20	100	3
6	15ME56X	Open Elective-I	3	0	0	03	80	20	100	3
7	15MEL57	Fluid Mechanics & Machinery Lab	1	0	2	03	80	20	100	2
8	15MEL58	Energy Lab	1	0	2	03	80	20	100	2
TOTAL			**21**	**06**	**04**		**640**	**160**	**800**	**26**

Professional Elective-I		Open Elective-I	
15ME551	Refrigeration and Air-conditioning	15ME561	Optimization Techniques
15ME552	Theory of Elasticity	15ME562	Energy and Environment
15ME553	Human Resource Management	15ME563	Automation and Robotics
15ME554	Non Traditional Machining	15ME564	Project Managemet

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch

3. OpenElective: Electives from other technical and/or emerging subject areas.

MANAGEMENT AND ENGINEERING ECONOMICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Management And Engineering Economics	15ME51	04	3-2-0	80	20	3Hrs

MODULE – 1

Management: Introduction - Meaning - nature and characteristics ofManagement, Scope and Functional areas of management - Management as ascience, art of profession - Management & Administration - Roles ofManagement, Levels of Management, Development of Management Thought- early management approaches – Modern management approaches.

Planning: Nature, importance and purpose of planning process Objectives -Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans. **10 Hours**

MODULE - 2

Organizing And Staffing: Nature and purpose of organization Principles oforganization - Types of organization - Departmentation Committees-Centralization Vs Decentralization of authority and responsibility - Span ofcontrol - MBO and MBE (Meaning Only) Nature and importance of staffing--:Process of Selection & Recruitment (in brief).

Directing & Controlling: Meaning and nature of directing Leadershipstyles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief) **10 Hours**

MODULE -3

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity.

Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems **10 Hours**

MODULE -4

Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons.

Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems **10 Hours**

MODULE -5

Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time.

Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems. **10 Hours**

Course outcomes

On completion of this subject students will be able to

1. Understand needs, functions, roles, scope and evolution of Management
2. Understand importance, purpose of Planning and hierarchy of planning and also analyze its types
3. Discuss Decision making, Organizing, Staffing, Directing and Controlling
4. Select the best economic model from various available alternatives
5. Understand various interest rate methods and implement the suitable one.
6. Estimate various depreciation values of commodities
7. Prepare the project reports effectively.

TEXT BOOKS

1. Principles of Management by Tripathy and Reddy
2. Mechanical estimation and costing, T.R. Banga& S.C. Sharma, 17th edition 2015
3. Engineering Economy, Riggs J.L. McGraw Hill, 2002
4. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS

1. Management Fundamentals- Concepts, Application, Skill Development - RobersLusier - Thomson
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Engineering Economics, R.Paneerselvam, PHI publication
4. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
5. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
6. Modern Economic Theory, By Dr. K. K. Dewett& M. H. Navalur, S. Chand Publications

DYNAMICS OF MACHINERY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Dynamics of Machinery	15ME52	04	3-2-0	80	20	3Hrs

Course Objectives

1. To gain the knowledge static and dynamic equilibrium conditions of mechanisms subjected forces and couple, with and without friction.
2. Analyse the mechanisms for static and dynamic equilibrium.
3. To understand the balancing principles of rotating and reciprocating masses, governors and gyroscopes.
4. Analyse the balancing of rotating and reciprocating masses, governors and gyroscopes.
5. To understand vibrations characteristics of single degree of freedom systems.
6. Characterise the single degree freedom systems subjected to free and forced vibrations with and without damping.

MODULE 1

Static force Analysis: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism with and without friction.

Dynamic force Analysis:D'Alembert's principle, Inertia force, Inertia torque. Dynamic force analysis of four-bar mechanism and Slider crank mechanism without friction, numerical problems. **10 Hours**

MODULE 2

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces), numerical problems. **10 Hours**

MODULE 3

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronism, Effort and Power.

Gyroscope:Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on plane disc, aeroplane, ship, stability of two wheelers and four wheelers, numerical problems. **10 Hours**

MODULE - 4

Introduction & Undamped free Vibrations (Single Degree of Freedom)

Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM. Methods of analysis – (Newton's, Energy & Rayleigh's methods). Derivations for spring mass systems, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems. **10 Hours**

MODULE – 5

Damped free Vibrations (Single Degree of Freedom)

Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and numerical problems.

Forced Vibrations (Single Degree of Freedom):

Analysis of forced vibration with constant harmonic excitation, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Excitation of support (absolute and relative), Numerical problems. **10 Hours**

Course outcomes

On completing the course the student will be able to

1. Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.
2. Determine magnitude and angular position of balancing masses under static and dynamic condition of rotating masses in same and different planes.
3. Determine unbalanced primary, secondary forces and couples in single and multi-cylinder engine.
4. Determine sensitiveness, isochronism, effort and power of porter and hartnell governors.
5. Determine gyroscopic couple and effects related to 2, 4 wheeler, plane disc, ship and aeroplanes.
6. Understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems.
7. Determine equation of motion, natural frequency, damping factor, logarithmic decrement of damped free vibration (SDOF) systems.
8. Determine the natural frequency, force and motion transmissibility of single degree freedom systems.
9. Determine equation of motion of rotating and reciprocating unbalance systems, magnification factor, and transmissibility of forced vibration (SDOF) systems.

Text Books:

1. Theory of Machines, Sadhu Singh, Pearson Education, 2nd Edition. 2007.
2. Mechanism and Machine Theory, A. G. Ambekar PHI, 2007
3. Mechanical Vibrations, V. P. Singh, Dhanpat Rai and Company,
4. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros.

Reference Books:

1. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.
2. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4edition, 2003.

TURBO MACHINES

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Turbo Machines	15ME53	04	3-2-0	80	20	3Hrs

Course Objectives:

- The course aims at giving an overview of different types of turbomachinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic and steam turbines.
- Explain the working principles of turbomachines and apply it to various types of machines
- It will focus on application of turbo machinery in power generation, power absorption and transportation sectors.

Module 1

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies.

(Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process **(10 Hours)**

Module 2

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems.

(10 Hours)

Module 3

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor.

Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Problems.

(10 Hours)

Module 4

Hydraulic Turbines: Classification, various efficiencies. **Pelton turbine –** velocity triangles, design parameters, Maximum efficiency.
Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. **Kaplan and Propeller turbines** - velocity triangles, design parameters. Problems. **(10 Hours)**

Module 5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.
Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems.
(10 Hours)

Course Outcomes:

- Able to give precise definition of turbomachinery
- Identify various types of turbo machinery
- Apply the Euler's equation for turbomachinery to analyse energy transfer in turbomachines
- Understand the principle of operation of pumps, fans, compressors and turbines.
- Perform the preliminary design of turbomachines (pumps, rotary compressors and turbines)
- Analyze the performance of turbo machinery.

TEXT BOOKS:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002

REFERENCE BOOKS:

1. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964).
2. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier (2005).

3. Text Book of Turbo machines, M. S. Govindegouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.

DESIGN OF MACHINE ELEMENTS – I

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Design of Machine Elements	15ME54	04	3-2-0	80	20	3Hrs

Course Objectives

1. Able to understandmechanicaldesign procedure, materials, codes and use of standards
2. Able to design machine components for static, impact and fatigue strength.
3. Able to design fasteners, shafts, joints, couplings, keys, threaded fasteners riveted joints, welded joints and power screws.

Module-1

Fundamentals of Mechanical Engineering Design

Mechanical engineering design, Phases of design process, Design considerations, Engineering Materials and their Mechanical properties,Standards and Codes, Factor of safety, Material selection.

Static Stresses: Static loads .Normal, Bending, Shear andCombinedstresses.Stress concentration and determination of stress concentration factor.

10 Hours

Module -2

Design for Impact and Fatigue Loads

Impact stress due to Axial, Bending and Torsional loads.

Fatigue failure: Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

10Hours

Module -3

Design of Shafts, Joints, Couplings and Keys

Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads.

Design of Cotter and Knuckle joints, Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling. Design of keys-square, saddle, flat and father.

10 Hours

Module - 4

Riveted Joints and Weld Joints

Rivet types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozanze Joints, Riveted Brackets, eccentrically loaded joints.
Types of welded joints, Strength of butt and fillet welds, welded brackets with transverse and parallel fillet welds, eccentrically loaded welded joints.

10 Hours

Module -5

Threaded Fasteners and Power Screws

Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loads, Design of eccentrically loaded bolted joints.
Types of power screws, efficiency and self-locking, Design of power screw, Design of screw jack: (Complete Design).

10 Hours

Course outcomes

On completion of the course the student will be able to

1. Describe the design process, choose materials.
2. Apply the codes and standards in design process.
3. Analyze the behavior of machine components under static, impact, fatigue loading using failure theories.
4. Design shafts, joints, couplings.
5. Design of riveted and welded joints.
6. Design of threaded fasteners and power screws

Text Books:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.
2. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition, 2009.

Design Data Handbook:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication
3. Design Data Hand Book, S C Pilli and H. G. Patil, I. K. International Publisher, 2010.

Reference Books:

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
2. Engineering Design, George E. Dieter, Linda C Schmidt, McGraw Hill Education, Indian Edition, 2013.
3. Design of Machined Elements, S C Pilli and H. G. Patil, I. K. International Publisher, 2017.
4. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outline series) adapted by S.K Somani, tata McGraw Hill Publishing company Ltd., New Delhi, Special Indian Edition, 2008

REFRIGERATION AND AIR-CONDITIONING
(Professional Elective-I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Refrigeration And Air-Conditioning	15ME551	03	3-0-0	80	20	3Hrs

Pre-requisites: Basic and Applied Thermodynamics

Courseobjectives

1. Study the basic definition, ASHRAE Nomenclature for refrigerating systems
2. Understand the working principles and applications of different types of refrigeration systems
3. Study the working of air conditioning systems and their applications
4. Identify the performance parameters and their relations of an air conditioning system

Module – I

Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications:Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air.

Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous

8 Hours

Module – II

Vapour Compression Refrigeration System(VCRS): Comparison of Vapour Compression Cycle and Gas cycle,Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency,Modifications to standard cycle – liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP – Ewing's construction and Gosney'smethod.Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure,Multi-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

10 Hours

Module – III

Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, Water-Ammonia Systems,Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly.Practical problems – crystallization and air leakage, Commercial systems

Other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration systems **8 Hours**

Module – IV

Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropicmixtures

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

8 Hours

Module – V

Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, ASHRAE Nomenclature pertaining to Air-Conditioning, Applications of Air-Conditioning, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems.

Transport air conditioning Systems:Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships. **8 Hours**

Course Outcomes

At the end of the course, the student will be able to:

1. Illustrate the principles, nomenclature and applications of refrigeration systems.
2. Explainvapour compression refrigeration system and identify methods for performance improvement
3. Study the working principles of air, vapour absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems
4. Estimate the performance of air-conditioning systems using the principles of psychometry.
5. Compute and Interpret cooling and heating loads in an air-conditioning system
6. Identify suitable refrigerant for various refrigerating systems

TEXT BOOKS

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited
2. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi, 2ndEdition, 2001.
3. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi 2nd edition, 1982.

REFERENCE BOOKS

1. Dossat,Principles of Refrigeration Pearson-2006.
2. McQuistion,Heating,Ventilation and Air Conditioning, Wiley Students edition,5thedition 2000.
3. PITA,Air conditioning 4rth edition, pearson-2005
4. Refrigeration and Air-Conditioning' by Manoharprasad
5. S C Arora& S Domkundwar, Refrigeration and Air-Conditioning DhanpatRai Publication
6. http://nptel.ac.in/courses/112105128/#

Data Book:

1. Shan K. Wang,Handbook of Air Conditioning and Refrigeration, 2/e,2001 McGraw-Hill Education
2. Mathur M.L. &Mehta ,Refrigerant and Psychrometric Properties (Tables & Charts) SI Units, F.S., Jain Brothers,2008

E- Learning

- VTU, E- learning, MOOCS, Open courseware

THEORY OF ELASTICITY
(Professional Elective-I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Theory of Elasticity	15ME552	03	3-0-0	80	20	3Hrs

Course objectives

1. To gain knowledge of stresses and strains in 3D and their relations and thermal stresses.
2. To understand the 2D analysis of elastic structural members.
3. To gain knowledge of thermal stresses and stability of columns
4. To analysis elastic members for the stresses and strains induced under direct loading conditions.
5. To analyse the axisymmetric and torsional members.
6. To analyse the thermal stresses induced in disks and cylinders.
7. To analyse the stability of columns

Module –1

Analysis of Stress: Definition and notation of stress, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants, principal stresses,octahedral stress, planes of maximum shear, stress transformation, plane state of stress, Numerical problems **8 Hours**

Module - 2

Analysis of Strain: Displacement field, strains in term of displacement field, infinitesimal strain at a point, engineering shear strains,strain invariants, principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical Problems. **8 Hours**

Module –3

Two-Dimensional classical elasticity Problems: Cartesian co-ordinates - Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy's stress functions, Investigation of Airy's stress function for simple beams, bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of simply supported beam under UDL.General equations in polar coordinates, stress distribution symmetrical about an axis, Thick wall cylinder subjected to internal and external pressures, Numerical Problems.

10 Hours

Module – 4

Axisymmetric and Torsion problems: Stresses in rotating discs of uniform thickness and cylinders. Torsion of circular, elliptical and triangular bars, Prandtl's membrane analogy,torsion of thin walled thin tubes, torsion of thin walled multiple cell closed sections. Numerical Problems

8 Hours

Module -5

Thermal stress and Elastic stability: Thermo elastic stress strain relations, equations ofequilibrium,thermal stresses in thin circular discs and in long circularcylinders.Euler's column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical Problems

8 Hours

Course outcomes

At the end of course student able to:

1. Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.
2. Analyse the structural members: beam, rotating disks, columns
3. Analyse the torsional rigidity of circular and non-circular sections.
4. Analyse the stability of columns

Text Books:

1. Theory of Elasticity, S. P. Timoshenko and J. N Goodier, Mc. Graw, Hill International, 3rd Ed., 2010.
2. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 2004.

References Books:

1.Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill,2009.
2. Theory of Elastic stability, Stephen P. Timoshenko, Mc Graw Hill, 2nd Ed, 2014.

HUMAN RESOURCE MANAGEMENT
(Professional Elective-I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Human Resource Management	15ME553	03	3-0-0	80	20	3Hrs

Course Objectives:

1. To develop a meaningful understanding of HRM theory, functions and practices.
2. To apply HRM concepts and skills across various types of organizations.

Module – 1

Human Resource Management

Introduction, meaning, nature, scope of HRM. Importance and Evolution of the concept of HRM. Major functions of HRM, Principles of HRM, Organization of Personnel department, Role of HR Manager.

Job Analysis: Meaning, process of job analysis, methods of collecting job analysis data, Job Description and Specification, Role Analysis.

08 hours

Module – 2

Human Resource Planning: Objectives, Importance and process of Human Resource planning, Effective HRP

Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.

Selection: Definition and Process of Selection. **08 hours**

Module – 3

Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.

Training and development: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.

08 hours

Module – 4

Performance Appraisal: Concept of Performance Appraisal, the Performance Appraisal process, Methods of Performance Appraisal, Essential Characteristic of an Effective Appraisal System.

Compensation: Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India, Wage and Salary Administration, Factors Influencing Compensation Levels, Executive Compensation. **09 hours**

Module – 5

Employee Welfare: Introduction, Types of Welfare Facilities and Statutory Provisions.
Employee Grievances: Employee Grievance procedure, Grievances management in Indian Industry.
Discipline: Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees.

09 hours

Course Outcomes

On completion of the course the student will be able to

1. Understand the importance, functions and principles Human Resource Management and process of Job analysis
2. Summarize the objectives of Human Resource planning, Recruitment and selection process
3. Understand the process involved in Placement, Training and development activities.
4. Understand the characteristics of an effective appraisal system and compensation planning.
5. Understand the issues related to employee welfare, grievances and discipline.

TEXTBOOKS

1. Human Resource Management- Rao V.S.P, Excel books, 2010
2. Human Resource Management- Cynthia D. Fisher, 3/e, AIPD, Chennai
3. Human Resource Management: A South Asian Perspective, Snell, Bohlander&Vohra, 16^{th} Rep., Cengage Learning, 2012
4. Human Resource Management- Lawrence S Kleeman, Biztantra, 2012
5. Human Resource Management- Aswathappa K, HPH

REFERENCE BOOKS

1. Human Resource Management- John M. Ivancevich, 10/e, McGraw Hill.
2. Human Resource Management in Practice- Srinivas R. Kandulla, PHI
3. Human Resource Management- Luis R Gomez-Mejia, David B. Balkin, Robert L Cardy, 6/e, PHI, 2010

NON TRADITIONAL MACHINING
(Professional Elective-I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Non Traditional Machining	15ME554	03	3-0-0	80	20	3Hrs

MODULE 1
INTRODUCTION
Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes. **08 hours**

MODULE 2
Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.
Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish.Applications, advantages & limitations of AJM.
Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.
08 hours

MODULE 3
ELECTROCHEMICAL MACHINING (ECM)
Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish.
Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials.
Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.

CHEMICAL MACHINING (CHM)

Elements of the process: Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

10 hours

MODULE 4

ELECTRICAL DISCHARGE MACHINING (EDM)

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

PLASMA ARC MACHINING (PAM)

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations. **08 hours**

MODULE 5

LASER BEAM MACHINING (LBM)

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM)

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

08 hours

Course Outcomes

On completion of the course, the students will be able to

1. Understand the compare traditional and non-traditional machining processand recognize the need for Non-traditional machining process.
2. Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.
3. Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.
4. Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.
5. Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

Text Books:

1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001

Reference Books

1. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
2. Modern Machining process, Aditya, 2002.

OPTIMIZATION TECHNIQUES
(OPEN ELECTIVE – I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Optimization Techniques	15ME561	03	3-0-0	80	20	3Hrs

COURSE OBJECTIVES

Course Objective:
The general objectives of the course is to
1. Introduce the fundamental concepts of Optimization Techniques;
2. Make the learners aware of the importance of optimizations in real scenarios;
3. Provide the concepts of various classical and modern methods of for constrainedand unconstrained problems in both single and multivariable.

MODULE I

Introduction to Classical Optimization Techniques
Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.
Classical Optimization Techniques
Single variable Optimization, Multi variable Optimization with and without constraints,Multivariable Optimization with equality constraints - solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints - Kuhn – Tucker conditions.
(8 Hours)

MODULE II
Linear Programming
Various definitions, statements of basic theorems and properties, Advantages, Limitations and Application areas of Linear Programming, Graphical method of Linear Programming problem.

Simplex Method – Phase I and Phase II of the Simplex Method, The Revised Simplex method, Primal and Dual Simplex Method, Big –M method.
(10 Hours)

MODULE III
Transportation Problem
Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems. (Including assignment and travelling salesman problems) (No degeneracy problems)
Queuing

Queuing Models : Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1 : ∞ /FCFS,M/M/1 : N/FCFS, M/M/C : ∞/FCFS, M/M/C : N/FCFS.

(8 Hours)

MODULE IV

Dynamic Programming

Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Integer Programming

Pure and mixed integer programming problems, Solution of Integer programming problems – Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero-one programming. **(8 Hours)**

MODULE V

Simulation Modeling

Introduction, Definition and types, Limitations, Various phases of modeling, Monte Carlo method, Applications, advantages and limitations of simulation

Inventory Models

Role of demand in the development of inventory models, objectives, inventory costs, quantity discount, Economic Order Quantity (EOQ), EOQ when stock replenishment is not instantaneous, Economic lot size when shortages are allowed, economic lot size with different rate of demand in different cycles (Instantaneous replenishment). (No Dynamic EOQ Models) **(8 Hours)**

COURSE OUTCOMES

Upon successful completion of this course, students will be able to

1. Understand the overview of optimization techniques, concepts of design space, constraint surfaces and objective function.
2. Review differential calculus in finding the maxima and minima of functions of several variables.
3. Formulate real-life problems with Linear Programming.
4. Solve the Linear Programming models using graphical and simplex methods.
5. Formulate real-life transportation, assignment and travelling salesman problems to find the optimum solution using transportation algorithms
6. Analyze the Queuing model for effective customer satisfaction
7. Apply dynamic programming to optimize multi stage decision problems.
8. Determine the level of inventory that a business must maintain to ensure smooth operation.
9. Construct precedence diagram for series of activities in a huge project to find out probability of expected completion time using PERT-CPM networks. Also reduce the duration of project by method of crashing.

TEXT BOOKS

1. Engineering optimization: Theory and practice”-by S.S.Rao, New Age International (P) Limited.
2. Operations Research: An Introduction" by H A Taha, 5th Edition, Macmillan, New York.
3. Operations Research by NVR Naidu, G Rajendra, T Krishna Rao, I K International Publishing house, New Delhi.

REFERENCE BOOKS

1. Optimization Methods in Operations Research and systems Analysis” – by K.V. Mittal and C. Mohan, New Age, International (P) Limited, Publishers
2. Operations Research – by S.D.Sharma, KedarnathRamanath& Co
3. Linear programming, G. Hadley, Narosa Publishing House, New Delhi.
4. Industrial Engineering and Production Management, M. Mahajan, Dhanpat Rai & co

ENERGY AND ENVIRONMENT
(OPEN ELECTIVE – I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Energy And Environment	15ME562	03	3-0-0	80	20	3Hrs

Course Objectives

1. Understand energy scenario, energy sources and their utilization
2. Learn about methods of energy storage, energy management and economic analysis
3. Have proper awareness about environment and eco system.
4. Understand the environment pollution along with social issues and acts.

Module – I

Basic Introduction to Energy: Energy and power, forms of energy,primary energy sources, energy flows, world energy production and consumption,Key energy trends in India:Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development:Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment. **8 Hours**

Module – II

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems
Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing
Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries
Economic Analysis: Scope, Characterization of an Investment Project **10 Hours**

Module – III

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness.
Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession. **8 Hours**

Module – IV

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards , Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. **8 Hours**

Module – V

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

8 Hours

Course Outcomes

At the end of the course, the student will be able to:

1. Summarize the basic concepts of energy, its distribution and general Scenario.
2. Explain different energy storage systems, energy management, audit and economic analysis.
3. Summarize the environment eco system and its need for awareness.
4. Identify the various types of environment pollution and their effects.
5. Discuss the social issues of the environment with associated acts.

TEXT BOOKS:

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute of environment education and Research ,Pune
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.

REFERENCE BOOKS:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. Murphy, W. R., Energy Management, Elsevier, 2007.
3. Smith, C. B., Energy Management Principles, Pergamum, 2007
4. Environment pollution control Engineering by C S rao, New Age Inytermnational, 2006, reprint 2015, 2nd edition
5. Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.

E- Learning

- India Energy Outlook 2015(www.iea.org/.../IndiaEnergyOutlook_WEO2015.pdf)
- Open courseware

AUTOMATION AND ROBOTICS
(OPEN ELECTIVE – I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Automation And Robotics	15ME563	03	3-0-0	80	20	3Hrs

Module - 1

Automation
History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies

Automated Manufacturing Systems: Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS. **08 Hours**

Module - 2

Robotics
Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration.

Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability, End effectors – Tools and grippers. **08 Hours**

Module - 3

Controllers and Actuators
Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Control system and analysis.

Robot actuation and feedback components
Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems. **09 Hours**

Module - 4

Robot Sensors and Machine vision system
Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics.

Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems. **08 Hours**

Module - 5

Robots Technology of the future: Robot Intelligence, Advanced Sensor capabilities, Telepresence and related technologies, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking.

Artificial Intelligence: Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, LISP programming, AI and Robotics, LISP in the factory. **09 Hours**

Course Outcomes

On completion of the course student will be able to

1. Classify various types of automation &manufacturing systems
2. Discuss different robot configurations, motions, drive systems and its performance parameters.
3. Describe the basic concepts of control systems, feedback components, actuators and power transmission systems used in robots.
4. Explain the working of transducers, sensors and machine vision systems.
5. Discuss the future capabilities of sensors, mobility systems and Artificial Intelligence in the field of robotics.

Text Books

1. Automation, Production Systems and Computer Integrated Manufacturing M.P. Groover, Pearson Education.5th edition, 2009
2. Industrial Robotics, Technology, Programming and Applications by M.P. Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.

Reference Books

1. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007. .
2. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.

PROJECT MANAGEMENT
(OPEN ELECTIVE – I)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Project Management	15ME564	03	3-0-0	80	20	3Hrs

MODULE – 1

Introduction: Definition of project, characteristics of projects, understandprojects, types of projects, scalability of project tools, project roles

Project Selection And Prioritization – Strategic planning process, Strategicanalysis, strategic objectives, portfolio alignment – identifying potentialprojects, methods of selecting projects, financial mode / scoring models toselect projects, prioritizing projects, securing and negotiating projects.

08 Hours

MODULE – 2

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system.

Scheduling Projects: Purpose of a project schedule, historical development,how project schedules are limited and created, develop project schedules,uncertainty in project schedules, Gantt chart.

08 Hours

MODULE – 3

Resourcing Projects: Abilities needed when resourcing projects, estimateresource needs, creating staffing management plant, project teamcomposition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control.
Project Risk Planning: Risk Management Planning, risk identification, riskanalysis, risk response planning, Project Quality Planning and ProjectKickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate projectmanagement plan, using Microsoft Project for project baselines.

08 Hours

MODULE –4

Performing Projects: Project supply chain management: - Plan purchasingand acquisitions, plan contracting, contact types, project partnering andcollaborations, project supply chain management.

Project Progress and Results: Project Balanced ScorecardApproach, Internal project, customer, financial issues, Finishing the project: Terminateproject early, finish projects on time, secure customer feedback and approval,knowledge management, perform administrative and contract closure.

08 Hours

MODULE - 5

Network Analysis

Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERTfor finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects. **10 Hours**

Course Outcomes

On completion of the course the student will be able to

1. Understand the selection, prioritization and initiation of individual projects and strategic role of project management.
2. Understand the work breakdown structure by integrating it with organization.
3. Understand the scheduling and uncertainty in projects.
4. Students will be able to understand risk management planning using project quality tools.
5. Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
6. Determine project progress and results through balanced scorecard approach
7. Draw the network diagram to calculate the duration of the project and reduce it using crashing.

TEXT BOOKS

1. Project Management, Timothy J Kloppenborg, Cengage Learning, Edition 2009.
2. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.
3. Project Management by S Choudhury, Mc Graw Hill Education (India) Pvt. Ltd. New Delhi, 2016

REFERENCE BOOKS

1. Project Management, Pennington Lawrence, Mc Graw hill
2. Project Management, A Moder Joseph and Phillips New Yark Van Nostrand, Reinhold.
3. Project Management,Bhavesh M. Patal, Vikas publishing House,

FLUID MECHANICS & MACHINERY LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Fluid Mechanics & Machinery Lab	15MEL57	02	1-0-2	80	20	3Hrs

Co-requisite Courses: Turbo Machines
Prerequisites : Fluid Mechanics and Thermodynamics
Course Objectives:

1. This course will provide a basic understanding of flow measurements usingvarious types of flow measuring devices, calibration and losses associated with these devices.
2. Energy conversion principles, analysis and understanding of hydraulic turbines and pumps will be discussed. Application of these concepts for these machines will be demonstrated. Performance analysis will be carried out using characteristic curves.

PART – A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of coefficient of friction of flow in a pipe.
3. Determination of minor losses in flow through pipes.
4. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades
5. Calibration of flow measuring devices.
6. Orifice meter
    - Nozzle
    - Venturimeter
    - V-notch

PART – B

7. Performance on hydraulic Turbines
    a. Pelton wheel
    b. Francis Turbine
    c. Kaplan Turbines
8. Performance hydraulic Pumps
    d. Single stage and Multi stage centrifugal pumps
    e. Reciprocating pump
9. Performance test on a two stage Reciprocating Air Compressor
10. Performance test on an Air Blower

PART – C (Optional)

11. Visit to Hydraulic Power station/ Municipal Water Pump House and Case Studies
12. Demonstration of cut section models of Hydraulic turbines and Pumps.

Course Outcomes:

At the end of this course students are able to,

1. Perform experiments to determine the coefficient of discharge of flow measuring devices.
2. Conduct experiments on hydraulic turbines and pumps to draw characteristics.
3. Test basic performance parameters of hydraulic turbines and pumps and execute the knowledge in real life situations.
4. Determine the energy flow pattern through the hydraulic turbines and pumps
5. Exhibit his competency towards preventive maintenance of hydraulic machines

Reading:

1. K.L.Kumar.“Engineering Fluid Mechanics” Experiments, Eurasia Publishing House, 1997
2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995
3. George E. Totten , Victor J. De Negri “Handbook of Hydraulic Fluid Technology, Second Edition, 2011.

Scheme of Examination:

ONE question from part -A: 25 Marks
ONE question from part -B: 40 Marks
Viva –Voice : 15 Marks
Total: 80 Marks

ENERGY LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Energy Lab	15MEL58	02	1-0-2	80	20	3Hrs

Prerequisites: Basic andApplied Thermodynamics

Course Objectives:

1. This course will provide a basic understanding of fuel properties and its measurements using various types of measuring devices
2. Energy conversion principles, analysis and understanding of I C Engines will be discussed. Application of these concepts for these machines will be demonstrated. Performance analysis will be carried out using characteristic curves.
3. Exhaust emissions of I C Engines will be measured and compared with the standards.

PART – A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3. Determination of Calorific value of solid, liquid and gaseous fuels.
4. Determination of Viscosity of a lubricating oil using Redwoods, Sayboltand Torsion Viscometers.
5. Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples
6. Valve Timing/port opening diagram of an I.C. Engine.

PART - B

7. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for
    a. Four stroke Diesel Engine
    b. Four stroke Petrol Engine
    c. Multi Cylinder Diesel/Petrol Engine, (Morse test)
    d. Two stroke Petrol Engine
    e. Variable Compression Ratio I.C. Engine.
8. Measurements of Exhaust Emissions of Petrol engine.
9. Measurements of Exhaust Emissions of Diesel engine.
10. Measurement of $p\theta$, pV plots usingComputerized IC engine test rig

PART – C (Optional)

11. Visit to Automobile Industry/service stations.
12. CFD Analysis of design, development, performance evaluation and process optimization in I C Engines.

Course Outcomes: At the end of this course students are able to,

1. Perform experiments to determine the properties of fuels and oils.
2. Conduct experiments on engines and draw characteristics.
3. Test basic performance parameters of I.C. Engine and implement the knowledge in industry.
4. Identify exhaust emission, factors affecting them and report the remedies.
5. Determine the energy flow pattern through the I C Engine
6. Exhibit his competency towards preventive maintenance of IC engines.

References

1. E.F.Obert, Internal combustion engines and air pollution intext educational publishers (1973). John Heywood, Internal combustion engine fundamentals, McGraw- Hill (1988) - USA.
2. Colin R Ferguson and Allan T. Kirkpatrick Internal combustion engines Applied Thermodynamics, John Wiley & sons – 2001.
3. Richard stone, Introduction to internal combustion engines, MacMillan (1992) – USA
4. M. L. Mathur And R.P. Sharma A course in internal combustion engines, Dhanpat Rai& sons- India.
5. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. by:, pub.: Wily.
6. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. by:, pub.: Wily.
7. Ganesan, V., Fundamentals of IC Engines, Tata McGraw Hill, 2003
8. Bosch, Automotive hand book, 9th edition.

Scheme of Examination:

ONE question from part -A: 25 Marks
ONE question from part -B: 40 Marks
Viva –Voice : 15 Marks
Total: 80 Marks

B.E. Mechanical Engineering

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME61	Finite Element Analysis	3	2	0	03	80	20	100	4
2	15ME62	Computer integrated Manufacturing	4	0	0	03	80	20	100	4
3	15ME63	Heat Transfer	3	2	0	03	80	20	100	4
4	15ME64	Design of Machine Elements -II	3	2	0	03	80	20	100	4
5	15ME65X	Professional Elective-II	3	0	0	03	80	20	100	3
6	15ME66X	Open Elective-II	3	0	0	03	80	20	100	3
7	15MEL67	Heat Transfer Lab	1	0	2	03	80	20	100	2
8	15MEL68	Modeling and Analysis Lab(FEA)	1	0	2	03	80	20	100	2
TOTAL			**21**	**6**	**04**		**640**	**160**	**800**	**26**

Professional Elective-II		Open Elective-II	
15ME651	Computational Fluid Dynamics	15ME661	Energy Auditing
15ME652	Mechanics of Composite Materials	15ME662	Industrial Safety
15ME653	Metal Forming	15ME663	Maintenance Engineering
15ME654	Tool Design	15ME664	Total Quality Management
15ME655	Automobile Engineering		

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch

3. OpenElective: Electives from other technical and/or emerging subject areas.

FINITE ELEMENT ANALYSIS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Finite Element Analysis	15ME61	04	3-2-0	80	20	3Hrs

Course Objectives:

1.To learn basic principles of finite element analysis procedure .

2.To learn the theory and characteristics of finite elements that represent engineering structures.

3.To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

Module I

Introduction to Finite Element Method : General description of the finite element method. Engineering applications of finite element method. Boundary conditions: homogeneous and nonhomogeneous for structural, heat transfer and fluid flow problems.Potential energy method, Rayleigh Ritz method, Galerkin’s method, Displacement method of finite element formulation. Convergence criteria, Discretisation process, Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects.

Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

10 Hours

Module II

One-Dimensional Elements-Analysis of Bars and Trusses,

Linear interpolation polynomials in terms of localcoordinate’s for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, , , Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA

8), 2D isoparametric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two point formulae, 2D integrals. Fore terms: Body force, traction force and point loads,

Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses.

10 Hours

Module III

Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.

Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

08 Hours

Module IV

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored insolid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.

10 Hours

Module V

Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.

Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

Course outcomes:

Upon successful completion of this course you should be able to:

1.Understand the concepts behind formulation methods in FEM.

2.Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

3.Develop element characteristic equation and generation of global equation.

4.Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi symmetric and dynamic problems and solve them displacements, stress and strains induced.

12Hours

Text Books:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering**,** 2nd Edition, PHI, 2013.

Reference Books:

1. J.N.Reddy, "**Finite Element Method"-** McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2. Cook R. D., et al. "**Conceptsand Application of Finite Elements Analysis"-** 4th Edition, Wiley & Sons, 2003.

Computer Integrated Manufacturing

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Computer Integrated Manufacturing	15ME62	04	3-2-0	80	20	3Hrs

Course Objectives:

CLO1	To impart knowledge of CIM andAutomation and different concepts of automation by developing mathematical models.
CLO2	To make students to understand the Computer Applications in Design and Manufacturing [CAD / CAM) leading to Computer integrated systems. Enable them to perform various transformations of entities on display devices.
CLO3	To expose students to automated flow lines,assembly lines,Line Balancing Techniques,and Flexible Manufacturing Systems.
CLO4	To expose students to computer aided process planning, material requirement planning, capacity planning etc.
CLO5	To expose the students to CNC Machine Tools,CNC part programming, and industrial robots.
CLO6	To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0leading to Smart Factory.

Module - 1

1. **Introduction to CIM and Automation:**
   Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM.
   Mathematical models and matrices:production rate, production capacity, utilization and availability, manufacturing lead time, work-in-process, numerical problems. **5 Hours**
2. **Automated Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems, numerical problems. **5 Hours**

Module – 2

3. **CAD and Computer Graphics Software:**The design process, applications of computers in design**,** software configuration, functions of graphics package, constructing the geometry.
   Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations. **5 Hours**

4. **Computerized Manufacture Planning and Control System:** Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System,computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control. **5 Hours**

Module- 3

5. **Flexible Manufacturing Systems:** Fundamentalsof Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RSand Automatic parts identification systems and data capture.
   5 Hours

6. **Line Balancing:** Linebalancing algorithms,methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line balancing, computerizedline balancing methods.
   5 Hours

Module-4.

7. **Computer Numerical Control:** Introduction,components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components inturning,drilling and milling systems, programming with canned cycles.Cutter radius compensations. **5 Hours**

8. **Robot Technology:** Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics.
   Robot programming methods: on-line and off-line methods.
   Robot industrial applications:material handling, processing and assembly and inspection.
   5 Hours

Module – 5

9. **Additive Manufacturing Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes:Photo polymerization, material jetting, binder jetting, materialextrusion, Powder bed sintering techniques, sheet lamination, directenergy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing. **5 Hours**

10. **Future of Automated Factory:**Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing,Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems. **5 Hours**

Course Outcomes:

After studying this course, students will be able to:

CO1	Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen.
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines.
CO3	Analyze the automated flow linesto reduce down time and enhance productivity.
CO4	Explain the use of different computer applications in manufacturing, and able to prepare part programs for simple jobs on CNC machine tools and robot programming.
CO5	Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

Text Books:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition,2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
3. CAD/CAM/CIM, Dr. P. Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

Reference Books:

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.

3. “Work Systems And The Methods, Measurement And Management of Work”, Groover M. P.,Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. “Computer Automation in Manufacturing”, Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. “Introduction to Robotics: Mechanics And Control”, Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition,by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
9. **“Understanding Additive Manufacturing”,** Andreas Gebhardt, Hanser Publishers,
2011
10. Industry 4.0: The Industrial Internet of Things, Apress, 2017, by Alasdair Gilchrist

Heat Transfer

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Heat Transfer	15ME63	04	3-2-0	80	20	3Hrs

Pre-requisites: Basic and Applied Thermodynamics

Course learning objectives:

- Study the modes of heat transfer.
- Learn how to formulate and solve 1-D steady and unsteady heat conduction problems.
- Apply empirical correlations for fully-developed laminar, turbulent internal flows and external boundary layer convective flow problems.
- Study the basic principles of heat exchanger analysis and thermal design.
- Understand the principles of boiling and condensation including radiation heat transfer related engineering problems.

Module – I

Introductory concepts and definitions: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer combined heat transfer mechanism, Types of boundary conditions. General Heat Conduction Equation: Derivation of the equation in (i) Cartesian, (ii) Polar and (iii) Spherical Co-ordinate Systems.

Steady-state one-dimensional heat conduction problems in Cartesian System: Steady-state one-dimensional heat conduction problems (i) with and without heat generation and (ii) with and without varying thermal conductivity - in Cartesian system with various possible boundary conditions, Thermal Resistances in Series and in Parallel. **8 Hours**

Module – II

Critical Thickness of Insulation: Concept, Derivation, Extended Surfaces or Fins: Classification, Straight Rectangular and Circular Fins, Temperature Distribution and Heat Transfer Calculations, Fin Efficiency and Effectiveness, Applications

Transient [Unsteady-state] heat conduction: Definition, Different cases - Negligible internal thermal resistance, negligible surface resistance, comparable internal thermal and surface resistance, Lumped body, Infinite Body and Semi-infinite Body, Numerical Problems, Heisler and Grober charts.

9 Hours

Module – III

Numerical Analysis of Heat Conduction: Introduction, one-dimensional steady conduction, one dimensional unsteady conduction, two-dimensional steady and unsteady conduction, the difference equation, boundary conditions, solution methods, cylindrical coordinates and irregular boundaries.

Thermal Radiation: Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's, Rayleigh-Jeans' and Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws, View factor, Net radiation exchange in a two-body enclosure, Typical examples for these enclosures, Radiation Shield.

9 Hours

Module – IV

Forced Convection: Boundary Layer Theory, Velocity and Thermal Boundary Layers, Prandtl number, Governing Equations – Continuity, Navier-Stokes and Energy equations, Boundary layer assumptions, Integral and Analytical solutions to above equations, Turbulent flow, Various empirical solutions, Forced convection flow over cylinders and spheres, Internal flows –laminar and turbulent flow solutions, Forced Convection Cooling of Electronic Devices.

Free convection: Laminar and Turbulent flows, Vertical Plates, Vertical Tubes and Horizontal Tubes, Empirical solutions.

8 Hours

Module – V

Heat Exchangers: Definition, Classification, applications, LMTD method, Effectiveness - NTU method, Analytical Methods, Fouling Factors, Chart Solution Procedures for solving Heat Exchanger problems: Correction Factor Charts and Effectiveness-NTU Charts, compact heat exchangers.

Heat Transfer with Phase Change: Introduction to boiling, pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, filmwise and dropwise Condensation, heat pipes, entrainment, wicking and boiling limitations. **9 Hours**

Course Outcomes

At the end of the course, the student will be able to:

- Understand the basic modes of heat transfer.
- Compute temperature distribution in steady-state and unsteady-state heat conduction
- Understand and interpret heat transfer through extended surfaces.
- Interpret and compute forced and free convective heat transfer.
- Explain the principles of radiation heat transfer and understand the numerical formula for heat conduction problems.
- Design heat exchangers using LMTD and NTU methods.

TEXT BOOKS:

1. Principals of heat transfer, Frank Kreith, Raj M. Manglik, Mark S. Bohn, Seventh Edition, Cengage learning, 2011.
2. Yunus A. Cengel - Heat transfer, a practical approach, Fifth edition,Tata Mc Graw Hill.

REFERENCE BOOKS:

1. Heat nd mass transfer, Kurt C, Rolle, second edition, Cengage learning.
2. Heat Transfer, M. Necati Ozisik, A Basic Approach, McGraw Hill, New York, 2005.
3. Fundamentals of Heat and Mass Transfer, Incropera, F. P. and De Witt, D. P., 5th Edition, John Wiley and Sons, New York, 2006.
4. Heat Transfer, Holman, J. P., 9th Edition, Tata McGraw Hill, New York, 2008.

E-Books/Web references:

1. A Text book of Heat Transfer, John H Lienhard, 4th Edition,
2. NPTEL Heat Transfer course for Mechanical Engineering, http://nptel.ac.in/courses/112101097/
3. Heat Transfer, Chris Long & Naser Sayma, Bookboon.com

MOOCs:

1. Fluid flow, Heat and Mass Transfer- http://ocw.tudelft.nl/courses/applied-earth-sciences/fluid-flow-heat-mass-transfer/course
2. Heat transfer course- https://legacy.saylor.org/me204/Intro/

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

DESIGN OF MACHINE ELEMENTS II

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Design of Machine Elements II	15ME64	04	3-2-0	80	20	3Hrs

Course Objectives:

CLO1	To understand various elements involved in a mechanical system.
CLO2	To analyze various forces acting on the elements of a mechanical system and design them using appropriate techniques, codes, and standards.
CLO3	To select transmission elements like gears, belts, pulleys,bearings from the manufacturers' catalogue.
CLO4	To design completely a mechanical system integrating machine elements.
CLO5	To produce assembly and working drawings of various mechanical systems involving machine elements like belts, pulleys, gears, springs, bearings, clutches and brakes.

MODULE I

Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links.

Cylinders & Cylinder Heads: Review of Lame's equations; compound cylinders, stresses due to different types of fit on cylinders; cylinder heads and flats.

08 Hours

MODULE 2

Belts: Materials of construction of flat and V belts, power rating of belts,concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition.

Selection of flat and V belts-length & cross section from manufacturers' catalogues.

Construction and application of timing belts.

Wire ropes: Construction of wire ropes, stresses in wire ropes, and selection of wire ropes.

(Only theoretical treatment)

Chain drive: Types of power transmission chains, modes of failure for chain, and lubrication of chains.(Only theoretical treatment)

Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs;springs under fluctuating loads.
Leaf Springs: Stresses in leaf springs,equalized stresses, and nipping of leaf springs.
Introduction to torsion and Belleville springs.

10 Hours

<u>MODULE 3</u>

Gear drives: Classification of gears, materials for gears, standard systems of gear tooth, gear tooth failure modes and lubrication of gears.
Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear.
Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.
Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear.

12 Hours

<u>MODULE 4</u>

Worm Gears: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.
Design of Clutches: Types of clutches and their applications, single plate and multi-plate clutches.
(Numerical examples only on single and multi-plate clutches)
Design of Brakes: Types of Brakes, Block and Band brakes,selflocking of brakes, and heat generation in brakes.

10 Hours

<u>MODULE 5</u>

Lubrication and Bearings: Lubricants and their properties, bearing materials and properties;mechanisms of lubrication,hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated.
Numericalexamples onhydrodynamic journal and thrust bearing design.

Anti friction bearings: Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers' catalogue; selection of bearings subjected to cyclic loads and speeds; probability of survival.

10 Hours

Course Outcomes:
After learning the course the students should be able to:

CO1	Apply engineering design tools to product design.
CO2	Design mechanical systems involving springs,belts and pulleys.
CO3	Design different types of gears and simple gear boxes for different applications.
CO4	Design brakes and clutches.
CO5	Design hydrodynamic bearings for different applications.
CO6	Select Anti friction bearings for different applications using the manufacturers, catalogue.
C07	Develop proficiency to generate production drawings using CAD software.
C08	Become good design engineers through learning the art of working in a team with morality and ethics.

Scheme of Examination:
Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Assignment:
Course work includes a **Design project**. Design project should enable the students to design a mechanical system (like single stage reduction gear box with spur gears, single stage worm reduction gear box, V-belt and pulley drive system, machine tool spindle with bearing mounting, C-clamp, screw jack, single plate clutch, etc.)A group of students (maximum number in a group should be 4) should submit assembly drawing and part drawings,completely dimensioned, indicating the necessary manufacturing tolerances, surface finish symbols and geometric tolerances wherever necessary. Design project must be completed using appropriate solid modeling software. Computer generated drawings must be submitted. Design calculations must be hand written and should be included in the report.

Design project should be given due credit (5 marks) in internal assessment.

Textbooks:

[1] Richard G. Budynas,and J. Keith Nisbett,**"**Shigley's Mechanical Engineering Design**",** McGraw-Hill Education, 10th Edition, 2015.
[2] Juvinall R.C, and Marshek K.M, "Fundamentals of Machine Component Design", John Wiley & Sons, Third Edition, Wiley student edition, 2007.
[3] V. B. Bhandari, *"Design of Machine Elements",*4th Ed., Tata Mcgraw Hill, 2016.

References:

[1] Robert L. Norton "Machine Design- an integrated approach", Pearson Education, 2nd edition.
[2] Spotts M.F., Shoup T.E "Design and Machine Elements", Pearson Education, 8th edition,2006.
[3] Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.

[4] Hall, Holowenko, Laughlin (Schaum's Outline Series), "Machine design" adapted by S.K.Somani, Tata McGrawHill Publishing Company Ltd., Special Indian Edition, 2008.
[5] G. M. Maithra and L.V.Prasad, "Hand book of Mechanical Design", Tata McGraw Hill, 2nd edition,2004.

Design Data Hand Book:

[1] Design Data Hand Book, K.Lingaiah, McGraw Hill, 2nd edition, 2003.
[2] Design Data Hand Book, K.Mahadevan and Balaveera Reddy, CBS publication.
[3] Design Data Hand Book, H.G.Patil, I.K.International Publisher, 2010
[4]PSG Design Data Hand Book, PSG College of technology, Coimbatore.

Computational Fluid Dynamics

Course	Code	Credits	L-T-P	Assessment		Exam duration
				SEE	CIA	
Computational Fluid Dynamics	15ME651	03	3-0-0	80	20	3Hrs

Pre-requisites: Fluid Mechanics, Vector Calculus, Linear Algebra.

Course learning objectives:

- Study the governing equations of fluid dynamics
- Learn how to formulate and solve Euler's equation of motion.
- Become skilled at Representation of Functions on Computer
- Solve computational problems related to fluid flows

Module – I

Introduction to CFD and Governing Equations

Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques. **9 Hours**

Module – II

One-dimensional Euler's equation

Conservative, Non conservative form and primitive variable forms of Governing equations. Flux Jacobian, Is there a systematic way to diagonalise '**A**'. Eigenvalues and Eigenvectors of Flux Jacobian. Decoupling of Governing equations, introduction of characteristic variables. Relation between the two non-conservative forms. Conditions for genuinely nonlinear characteristics of the flux Jacobian.

Introduction to Turbulence Modeling: Derivation of RANS equations and k-epsilon model.

8 Hours

Module – III

Representation of Functions on Computer

Need for representation of functions, Box Function, Hat Function, Representation of sinx using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. Derivatives of hat functions, Haar functions, Machine Epsilon. Using Taylor series for representation of Derivatives. 7 **Hours**

Module – IV

Finite difference method – Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations • Explicit methods and Implicit methods – as applied to applied to linear convection equation, Laplace equations, convection-diffusion equation◦ FTCS,FTFS,FTBS,CTCS ◦ Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA.• VonNaumann stability (linear stability) analysis. Upwind Method in Finite Difference method. **8 Hours**

Module – V

Finite volume method

Finite volume method. Finding the flux at interface.

Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method

Upwind Method in Finite Volume methods - Flux Splitting Method Steger and Warming, vanLeer, Roe's Method and finding Roe's Averages. 8 **Hours**

Course Outcomes

At the end of the course, the student will be able to:

- Understand mathematical characteristics of partial differential equations.
- Explain how to classify and computationally solve Euler and Navier-Stokes equations.
- Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.
- Identify and implement numerical techniques for space and time integration of partial differential equations.
- Conduct numerical experiments and carry out data analysis.
- Acquire basic skills on programming of numerical methods used to solve the Governing equations.

Text Books

1. T.j.chung, Computational Fluid Dynamics, , Cambridge University Press
2. Ghoshdastidar, Computational fluid dynamics and heat transfer, Cengage learning, 2017.
3. Charles Hirsch, Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 & Vol 2, Butterworth- Heinemann, 2007

Reference Books:

1. Pletcher, r. H., Tannehill, j. C., Anderson, d., Computational fluid mechanics and heat transfer, 3rd ed., Crc press, 2011, ISBN 9781591690375.
2. Moin, p., Fundamentals of engineering numerical analysis, 2nd ed., Cambridge university press, 2010, ISBN 9780521805261 (e- book available).
3. Ferziger, j. H., Numerical methods for engineering application, 2nd ed., Wiley, 1998.
4. Ferziger, j. H., Peric, m., Computational methods for fluid dynamics, 3rd ed., Springer, 2002.
5. Leveque, r., Numerical methods for conservation laws, lectures in mathematics, eth Zurich, birkhauser,199
6. Riemann Solvers and Numerical methods for Fluid Dynamics – A
7. Practical Introduction- Eleuterio F Toro, Springer Publications.

MOOCs:

1. Introduction to CFD by Prof M. Ramakrishna, Aerospace Engineering, IIT Madras.

2. Computational fluid dynamics by Prof Suman Chakraborty, Mechanical Engineering, IIT Kharagpur

E-Books:

1. Hirsch, c., Numerical computation of internal and external flows, 2nd ed., Butterworth- Heinemann, 2007, ISBN 9780750665940 (e-book available).

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MECHANICS OF COMPOSITE MATERIALS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanics of Composite Materials	15ME652	03	3-0-0	80	20	3Hrs

Course objectives:

The course is intended to provide basic understanding of Composite Materials to engineeringstudents with following aspects:

- To acquire basic understanding of composites and its manufacturing
- To develop an understanding of the linear elastic analysis of composite materials, which include concepts such as anisotropic material behavior and the analysis of laminated plates.
- Provides a methodology for stress analysis and progressive failure analysis of laminated composite structures for aerospace,automobile, marine and other engineering applications
- The students will undertake a design project involving application of fiber reinforced laminates.

MODULE -1

Introduction to composite materials:Definition and classification of composite materials: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon-Carbon Composites. Reinforcements and Matrix Materials.

Manufacturing Techniques of Composites:

Fiber Reinforced Plastic (FRP) Processing: Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

Fabrication Process for Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques. **10 Hrs**

MODULE -2

Micromechanics of Composites: Density, Mechanical Properties; Prediction of Elastic Constants,Micromechanical Approach, Halpin-Tsai Equations, Transverse Stresses. Thermal Properties; Expression for Thermal Expansion Coefficients of Composites, Expression for Thermal Conductivity of Composites,Hygral and Thermal Stresses. Mechanics of Load Transfer from Matrix to Fiber;Fiber elastic-Matrix Elastic,Fiber Elastic-Matrix Plastic. Load transfer in Particulate Composites. Numerical Problems. **10 Hrs**

MODULE -3

Macromechanics of Composites: Elastic Constants of an Isotropic Material, Elastic Constants of a Lamina, Relationship between Engineering Constants and Reduced Stiffnesses and Compliances, Variation of Lamina Properties with Orientation, Analysis of Laminated Composites,Stresses and Strains in Laminate Composites, Inter-laminar Stresses and Edge Effects. Numerical Problems. **10 Hrs**

MODULE -4

Monotonic Strength, Fracture, Fatigue and Creep: Tensile and Compressive strength of Unidirectional Fiber Composites. Fracture Modes in Composites; Single and Multiple Fracture, Debonding, Fiber Pullout and Delamination Fracture. Strength of an Orthotropic Lamina; Maximum Stress Theory, Maximum Strain Criterion, Tsai-Hill Criterion, Quadratic Interaction Criterion, Comparison of Failure Theories. Fatigue;S-N Curves, Fatigue Crack Propagation Tests, Damage Mechanics of Fatigue, Thermal Fatigue. Creep behavior of Composites. **10 Hrs**

MODULE -5

Failure Analysis and Design of Laminates: Special cases of Laminates; Symmetric Laminates, Cross-ply laminates, Angle ply Laminates, Antisymmetric Laminates, Balanced Laminate. Failure Criterion for a Laminate.Design of a Laminated Composite. Numerical Problems.

10 Hrs

Course outcomes:

On completion of this subject students will be able to:

1. To identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
2. To predict the failure strength of a laminated composite plate
3. Understand the linear elasticity with emphasis on the difference between isotropic and anisotropic material behaviour.
4. Acquire the knowledge for the analysis, design, optimization and test simulation of advanced composite structures and Components.

TEXT BOOKS:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005
2. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012
3. Robert M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1999.

REFERENCE BOOKS:

1.Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press,2004
2. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009
3. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993
4. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

E- Learning

- VTU, E- learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

METAL FORMING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Metal Forming	15ME653	3	3-0-0	80	20	3Hrs

Course objectives:

The course is intended to provide basic understanding of Metal Forming with following aspects:

- To acquaint with the basic knowledge on fundamentals of metal forming processes
- To study various metal forming processes
- Understanding plastic deformation during forming processes

MODULE -1

Introduction to Metal Forming: Classification ofmetal forming processes, advantages and limitations, stress-strainrelations in elastic and plastic deformation.Concepts of true stress, true strain, triaxial & biaxial stresses. Determination of flow stress,principal stresses, yield criteria and their significance,Tresca& Von-Mises yield criteria, concepts of plane stress & plane strain.Deformation mechanisms, Hot and Cold working processes and its effecton mechanical properties. **10 Hrs**

MODULE -2

Effects of Parameters: Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, Effects of Temperature, strain rate, friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, Residual stresses in wrought products.

Forging: Classification of forging processes. Forging machines equipment. Expressions for forging pressures& load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it. Die-design parameters. Material flow lines in forging,forging defects, residual stresses in forging. Simple problems. **10 Hrs**

MODULE -3

Rolling: Classification of rolling processes. Types of rolling mills, expression for rolling load. Roll separating force. Frictional losses in bearing, power required in rolling, effects of front & back tensions, friction, friction hill. Maximum possible reduction. Defects in rolled products. Rolling variables. Simple problems.

Drawing: Drawingequipment & dies, expression for drawing load by slab analysis, power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, Tube drawing, classification of tube drawing. Simple problems. **10 Hrs**

MODULE -4

Extrusion: Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, extrusion of seamless tubes. Extrusion variables. Simple problems.

Sheet Metal Forming: Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming. Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, LDR in drawing, Forming limit criterion, defects of drawn products, stretch forming. Roll bending & contouring. Simple problems. **10 Hrs**

MODULE -5

High Energy Rate Forming Methods &Powder Metallurgy: High Energy Rate Forming Methods: Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic forming.

Powder Metallurgy: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations. **10 Hrs**

Course outcomes:

On completion of this subject, students will be:

5. Able to understandthe concept of different metal forming process.
6. Able to approach metal forming processes both analytically and numerically
7. Able to design metal forming processes
8. Able to develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

TEXT BOOKS:

1. Mechanical metallurgy (SI Units), G.E.Dieter, McGraw hill Pub-2001.
2. Production Technology (Manufacturing process, technology and Automation), R.K Jain, Khanna Publishers-2004.
3. Manufacturing Science, Amithab Gosh &A.K.Malik, East-West press 2001.
4. Production Technology Vol-II by O. P. Khanna & Lal, Dhanpat Rai Publications-2012.
5. A Course in Workshop Technology Vol: 1, Manufacturing Process, B.S Raghuwanshi, Published by Dhanpat Rai & Co (P) Ltd.-2014.

REFERENCE BOOKS:

1. Materials & Process in Manufacturing – E.Paul, Degramo, J.T.Black, Ranold, A.K.Prentice-hall of India 2002
2. Elements of Workshop Technology Vol:1, S.K.Hajra Choudhury, Media Promoters & Publishers Pvt Ltd.-2008.
3. Fundamentals of Manufacturing Processes by Lal G K , Narosa
4. Textbook of Production Engineering by P. C. Sharma, S Chand & Company Ltd.

E- Learning

- VTU, E- learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

TOOL DESIGN

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Tool Design	15ME63	03	3-0-0	80	20	3Hrs

Course Objectives:

CLO1	To develop capability to design and select single point and multipoint cutting tools for various machining operations.
CLO2	Exposure to variety of locating and clamping methods available.
CLO3	To enable the students to design jigs and fixtures for simple components.
CLO4	To expose the students to the design/selection procedure of press tools and die casting dies.

MODULE 1

Introduction to tool design: Tooling, requirements of a tool designer, general tool design procedure, tool engineering functions and its importance to enhance productivity and quality.

Review of cutting tool materials. Tool angles and signature, Carbide inserts grades - ISO designation and applications, tool holders for turning-ISO designation.Solid type tool, brazed tip tool,throwaway indexable insert types, coated carbides and chip breakers.

Design of single point cutting tools: Design of shank dimensions using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry.

08 Hours

MODULE 2

Design of Multi Point Cutting Tools: Types of drills, Drill bit design - elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry. Re-sharpening of drill bit.

Tool holders for milling, different tapers used for mounting tool holders in milling, ISO designation. Tool mounting systems.

Design of milling cutters: Design of elements like number of teeth and height, circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry. Profile sharpened and form relieved milling cutters. Re-sharpening of side and face milling cutter and end mill.

08 Hours

MODULE 3

Jigs and Fixtures: Functions and differences between jigs and fixtures, advantages in mass production, design principles, economics of jigs and fixtures.
Location: 3-2-1 Principle of location, different types of locating elements.
Clamping: Principles of clamping, types of clamping devices, and power clamping.
Drill bushes;Drill jigs:different types, exercises of designing jigs for simple components.
Fixture Design: Turning fixtures, milling fixtures, grinding fixtures,fixturing for CNC machining centers, and modular fixtures. Design exercises on fixtures for turning and millingfor simple components.

08 Hours

MODULE 4

Press tools: Classificationandworking of power presses. Concept and calculations of press tonnage and shut height of a press, components of a simple die, press tool operation, die accessories, shearing action in punch & die, clearance, shear on punch and die, Centre of pressure, and strip layout.
Simple, progressive, compound, combination and inverted dies. Design problems on blanking and piercing dies for simple components.
Bending dies – Introduction, bend allowance, spring back, edge bending die design.

08 Hours

MODULE 5

Drawing dies – Single action, double action and triple action dies, factors affecting drawing and drawing die design. Design of drawing dies for simple components.
Die casting: Die casting alloys, terminology-core, cavity,sprue, slug, fixed and movable cores, finger cams, draft, ejector pins and plates, gate, goosenozzle, over-flow, platten, plunger, runner, vent, water-line etc.
Types of Dies: Single cavity, multicavity dies, combination dies, unit dies, advantages and disadvantages of types of dies; finishing, trimming and inspection of die casting components, safety, and modern trends in die casting dies.

08 hours

Course Outcomes:

After learning the course the students should be able to:

CO1	Selection appropriate cutting tools required for producing a component.
CO2	Ability to interpret cutting tool and tool holder designation systems.
CO3	Ability to design/select suitable locating and clamping devices for a given component for various operations.
CO4	Capability to design a jig/fixture for a given simple component.
CO5	Comprehensive understanding of various press tools and press tool operations.
CO6	Classify and explain various die casting and injection moulding dies.

Scheme of Examination:
Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Assignment:
Course work includes a **ToolDesign project**. Tool design project should enable the students to design a tooling like Jig or a fixture for a simple component, fixture for a simple component on CNC machining centers, design of a simple blanking and piercing die, progressive die, drawing die etc. Any one of these exercisesshould be given as an assignment. A group of students (maximum number in a group should be 4) should submit assembly drawing and part drawings, completely dimensioned, indicating the necessary manufacturing tolerances, surface finish symbols and geometric tolerances wherever necessary. Tool design project must be completed using appropriate solid modeling software. Computer generated drawings must be submitted. Design calculations must be hand written and should be included in the report.

Design project should be given due credit (5 marks) in internal assessment.

Textbook:

[1]Cyril Donaldson, George H. Lecain,V.C.Goold, "Tool Design", Mc Graw Hill Education, 5th edition,2017.
[2]P.N.Rao, "Manufacturing technology", Mc Graw Hill Education, 4th edition, 2013.

References:

[1] P.H.Joshi, "Jigs and Fixtures", Mc Graw Hill Education, 3rd edition, 2010.
[2] John.G. Nee, William Dufraine, John W.Evans, Mark Hill, " Fundamentals of Tool Design", Society of Manufacturing Engineers, 2010.
[3] Frank W.Wilson, "Fundamentals of Tool Design",PHI publications.
[4] Kempester M.H.A., "An introduction to Jig and Tool design", VIVABooksPvt.Ltd., 2004.
[5] Ranganath B.J., "Metal cutting and Tool Design", Vikas publishing house.
[6] HMT, "Production Technology", TataMc Graw Hill, 2013.
[7] V. Arshinov& G. Alekseev, "Metal cutting theory and practice", MIR publishers, Moscow.
[8] Rodin, "Design and production of metal cutting tools", Beekman publishers.

AUTOMOBILE ENGINEERING

Course	Code	Credits	L-T-P	Assessment		Exam duration
				SEE	CIA	
Automobile	15ME655	3	3-0-0	80	20	3 Hrs

Course learning objectives: The student will be able to learn

- The layout and arrangement of principal parts of an automobile
- The working of transmission and brake systems
- The operation and working of steering and suspension systems
- To know the Injection system and its advancements
- To know the automobile emissions and its effects on environment

MODULE 1

ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I.Engine and C.I.Engines, methods of a Swirl generation, choice of materials for different engine components, engine positioning. Concept of HCCI engines, hybrid engines, twin spark engine, electric car.

COOLING AND LUBRICATION: cooling requirements, types of cooling- thermo siphon system, forced circulation water cooling system, water pump, Radiator, thermostat valves. Significance of lubrication, splash and forced feed system. **10 Hours**

MODULE 2

TRANSMISSION SYSTEMS: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints ,Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

BRAKES: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical **08 Hours**

MODULE 3

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

08 Hours

MODULE 4

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburetors, C.D.& C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System.

08 Hours

MODULE 5

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.

EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act

08 Hours

Course Outcomes: Student will be able

- To identify the different parts of an automobile and it's working
- To understand the working of transmission and braking systems
- To comprehend the working of steering and suspension systems
- To learn various types of fuels and injection systems
- To know the cause of automobile emissions ,its effects on environment and methods to reduce the emissions.

TEXT BOOKS:

1. Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011
2. Automotive Mechanics, S. Srinivasan, (2nd Edition) Tata McGraw Hill 2003.

REFERENCE BOOKS:

1. Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007
2. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
3. Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
4. Automobile Engineering, R. B. Gupta, Satya Prakashan,(4th Edition) 1984.

Energy Auditing

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Energy Auditing	15ME661	03	3-0-0	80	20	3Hrs

Course learning objectives is to

- Understand energy scenario and general aspects of energy audit.
- Learn about methods and concept of of energy audit
- Understand the energy utilization pattern including wastage and its management

Module – I

General Aspects: Review of energy scenario in India, General Philosophy and need of Energy Audit and Management, Basic elements and measurements - Mass and energy balances – Scope of energy auditing industries - Evaluation of energy conserving opportunities, Energy performance contracts, Fuel and Energy substitution, Need for Energy Policy for Industries, National & State level energy Policies

8 Hours

Module – II

Energy Audit Concepts: Need of Energy audit - Types of energy audit – Energy management (audit) approach - understanding energy costs - Bench marking – Energy performance - Matching energy use to requirement - Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors - Energy audit instruments - Procedures and Techniques.

8 Hours

Module – III

Principles and Objectives of Energy Management: Design of Energy Management Programmes - Development of energy management systems – Importance - Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Monitoring and targeting, some case study and potential energy savings.

8 Hours

Module – IV

Thermal Energy Management: Energy conservation in boilers - steam turbines and industrial heating systems - Application of FBC - Cogeneration and waste heat recovery - Thermal insulation - Heat exchangers and heat pumps – HVC industries-Building Energy Management.

8 Hours

Module – V

Electrical Energy Management: Supply side Methods to minimize supply-demand gap - Renovation and modernization of power plants - Reactive power management – HVDC - FACTS - Demand side - Conservation in motors - Pumps and fan systems – Energy efficient motors.

8 Hours

Note: A case study involving energy audit may be taken up with suggestion for energy improvements as a part of assignment.

Course Outcomes

At the end of the course, the student will be able to:

- Understand the basic concepts of energy audit and energy management
- Explain different types of energy audit, maximizing and optimizing system efficiency.
- Summarize energy management systems, prepare and present energy audit report
- Identify energy saving potential of thermal and electrical systems
- Discuss Energy audit instruments, Procedures and Techniques.

TEXT BOOKS:

1. Murphy, W. R., Energy Management, Elsevier, 2007.
2. Smith, C. B., Energy Management Principles, Pergamum, 2007

REFERENCE BOOKS:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience publication)
4. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988)
5. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
6. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993)

E- Learning

https://beeindia.gov.in/content/energy-auditors

Scheme of Examination: Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

INDUSTRIAL SAFETY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
INDUSTRIAL SAFETY	15ME662	03	3-0-0	80	20	3Hrs

Prerequisites:

Elements of Mechanical Engineering
Electrical Engineering
Elements of Civil Engineering
Engineering Chemistry lab
Workshop Practice
Other labs of various courses

Overview:

Accidents lead to human tragedy, economical loss to individual, company and the nation. Safe acts lead to increase in productivity. The present course highlights the importance of general safety and its prevention, extended to mechanical, electrical sand chemical safety. The Industrial safety course helps in motivating the staff and students to understand the reason for fire , its prevention. Controlling of fire by various means are highlighted. Importance of chemical safety, labeling of chemicals, hand signals during forklift operations in industrial and aerodromes will help in to understand and apply the techniques in practical field. A visit to campus, various labs, workshops, local industries and fire stations helps in analyzing the importance of safety and corrective measures through case studies.

MODULE-1 : INTRODUCTION TO SAFETY

Terms used: accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall.
Ladders and scaffolding. Unsafe acts, reason for accidents, MSDS (material safety data sheet), OSHA, WHO.
Lockout and tag out procedures. Safe material handling and storage.
Case studies: Student should identify the unsafe acts near their surroundings like housekeeping, lab layouts, road safety, campus layout, safety signs.
12 hours

MODULE-2 : FIRE SAFETY

Introduction, Class A, B, C, D and E fire. Fire triangle, Fire extinguishers, Fire hazard and analysis, prevention of fire. Fire protection and loss prevention, steps after occurrence of fire. Portable fire extinguishers. Fire detection, fire alarm and fire fighting systems.
Safety sign boards, instruction on portable fire extinguishers.

Case studies: demonstration of fire extinguishers, visit to local fire fighting stations. Visit to fire accident sites to analyze the cause of fire and its prevention for future. 10 hours

MODULE-3 :MECHANICAL SAFETY

PPE, safety guards, Safety while working with machine tools like lathe, drill press, power and band saws, grinding machines. Safety during welding, forging and pressing.
Safety while handling Material, compressed gas cylinders, corrosive substance, waste drum and containers.
Case studies: Visit to machine shop, workshops, foundry lab and local industries to record the practical observation and report the same with relevant figures and comments.

12 hours

MODULE-4 :ELECTRICAL SAFETY

Introduction to electrical safety, Electric hazards, effect of electric current on human body, causes of electrical accidents, prevention of electric accidents, PPE used .
Electric shock. Primary and secondary electric shocks, AC and DC current shocks.
Safety precautions against shocks. Safety precautions in small and residential building intallations.Safety procedures in electric plant.

Case studies: To visit electrical sub stations, local distribution systems, observe and share the experience and report.

12 hours

MODULE-5: CHEMICAL SAFETY AND OTHER SAFETY CHECKS

Introduction to Chemical safety, Labeling of chemicals, acid hoods. Handling of acids, eye washers and showers. Safety thinking, accident investigation, safety policy of the company, safety, loss prevention and control, check list for LPG installations, safety precautions using CNG, fire prevention and safety audit, confined space entry, risk assessment.
Case studies: To visit chemical laboratory of the college and other chemical industries like LPG , CNG facilities and report.

10 hours

Course Outcomes:

At the end of the course, student is able to:

1- Understand the basic safety terms.
2- Identify the hazards around the work environment and industries.
3- Use the safe measures while performing work in and around the work area of the available laboratories.
4- Able to recognize the sign boards and its application.
5- Able to demonstrate the portable extinguishers used for different class of fires.
6- Able to write the case studies by sharing experience of the employees working in housekeeping, laboratories like workshops, electrical labs, machine shops, electronics and computer laboratories.
7- Able to understand and report the case studies from various references (text books, news report, journals, visiting industries like power stations, manufacturing and maintenance).

Text Books:

1- Industrial Safety and Management by L M Deshmukh by McGraw Hill Education (India) private Limited, ISBN-13: 978-0-07-061768-1, ISBN-10: 0-07-061768-6
2- Electrical Safety, fire safety and safety management by S.Rao, R K Jain and Saluja. Khanna Publishers, ISBN: 978-81-7409-306-6

Reference books:

1- Chemical process Industrial safety by K S N Raju by McGraw Hill Education (India) private Limited, ISBN-13: 978-93-329-0278-7, ISBN-10:93-329-0278-X
2- Industrial Safety and Management by L M Deshmukh. McGraw Hill Education (India) private Limited, ISBN-13: 978-0-07-061768-1, ISBN-10: 0-07-061768-6
3- Environmental engineering by Gerard Kiely by McGraw Hill Education (India) private Limited, ISBN-13: 978-0-07-063429-9

VISITS:

1- To visit respective Institution:
   stores, office, housekeeping area, laboratories.
2- To visit local industries, workshops, district fire fighting system facility and local electrical power stations.

Maintenance Engineering

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Maintenance Engineering	15ME663	3	3-0-0	80	20	3Hrs

Course objectives:

The course is intended to provide basic concepts of maintenance engineeringto engineeringstudents with following aspects:

- To acquire basic understanding of Maintenance systems
- To develop an understanding of the principles of Preventive Maintenance & Predictive Maintenance
- Provides a methodology for reliability & probability concepts applied to maintenance engineering
- The students will concepts and procedures for Condition Monitoring in Mechanical and Electrical systems along with the analysis and processing techniques for machine fault identification

MODULE -1

Maintenance systems: Maintenance objectives and scopes; Maintenance strategies & organizations; Maintenance works; life cycle costsPreventive Maintenance: Principles of preventive maintenance, procedures & selection; Preventive Maintenance planning, scheduling and control; Forms & resources; Maintenance work measurement; Modeling and analysis techniques in PM and inspections; Predictive maintenance.

Computerized Maintenance Management systems: Benefits and applications; Work order systems & plant registers; Maintenance reports, analysis and monitoring; Introduction to commercial packages Equipment maintenance:Installation, commissioning and testing of plant equipment, checking for alignment, lubrication and lubrication schedule; maintenance of typical rotating and process equipment systems like turbines, pumps and fans, centrifuges, heat exchangers, boilers and pressure vessels etc.

10 hrs

MODULE -2

Reliability & probability Concepts: Basic concepts of probability theory and distributions, definition of reliability, failure probability, reliability and hazard rate function, MTBF and MTTR, System reliability , series and parallel system, redundancy.

10hrs

MODULE -3

Reliability Centered Maintenance:principles of RCM, Benefits of RCM, application of RCMStep-by-step procedure in conducting RCM analysis. The Plant Register. Functions and Failures. Failure mode and effect analysis (FMEA). Failure consequences. Maintenance and decision making. Acturial analysis and Failure data. Perspective loops. Default action. The RCM Decision diagram. The nature of Failure and Technical history.

10 hrs

MODULE -4

Total Productive Maintenance: Goals of TPM and methodology, TPM improvement plan & procedures. The modern role of care and asset management through TPM The use of TPM concepts consisting of Pareto ABC analysis, Fishbone diagrams, OEE and 5S. Fault analysis.

10 hrs

MODULE -5

Condition Monitoring:

Measurable phenomena from different Plant Items:

Measurable phenomena associated with degradation from a range of plant items includingmotors/generators, transformers, cables, bushings, connectors, capacitors and circuit breakers.

Fault diagnosis of Rotational Machines:

Unbalance, shaft and coupling misalignments, bent shafts, gear and bearing wear, oil whirls and shaft eccentricity.

Measurement Strategies and Techniques:

A wide range of strategies and associated technologies will be discussed including light emission (photo multipliers, fiber optic techniquesetc.), heat emissions (IR, cameras, direct temperature measurement, etc.), electrical charges (tan d, electrical particle discharge, etc.), force, power and vibration.

Data Processing and Analysis:

For each of the approaches, options with respect to data processing and analysis will be discussed including digital signal processing and computational techniques. Close attention will be paid through examples of the cost benefits and the reliability which can be placed on data with respect to formulating a view on the condition of a give item of plant.

10 hrs

Course outcomes:

On completion of this subject students will be able to:

1. Understand maintenance objectives and evaluate various maintenance strategies for process plant application, Develop necessary planning and scheduling and control of preventive maintenance activities.
2. Evaluate reliability of a simple plant component and system.
3. Understand and apply the advanced concepts such as RCM and advantages for a company employing them
4. Understand and apply the advanced concepts such as TPM and advantages for a company employing
5. Applythe principles of condition monitoring systems.
6. Apply the mechanical condition monitoring techniques and analyze the data used in condition monitoring

TEXT BOOKS:

1. Practical machinery Vibration Analysis & Predictive Maintenance, C. Scheffer and P. Girdhar,, IDC technologies, 2004.
2. Introduction to Machinery Analysis and Monitoring, John S. Mitchell, PennWell Books, 1993.
3. Machinery Vibration, Measurement and Analysis, Victor Wowk, Mc Craw Hill,1991

REFERENCE BOOKS:

1. Handbook of Condition Monitoring, B.K.N. Rao,1996
2. Reliability Engineering, Srinath L S,
3. Maintenance Replacement and Reliability, Jardine AKS,
4. Practical reliability engineering, Oconnor, Patrick D T
5. , Reliability and Maintainability Engineering, Charles E Ebeling
6. Introduction to Reliability Engineering Lewis E,

E- Learning

- VTU, E- learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

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TOTAL QUALITY MANAGEMENT

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Total Quality Management	15ME664	03	3-0-0	80	20	3Hrs

COURSE LEARNING OBJECTIVES:
This course enables students to

1. Understandvarious approaches to TQM
2. Understandthe characteristics of quality leader and his role.
3. Developfeedback and suggestion systems for quality management.
4. Enhance the knowledge in Tools and Techniques of quality management

Module - 1
Principles and Practice: Definition, basic approach, gurus of TQM, TQMFramework, awareness, defining quality, historical review, obstacles, benefitsof TQM.
Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.
08 Hours

Module - 2
Leadership: Definition, characteristics of quality leaders, leadership concept,characteristics of effective people, ethics, the Deming philosophy, role ofTQM leaders, implementation, core values, concepts and framework,strategic planning communication, decision making,
08Hours

Module - 3
Customer Satisfaction and Customer Involvement:
Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs intorequirements, customer retention,casestudies.
Employee Involvement – Motivation, employee surveys, empowerment,teams, suggestion system, recognition and reward, gain sharing, performanceappraisal, unions and employee involvement, case studies.
08 Hours

Module - 4
Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.
Statistical Process Control : Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies

Module - 5

Tools and Techniques: Benching marking, information technology, quality management systems, environmental management system, and qualityfunction deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.

08 Hours

COURSE OUTCOMES:

Student will be able to

1. Explain the various approaches of TQM
2. Infer the customer perception of quality
3. Analyze customer needs and perceptions to design feedback systems.
4. Apply statistical tools for continuous improvement of systems
5. Apply the tools and technique for effective implementation of TQM.

TEXT BOOKS:

1. Total Quality Management: Dale H. Besterfield, Publisher -Pearson Education India, ISBN: 8129702606, Edition 03.
2. Total Quality Management for Engineers: M. Zairi, ISBN:1855730243, Publisher: Wood head Publishing

REFERENCE BOOKS:

1. Managing for Quality and Performance Excellence by James R.Evans and Williuam M Lindsay,9th edition, Publisher Cengage Learning.
2 A New American TQM, four revolutions in management, ShojiShiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
3. Organizational Excellence through TQM, H. Lal, New age Publications, 2008

Reference Books:

1. Engineering Optimization Methods and Applications, A Ravindran, K, M.Ragsdell, Willey India Private Limited,2nd Edition,2006.
2. : Introduction to Operations Research- Concepts and Cases, F.S. Hillier. G.J. Lieberman, 9th Edition, Tata McGraw Hill. 2010.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

Heat Transfer Lab

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Heat Transfer Lab	15MEL67	02	1-0-2	80	20	3Hrs

Co□requisite Courses: Heat Transfer

Course Objectives:

- The primary objective of this course is to provide the fundamental knowledge necessary to understand the behavior of thermal systems.
- This course provides a detailed experimental analysis, including the application and heat transfer through solids, fluids, and vacuum. Convection, conduction, and radiation heat transfer in one and two dimensional steady and unsteady systems are examined.

PART – A

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Determination of Effectiveness on a Metallic fin.
4. Determination of Heat Transfer Coefficient in a free Convection on a
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
6. Determination of Emissivity of a Surface.
7. Analysis of steady and transient heat conduction, temperature distribution of plane wall and cylinder using Numerical approach (ANSYS/CFD package).

PART – B

1. Determination of Steffan Boltzmann Constant.
2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
3. Experiments on Boiling of Liquid and Condensation of Vapour.
4. Performance Test on a Vapour Compression Refrigeration.
5. Performance Test on a Vapour Compression Air – Conditioner.
6. Experiment on Transient Conduction Heat Transfer.
7. Determination of temperature distribution along a rectangular and circular fin subjected to heat loss through convection using Numerical approach (ANSYS/CFD package)

Course Outcomes: At the end of this course students are able to,

- Perform experiments to determine the thermal conductivity of a metal rod

- Conduct experiments to determine convective heat transfer coefficient for free and forced convection and correlate with theoretical values.
- Estimate the effective thermal resistance in composite slabs and efficiency in pin-fin
- Determine surface emissivity of a test plate
- Estimate performance of a refrigerator and effectiveness of fin
- Calculate temperature distribution of study and transient heat conduction through plane wall, cylinder and fin using numerical approach.

Reading:

1. M. Necati Ozisik, Heat Transfer – A Basic Approach, McGraw Hill, New York, 2005.
2. Incropera, F. P. and De Witt, D. P., Fundamentals of Heat and Mass Transfer, 5th Edition, John Wiley and Sons, New York, 2006.
3. Holman, J. P., Heat Transfer, 9th Edition, Tata McGraw Hill, New York, 2008.

Scheme of Examination:

ONE question from part -A: 25 Marks

ONE question from part -B: 40 Marks

Viva –Voice : 15 Marks

Total: 80 Marks

Modeling and Analysis Lab (FEA)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Modeling and Analysis Lab	15MEL68	02	1-0-2	80	20	3Hrs

CREDITS – 02

Prerequisites: Knowledge of any Modeling software, knowledge of coordinate systems and Geometric transformations etc.

Course objectives:

The course is intended to provide basic understanding of Modeling and Analysis techniques students with following aspects:

- To acquire basic understanding of Modeling and Analysis software
- To understand the different kinds of analysis and apply the basic principles to find out the stress and other related parameters of bars, beams loaded with loading conditions.
- To lean to apply the basic principles to carry out dynamic analysis to know the natural frequency of different kind of beams.

PART – A

Study of a FEA package and modeling and stress analysis of:

1. Bars of constant cross section area, tapered cross section area and stepped bar
2. Trusses – (**Minimum 2 exercises of different types)**
3. Beams – Simply supported, cantilever, beams with point load , UDL, beams with varying load etc **(Minimum 6 exercises different nature)**

4. Stress analysis of a rectangular plate with a circular hole

PART - B

1) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions **(Minimum 4 exercises of different types)**

2) Dynamic Analysis to find

a) Fixed – fixed beam for natural frequency determination

b) Bar subjected to forcing function
c) Fixed – fixed beam subjected to forcing function

PART – C (<u>only for demo and oral exam</u>)

1) Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver
2) Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.
3) Demonstrate at least two different type of example to model and analyze bars or plates made from composite material

Course Outcomes: At the end of the course the students are able to:

- Demonstrate the basic features of an analysis package.
- Use the modern tools to formulate the problem, and able to create geometry, descritize, apply boundary condition to solve problems of bars, truss, beams, plate to find stress with different-loading conditions.
- Demonstrate the deflection of beams subjected to point, uniformly distributed and varying loads further to use the available results to draw shear force and bending moment diagrams.
- Analyze the given problem by applying basic principle to solve and demonstrate 1D and 2D heat transfer with conduction and convection boundary conditions.
- Carry out dynamic analysis and finding natural frequencies for various boundary conditions and also analyze with forcing function.

REFERENCE BOOKS:

1. **A first course in the Finite element method,** Daryl L Logan, Thomason, Third Edition

2. **Fundaments of FEM,** Hutton – McGraw Hill, 2004

3. **Finite Element Analysis,** George R. Buchanan, Schaum Series

Scheme for Examination:

One Question from Part A - 32 Marks (08 Write up +24)

One Question from Part B - 32 Marks (08 Write up +24)

Viva-Voce - 16 Marks

Total 80 Marks

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Mechanical Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME71	Energy Engineering	3	2	0	03	80	20	100	4
2	15ME72	Fluid Power Systems	4	0	0	03	80	20	100	4
3	15ME73	Control Engineering	3	2	0	03	80	20	100	4
4	15ME74X	Professional Elective - III	3	0	0	03	80	20	100	3
5	15ME75X	Professional Elective-IV	3	0	0	03	80	20	100	3
6	15MEL76	Design Lab	1	0	2	03	80	20	100	2
7	15MEL77	CIM Lab	1	0	2	03	80	20	100	2
8	15MEP78	Project Phase – I	-	-	-	-	-	100	100	2
TOTAL			**18**	**4**	**04**		**560**	**240**	**800**	**24**

Professional Elective-III		Professional Elective-IV	
15ME741	Design of Thermal Equipments	15ME751	Automotive Electronics
15ME742	Tribology	15ME752	Fracture Mechanics
15ME743	Financial Management	15ME753	Mechatronics
15ME744	Design for Manufacturing	15ME754	Advanced Vibrations
15ME745	Smart Materials & MEMS		

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch

ENERGY ENGINEERING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Energy Engineering	15ME71	04	3-2-0	80	20	3Hrs

Courselearning objectives is to

- Understand energy scenario,energy sources and their utilization
- Learn about energy conversion methods and their analysis
- Study the principles of renewable energy conversion systems
- Understand the concept of green energy and zero energy.

Module – I

Thermal Energy conversion system: Review of energy scenario in India,General Philosophy and need of Energy ,Different Types of Fuels used for steam generation,Equipment for burning coal in lump form, strokers, different types, Oilburners, Advantages and Disadvantages of using pulverized fuel, Equipmentfor preparation and burning of pulverized coal, unit system and bin system.Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generationof steam using forced circulation, high and supercritical pressures.Chimneys: Natural, forced, induced and balanced draft, Calculations andnumerical involving height of chimney to produce a given draft. Coolingtowers and Ponds. Accessories for the Steam generators such asSuperheaters, De-superheater, control of superheaters, Economizers, Air preheatersand re-heaters.

9 Hours

Module – II

Diesel Engine Power System: Applications of Diesel Engines in Power field.Method of starting Diesel engines. Auxiliaries like cooling and lubricationsystem, filters, centrifuges, Oil heaters, intake and exhaust system, Layout ofdiesel power plant.

Hydro-Electric Energy: Hydrographs, flow duration and mass curves, unithydrograph and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks,gates and valves. General layout of hydel power plants.

7 Hours

Module – III

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data, Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems, Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems

8 Hours

Module – IV

Wind Energy: Properties of wind, availability of wind energy in India, windvelocity and power from wind; major problems associated with wind power,wind machines; Types of wind machines and their characteristics, horizontaland vertical axis wind mills, coefficient of performance of a wind mill rotor(Numerical Examples).

Tidal Power: Tides and waves as energy suppliers and their mechanics;fundamental characteristics of tidal power, harnessing tidal energy,limitations. **8 Hours**

Module – V

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Green Energy: Introduction: Fuel cells: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics Nuclear, ocean, MHD, thermoelectric and geothermal energy applications; Origin and their types; Working principles, Zero energy Concepts

8 Hours

Course Outcomes

At the end of the course, the student will be able to:

- Summarize the basic concepts of thermal energy systems,
- Identify renewable energy sources and their utilization.
- Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
- Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas.
- Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.
- Identify methods of energy storage for specific applications

TEXT BOOKS:

1. B H Khan, Non conventional energy resources, 3rd Edition, McGraw Hill Education
2. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill. 1996

REFERENCE BOOKS:

1. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).
2. C. S. Solanki, “Solar Photovoltaic’s: Fundamental A pplications and Technologies, Prentice Hall of India, 2009.
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Scheme of Examination: Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

FLUID POWER SYSTEMS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Fluid Power Systems	15ME72	04	3-2-0	80	20	3Hrs

Course objectives:

CLO1	To provide an insight into the capabilities of hydraulic and pneumatic fluid power.
CLO2	To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
CLO3	To examine concepts centering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
CLO4	Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
CLO5	To familiarize with logic controls and trouble shooting

Module 1: Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications. Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers.

10 hours

Module 2: Pumps and actuators

Pumps: Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps.

Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor.

Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders.

Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power,flowrate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).

10 hours

Module3: Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves.
Pressure control valves - types, direct operated types and pilot operated types.

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application,hydrauliccylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication;speedcontrol of hydraulic cylinder- metering in, metering out and bleed off circuits.Pilot pressure operated circuits.Hydraulic circuit examples withaccumulator.

10 hours

Module4: Pneumatic power systems

Introduction to Pneumatic systems:Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.

Pneumatic Actuators: Linear cylinder –types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols.

10 hours

Module5: Pneumatic control circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.
Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications.
Practical examples involving the use of logic gates.
Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).
Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application.

10 hours

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Identify and analyse the functional requirements of a fluid power transmission system for a

	given application.
CO2	Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.
CO3	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.
CO4	Select and size the different components of the circuit.
CO5	Develop a comprehensive circuit diagramby integrating the components selected for the given application.

TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with applications”, Pearson edition,2000 .
2. Majumdar S.R., “Oil Hydraulics”,TalaMcGRawHllL, 2002 .
3. Majumdar S.R., “Pneumatic systems - Principles and Maintenance”,Tata McGraw-Hill, New Delhi, 2005

REFERENCE BOOKS:

1. John Pippenger, Tyler Hicks, “Industrial Hydraulics”, McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol I,IIandIII.
4. Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, PrentcieHall, 2004
6. John Watton, “Fundamentals of fluid power control”, Cambridge University press, 2012.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Learning Assignment:

The faculty will allocate one or more of the following experiments from group A and B to group of students(containing not more than fourstudents in a group):

Group A: Experiments on hydraulic trainer:

a. Speed control circuit using metering in and metering out technique

b. Regenerative and sequencing circuits.

c. Extend-Retract and Stop system of a linear actuator

d.Rapid Traverse and Feed circuit.

Group B: Experimentson pneumatic trainer:

a. Automatic reciprocating circuit
b. Speed control circuit
c. Pneumatic circuit involving shuttle valve/ quick exhaust valve
d. Electro pneumatic valves and circuit

Students should build up the above circuits on computer using software and simulate the flow of fluid during the operation. Afterwards, they themselves can physically connect the circuit on the hydraulic/pneumatic trainer and run the circuit. Record of experiments shall be submitted in the form of journal. Due credit must be given for this assignment (5 Marks).

List of Open Source Software/learning website:

1. Simulink
2. SimHydraulics

CONTROL ENGINEERING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Control Engineering	15ME73	04	3-2-0	80	20	3Hrs

Course Objectives	1. Modeling of mechanical, hydraulic, pneumatic and electrical systems. 2. Representation of system elements by blocks and its reduction 3. Transient and steady state response analysis of a system. 4. Frequency response analysis using polar plot. 5. Frequency response analysis using bode plot. 6. Analysis of system using root locus plots. 7. Different system compensators and variable characteristics of linear systems.

MODULE I

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.

(**7 Hours)**

MODULE 2

Modeling of Physical Systems : Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems.
(3 hours)

Analogous Systems: Direct and inverse analogs for mechanical, thermal and fluid systems. **(4 hours)**

Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block dia. to obtain closed loop transfer function.

Signal flow graphs : Mason's gain formula **(6 Hours)**

MODULE 3

Steady state operation: Steady state analysis for general block dia. for a control system, steady state characteristics, equilibrium in a system**. (3 hours)**

Transient Response: Transient response and steady state analysis of unit, step input, general operational representation for a differential equation of control system, distinct, repeated and complex conjugate zeros, general form of transient response, Routh's stability criterion for a control system. **(4 hours)**

Root Locus Plots : Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation **(6 Hours)**

MODULE 4

Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins **(14 Hours)**

MODULE 5

System Compensation and State Variable Characteristics of Linear Systems : Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalmanand Gilberts test .

(**7 Hours)**

Course Outcomes
CO1: Recognize control system and its types , control actions
CO2: Determine the system governing equations for physical models(Electrical, Thermal, Mechanical, Electro Mechanical)
CO3: Calculate the gain of the system using block diagram and signal flow graph
CO4: Illustrate the response of 1st and 2nd order systems
CO5: Determine the stability of transfer functions in complex domain and frequency domain
CO6: Employ state equations to study the controllability and observability

DESIGN OF THERMAL EQUIPMENTS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Design of thermal Equipments	15ME741	03	3-0-0	80	20	3Hrs

Course objectives :

1. To understand types of heat exchanger
2. To study the design shell and tube heat exchanger
3. To study types and design of steam heat condenser and compact heat exchanger
4. To comprehend and design air cooled heat exchanger
5. To understand and to design air cooled heat exchanger, furnaces

Module I

Introduction To Heat Exchanger Design: Types of heat exchangers and their applications. Flow arrangements and temperature distributions in transfer type of heat exchangers. Overall heat transfer coefficient;- Clean overall heat transfer coefficient, dirt factor dirt overall heat transfer coefficient, dirt factors for various process services.

Double Pipe Heat Exchangers: Film coefficients for tubes and annuli, equivalent diameter of annuli, fouling factors, caloric or average fluid temperature, true temperature difference; Design calculation of double pipe heat exchanger, double pipe exchangers in series-parallel arrangements.**08 Hrs**

Module II

Shell and tube heat exchangers - tube layouts, baffle spacing, classification of shell and tube exchangers, Design calculation of shell and tube heat exchangers, flow assignments: tube side flow area calculations; viscosity correction factor, shell side equivalent diameter, calculation of shell side heat transfer coefficient, evaluation for wall temperature, evaluation of overall heat transfer coefficient, Calculation of surface area. Calculations of tube side and shell side pressure drops. **08 Hrs**

Module III

Steam Condensers: Specifications of other details as per TEMA standards. Flow arrangement for increased heat recovery: - lack of heat recovery in 1-2 exchangers true temperature difference in a 2-4 exchanger. Calculationprocedure for steam condensers.

Compact Heat Exchangers: Introduction; definition of Geometric Terms: plate fin surface geometries and surface performance data; correlation of heat transfer and friction data; Goodness factor comparisons; specification ofrating and sizing problems; calculation procedure for a rating problem.**08 Hrs**

Module IV

Air-Cooled Heat Exchangers: Air as coolant for industrial processes; custom-built units; fin-tube systems for air coolers; fin-tube bundles; thermal rating; tube side flow arrangements; cooling air supply by fans; cooling airsupply in natural draft towers.

Furnaces And Combustion Chambers: Introduction; process heaters and boiler; heat transfer in furnaces: - Heat source; Heat sink; refractory surfaces; heat transfer to the sink; Design methods: - Method of Lobo and Evans:Method of Wilson, Lobo and Hottel; The Orrok-Hudson equation;Wallenberg simplified method. **08 Hrs**

Module V

Heat pipes - types and applications, operating principles, working fluids, wick structures, control techniques, pressure balance, maximum capillary pressure, liquid and vapor pressure drops, effective thermal conductivity of wick structures, capillary limitation on heat transport capability, sonic, entrainment, and boiling limitations, determination of operating conditions; Heat pipe design – fluid selection, wick selection, material selection, preliminary design considerations, heat pipe design procedure, determination of heat pipe diameter, design of heat pipe containers, wick design, entertainment and boiling limitations, design problems **08 Hrs**

Course outcomes:

1. To have complete knowledge of heat exchanger and its applications
2. To be able to design shell and tube heat exchanger
3. To be able to select and design of steam heat condenser and compact heat exchanger condenser and heat pipes for various application

TEXT BOOKS:

1. **Process Heat Transfer**: Donald Q. Kern, Tata McGraw –Hill Edition (1997)
2. **Compact Heat Exchangers:** W. M. Kays & A. L. London, McGraw –Hill co. (1997)
3. **Heat Pipe Theory and Practice** Chi, S. W., - A Source Book, McGraw-Hill, 1976

REFERENCE BOOKS:

1. **Heat Transfer – A Basic Approach:** NecatiOzsisik, McGraw – Hill International edition (1985).
2. **Heat Exchanger Design Hand Book:** Volumes 2 and 3, edited by Ernst U schlunder. et. al Hemisphere Publishing Co. (1983)
3. **Heat exchanger-** Kokac Thermal- hydraulic and design analysis.
4. **Heat Pipes** Dunn, P. D. and Reay, D. A., , Fourth Edition, Pergamon Press, 1994

TRIBOLOGY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Tribology	15ME742	03	3-0-0	80	20	3Hrs

Course objectives:

CLO1	To educate the students on theimportance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.
CLO2	To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
CLO3	Tomake the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
CLO4	To expose the students to the factors influencing the selection of bearing materials fordifferent sliding applications.
CLO5	To introduce the concepts of surface engineering and its importance in tribology.

Module 1

Introduction to tribology: Historical background, practical importance, and subsequent use in the field.

Lubricants: Types and specific field of applications. Properties of lubricants,viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

8 hours

Module 2

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals.
Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

8 hours

Module3

Hydrodynamic journal bearings: Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D.

Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's number and it'ssignificance;partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only.

10 hours

Module4

Plane slider bearings with fixed/pivoted shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing,center of pressure, numerical examples.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples.

8 hours

Module5

Bearing Materials: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials.

Introduction to Surface engineering: Concept and scope of surface engineering.

Surface modification – transformation hardening, surface melting, thermo chemical processes.

Surface Coating – plating,fusionprocesses, vapor phase processes.

Selection of coating for wear and corrosion resistance.

8 hours

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Understand the fundamentals of tribology and associated parameters.
CO2	Apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
CO3	Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application.
CO4	Select proper bearing materials and lubricants for a given tribological application.
CO5	Apply the principles of surface engineering for different applications of tribology.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Use of approved Design Data Handbook/charts can be permitted during the examination.

TEXTBOOKS:

1.”Introduction to Tribology”, B. Bhushan, John Wiley & Sons, Inc., New York, 2002

2. “Engineering Tribology”, Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011. 3.“Engineering Tribology”, J. A. Williams, Oxford Univ. Press, 2005.

REFERENCES:

1. “Introduction to Tribology in bearings”, B. C. Majumdar, Wheeler Publishing.
2. “Tribology, Friction and Wear of Engineering Material”, I. M.Hutchings, Edward Arnold, London,1992.
3. “Engineering Tribology”, G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann,1992.
4. “Friction and Wear of Materials”, Ernest Rabinowicz, John Wiley & sons,1995.
5. “Basic Lubrication Theory”, A. Cameron, Ellis Hardwoods Ltd., UK.
6. “Handbook of tribology: materials, coatings and surface treatments”, B.Bhushan, B.K. Gupta, McGraw-Hill,1997.

FINANCIAL MANAGEMENT

<table>
<tr><td rowspan="2">Course</td><td rowspan="2">Code</td><td rowspan="2">Credits</td><td rowspan="2">L-T-P</td><td colspan="2">Assessment</td><td rowspan="2">Exam Duration</td></tr>
<tr><td>SEE</td><td>CIA</td></tr>
<tr><td>Financial Management</td><td>15ME743</td><td>03</td><td>3-0-0</td><td>80</td><td>20</td><td>3Hrs</td></tr>
</table>

Subject Overview: Finance is the lifeblood of any enterprise. Financial Management is imperative for efficient utilization and generation of monetary resources and funds. The subject deals with fundamental books and records of accounts with financial analysis. The subject imparts expose to statutory levies to strengthen the understanding of government taxed and duties including the general sales tax structure. The subject includes concepts of market risks and returns to efficiently manage the cash and circumvent liquidity problems both at the individual and organizational levels. In the new CBCS scheme, topics on investment decisions and asset management decisions besides the financing decisions. The curriculum also includes costing and budgeting to enable budding engineers to make a comparative study of finance and economics and evaluate costs and revenues of engineering operations.

MODULE - 1

INTRODUCTION: Book keeping – systems of book keeping, journal an d ledger posting. Financial Statement, Preparation of Trial balance, profit and Loss Account, Balance Sheet with adjustments.

05HoursSTATUTORY LEVIES: Forms of organization, direct and indirect taxes. Statutory Registration- excise Duty, central sales tax, VAT, service tax, central and state general Sales tax, international fund availability.

05 Hours

MODULE - 2

WORKING CAPITAL MANAGEMENT: Definition, need and factors influencing the working capital requirement. Determination of operating cycle, cash cycle and operating cycle analysis. Calculation of gross working capital and net working capital requirement.

06 Hours

LONG TERM FINANCING: Raising of finance from primary and secondary markets. Valuation of securities, features of convertible securities and warrants. Features of debt, types of debt instruments, return on investment(ROI) and credit rating of units. Shares, debentures.

06 Hours

MODULE-3

INVESTMENT DECISIONS: Inventory investment , Strategic investment , Ownership investments , lending investment, cash equivalent investment, factors affecting investment decisions, Capital Budgeting, disinvestment methods - public offer, sale of equity, cross holding

06 Hours

ASSET MANAGEMENT DECISIONS : Current Asset Management , Fixed Asset Management, Wealth management , engineering asset management (EAM) - asset maintenance technologies, asset reliability management, project management

06 Hours

MODULE -4

RISK AND REQUIRED RETURN: Risk and return relationship, methods of measuring the risk, Business risk, financial risk, calculation of expected rate of return to the portfolio, financial theories - portfolio theory , capital asset pricing model , arbitage pricing theorynumerical problems. **06 Hours**

RATIO ANALYSIS / ACCOUNTING RATIO: Liquidity ratio – Current ratio, quick ratio, turn over ratio, capital structure ratio- Debt – equity ratio, Coverage ratio, Profitability ratio, Profit margin, Return on assets, Activity ratios – Invento ry turnover ratio, Debtors Turnover ratio. Preparation of the balance sheet from various ratios. Analysis of any one published balanced sheet.

07 Hours

MODULE - 5

COSTING: Classification of costs, preparation of cost sheet, absorption and variable costing, standard costing, job costing, process costing. Classification of the variances analysis – material , labor and overhead variances.

06 Hours

BUDGETING: Types of budgets – Flexible budgets, preparation of cash budgets, purchase and production budgets and master budget, Budgetary control, advantages & limitations of budgeting.

06 Hours

Course Outcomes: Upon successful completion of the course, students will be able to:

1. Measure the returns from engineering projects of differing risks and present a risk-return tradeoff relationship (PO 4, 12)
2. Determine the financial ratios and profitability margins of projects to evaluate economic viability to accept or reject the project. (PO 11)
3. Evaluate cost break ups of engineering projects and processes to determine and control the prohibitive cost components (PO 11)
4. Apply a Engineering Asset Management techniques to evaluate the economic value of physical assets. (PO 1, 11, 12)

TEXTBOOKS:

1. **Financial Management,** Khan & Jain, text & problems TMH ISBN 0-07-460208-A. 20001
2. **Financial Accounting, Costing and Management Accounting,** S. M. Maheshwari, 2000
3. **Srivatsava, Radhey Mohan, Financial Decision Making** : Text Problem and Cases, New Delhi : Sterling Publishers (Private) Limited, 198*, p»H
4. Francis, Pitt, The Foundations of Financial Management, London : Arnold Heinmann, 1983, p.l

REFERENCE BOOKS:

2. **Financial Management,** I. M. Pandey, Vikas Publication House ISBN 0-7069-5435-1. 2002
3. **Financial Management,** Abrish Gupta, Pearson.
4. **Financial Decision Making,**Humpton. 2000
5. **Financial Management,** Theory and Practice, Prasanna Chandra TMH ISGN -07-462047-9, 3rd edition 2002
6. **Essentials of Financial Management**, Walker, Ernest W., New Delhi : Prentice Hall of India Pvt. Ltd, 1976, p.l

Course Outcomes: Upon successful completion of the course, students will be able to:

1. Measure the returns from engineering projects of differing risks and present a risk-return tradeoff relationship (PO 4, 12)
2. Determine the financial ratios and profitability margins of projects to evaluate economic viability to accept or reject the project. (PO 11)
3. Evaluate cost break ups of engineering projects and processes to determine and control the prohibitive cost components (PO 11)
4. Apply a Engineering Asset Management techniques to evaluate the economic value of physical assets. (PO 1, 11, 12)

Design for Manufacturing

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Design for Manufacturing	15ME744	03	3-0-0	80	20	3Hrs

Course objectives:

CLO1	To educate students on factors to be considered in designing parts and components with focus on manufacturability.
CLO2	To expose the students to dimensional tolerances, geometric tolerances and true position tolerance techniques in manufacture.
CLO3	To impart the knowledge on design considerations for designing components produced using various machining operations like turning, drilling, milling, grinding etc.
CLO4	To educate the students on design rules and recommendations for processes like casting, welding, forgings powder metallurgy and injection moulding.

Module 1:

Major phases of design, effect of material properties on design, effect of manufacturing processes on design. Material selection process- cost per unit property, weighted properties and limits on properties methods. Guidelines for design for manufacturability.

Review of relationship between attainable tolerance grades and different machining processes.Processcapability,mean, variance, skewness, kurtosis, process capability indices- Cp, and Cpk.

Cumulative effect of tolerance- Sure fit law and truncated normal law, problems.

8 hours

Module 2:

Selective Assembly: Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.

True positional theory: Comparison between coordinate and true position method offeature location. True position tolerance- virtual size concept, floating and fixed fasteners, projected tolerance zone and functional gages. Concept of Zero true position tolerance. Simple problems on true position tolerancing.

10 hours

Module3:

Datum Features: Functional datum, datum for manufacturing, changing the datum;examples.

Component Design: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility. Design for assembly

8 hours

Module4:

Design of components with casting considerations: Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possibleand probable parting lines. Castings requiring special sand cores. Designing to obviatesand cores.
Welding considerations: requirements and rules, redesign of components for welding; case studies.

8 hours

Module5:

Forging considerations -requirements and rules-redesign of components for forging and case studies.
Design of components for powder metallurgy- requirements and rules-case studies.
Design of components for injection moulding- requirements and rules-case studies.

8 hours

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Describe the different types of manufacturing systems and comparetheir suitability foreconomic production of various components and products.
CO2	Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.
CO3	Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.
CO4	

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

TEXTBOOKS:

1. Peck, H. "Designing for Manufacture", Pitman Publications, London, 1983.
2. Dieter, G.E. "Engineering Design: A Materials and processing Approach", McGraw Hill Co.Ltd, 2000.
3. Bralla, James G., "Handbook of Products Designfor Manufacturing: A Practical Guide to Low-cost Production", McGraw Hill, New York, 1986.

REFERENCES:

1. Eggert, R.J. "Engineering Design" Pearson Education, Inc., New Jersey, 2005.
2. Matousek , R. "Engineering Design", Blackie and Son Limited, Glasgow, 1967.
3. Kalandar Saheb, S.D and Prabhakar, O. "Engineering Design for Manufacture",ISPE 1999.
4. Trucks, H.E., "Design for Economical Production", 2nded., Mich., Dearborn, SME 1987.
5. Linberg, Roy A., "Processes and Materials of Manufacture", 4thed., Allyn and Bacon, Boston, U.S.A., 1990.

SMART MATERIALS and MEMS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Smart Materials and MEMS	15ME745	03	3-0-0	80	20	3Hrs

Course Objective:

This course provides a detailed overview to smart materials, piezoelectric materials structures and its characteristics. The study of Smart structures and modelling helps in Vibration control using smart materials in various applications. Helps to understand the principles and concepts of using MEMS, ER & MR Fluids for various applications.

MODULE 1

Unit1: Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics.

– 5hrs

Unit 2: Shape Memory Alloys: Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators.

– 5hrs

MODULE -2

Unit-3 Electro rheological and Magneto rheological Fluids:Mechanisms and Properties, Characteristics,Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applicationsof ER and MR fluids (Clutches, Dampers, others).

– 5hrs

Unit-4FibreOptics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements. – 5hrs

MODULE-3

Unit 5: Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.

– 6hrs

Unit 6: Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Mollusks. Biomimetic sensing, Challenges and oppurtunities.

– 5hrs

MODULE -4

Unit7: MEMS:History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Microfabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design.

– 5hrs

Unit 8: Piezoelectric Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies,Comparison of major sensing and actuation methods.

– 5hrs

MODULE-5

Unit 9: Polymer MEMS&Microfluidics:Introduction, Polymers in MEMS(Polyimide, SU-8,LCP,PDMS,PMMA,Parylene, Others) Applications(Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves.

– 6hrs

Unit 10: Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition

. – 5hrs

TEXT BOOKS:

1.“Smart Structures –Analysis and Design”, A.V.Srin ivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).
2. “Smart Materials and Structures”, M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107)
3. “Foundation of MEMS, by Chang Liu. Pearson Educa tion. (ISBN:9788131764756)

COURSE OUTCOMES:

1. Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.
2. Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.
3. Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.
4. Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation.

Automotive Electronics

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Automotive Electronics	15ME751	03	3-0-0	80	20	3Hrs

Course Objective

Students will learn

1. Basics of electronic control of internal combustion engines and the drives
2. Understand principle of working of sensors and actuators used in automobiles for control
3. Diagnostics and safety systems in automobiles

Module 1

Automotive Fundamentals Overview –Evolution of Automotive Electronics,

Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control,

Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission,

Drive Shaft, Differential, Suspension, Brakes, Steering System\, Starter Battery –Operating principle: (

7 hours

The Basics of Electronic Engine Control – Motivation for Electronic EngineControl – Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system,

Analysis of intake manifold pressure, Electronic Ignition.

6 hours

Module 2

Control Systems - Automotive Control System applications of Sensors and Actuators – Typical Electronic Engine Control System, Variables to be measured

3 hours

Automotive Sensors –Airflow rate sensor, Strain Gauge MAP sensor, Engine

Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O2/EGO) Lambda Sensors, Piezoelectric Knock Sensor.

5 hours

Automotive Actuators – Solenoid, Fuel Injector, EGR Actuator, Ignition System

3 hours

Module 3

Digital Engine Control Systems – Digital Engine control features, Controlmodes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control - Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System - Secondary Air Management, Evaporative

Emissions Canister Purge, Automatic System Adjustment, System Diagnostics.

6 hours

Control Units – Operating conditions, Design, Data processing,Programming, Digital modules in the Control unit, Control unit software.

3 hours

Module 4

Automotive Networking –Bus Systems–Classification, Applications in thevehicle, Coupling of networks, Examples of networked vehicles (Text 2: Pg. 85-91), Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, FlexRay, Diagnostic Interfaces. **6 hours**

Vehicle Motion Control –Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock

Brake System (ABS) **3 hours**

Module 5

Automotive Diagnostics–Timing Light, Engine Analyzer, On-boarddiagnostics, Off-board diagnostics, Expert Systems, Occupant Protection
Systems – Accelerometer based Air Bag systems.

4hours

Future Automotive Electronic Systems –Alternative Fuel Engines, Electricand Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display,
Speech Synthesis, Navigation – Navigation Sensors - Radio Navigation,Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving Control

6 hours

Course Outcomes

1. Explain the electronics systems used for control of automobiles
2. Select sensors, actuators and control systems used in automobiles
3. Diagnose the faults in the sub systems and systems used automobile

Text Books:

1. William B.Ribbens, "Understanding Automotive El ectronics", 6th Edition, Elsevier Publishing.

2. Robert Bosch Gmbh (Ed.) Bosch Automotive Electrics and AutomotiveElectronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley& Sons Inc., 2007.

FRACTURE MECHANICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Fracture Mechanics	15ME752	03	3-0-0	80	20	3Hrs

Course Objective:

Fracture mechanics provides a methodology for prediction, prevention and control of fracture in materials, components and structures.
It provides a background for damage tolerant design.
It quantifies toughness as materials resistance to crack propagation.

Course Content:

Module 1.
Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, and Griffith's energy balance approach. Fracture mechanics approach to design, NDT andVarious NDT methods used in fracture mechanics, Numerical problems. The Airy stress function. Effect of finitecracksize. Elliptical cracks, Numerical problems.
10Hrs

Module 2.
Plasticity effects: Irwin plastic zone correction. Dugdale's approach . The shape of the plastic zone for plane stress and plane strain cases.Theplate thickness effect, numerical problems.Determination of Stress intensity factors and plane strain fracture toughness: Introduction, estimation of stress intensity factors. Experimental method- Plane strain fracture toughness test, The Standard test,sizerequirements,etc. **08 Hrs**

Module 3.
The energy release rate, Criteria for crack growth. The crack resistance(R curve). Compliance.Tearingmodulus.Stability.
Elastic plastic fracture mechanics: Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD.
08Hrs

Module 4.
J integral: Use of J integral. Limitation of J integral. Experimental determination of J integral and the parameters affecting J integral.
Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crackbranching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.** **08 Hrs**

Module 5.

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, Means to provide fail-safety, Paris law, Required information for fracture mechanics approach, **08 Hrs**

Course Outcome:

At the end of the course students will:

1. Develop basic fundamental understanding of the effects of cracklike defects on the performance of aerospace, civil, and mechanical Engineering structures.
2. Learn to select appropriate materials for engineering structures to insure damage tolerance.
3. Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
4. Gain an appreciation of the status of academic research in field of fracture mechanics.

Text Books

1. Elements of Fracture Mechanics by Prasant Kumar, Mc Graw Hill Education, 2009 Edition
2. Anderson , "Fracture Mechanics-Fundamental and A pplication", T.L CRC press1998.
3. David Broek, "Elementary Engineering Fracture Me chanics", Springer Netherlands,2011

Reference Books

1. Karen Hellan , "Introduction to fracture mechani cs", McGraw Hill, 2 nd Edition
2. S.A. Meguid , "Engineering fracture mechanics" E lsevier Applied Science, 1989
3. Jayatilaka, "Fracture of Engineering Brittle Mat erials", Applied Science Publishers, 1979
4. Rolfe and Barsom , "Fracture and Fatigue Control in Structures" , Prentice Hall, 1977
5. Knott , "Fundamentals of fracture mechanisms", B utterworths, 1973

MECHATRONICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechatronics	15ME753	03	3-0-0	80	20	3 Hrs

Course objectives:

1. Understand the evolution and development of Mechatronics as a discipline.
2. Substantiate the need for interdisciplinary study in technology education.
3. Understand the applications of microprocessors in various systems and to know the functions of each element
4. Demonstrate the integration philosophy in view of Mechatronics technology

MODULE -1

Introduction: Definition, Multidisciplinary Scenario, Evolution of Mechatronics,Design of Mechatronics system, Objectives, advantages and disadvantages ofMechatronics.

Transducers and sensors: Definition and classification of transducers, Differencebetween transducer and sensor, Definition and classification of sensors, Principleof working and applications of light sensors, proximity switches and Hall Effectsensors. 10 Hours

MODULE -2

Microprocessor &Microcontrollers: Introduction, Microprocessor systems,Basic elements of control systems, Microcontrollers, Difference betweenMicroprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU,memory and address, I/O and Peripheral devices, ALU, Instruction andProgram, Assembler, Data, Registers, Program Counter, Flags, Fetch cycle, writecycle, state, bus interrupts. Intel's 8085A Microprocessor. 10 Hours

MODULE -3

Programmable logic controller: Introduction to PLC's, basic structure, Principleof operation, Programming and concept of ladder diagram, concept of latching &selection of a PLC.

Integration: Introduction & background, Advanced actuators, Pneumaticactuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, EndEffectors, Sensor & Functional requirements of robot. 10 Hours

MODULE -4

Mechanical actuation systems: Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives, mechanical aspects of motorselection.

Electrical actuation systems: Electrical systems, Mechanical switches, Solenoids,Relays, DC/AC Motors, Principle of Stepper Motors & servomotors.

10 Hours

MODULE -5

Pneumatic and hydraulic actuation systems: Actuating systems, Pneumatic andhydraulic systems, Classifications of Valves, Pressure relief valves, Pressureregulating/reducing valves, Cylinders and rotary actuators.

DCV & FCV: Principle & construction details, types of sliding spool valve, solenoid operated, Symbols of hydraulic elements, components of hydraulicsystem, functions of various units of hydraulic system. Design of simple hydrauliccircuits for various applications. 10 Hours

Course outcomes:

On completion of this subject, students will be able to:

1. Illustrate various components of Mechatronics systems.
2. Assess various control systems used in automation.
3. Develop mechanical, hydraulic, pneumatic and electrical control systems.

TEXT BOOKS:

1. NitaigourPremchandMahalik , Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill, 1st Edition, 2003 ISBN.No. 0071239243, 9780071239240.
2. W.Bolton-Pearson Education, Mechatronics – Elect ronic Control Systems in Mechanicaland Electrical Engineering, 1st Edition, 2005 ISBN No. 81-7758-284-4.

REFERENCE BOOKS:

1. Mechatronics by HMT Ltd. – Tata McGrawHill, 1 st Edition, 2000. ISBN:9780074636435.
2. Anthony Esposito, Fluid Power , Pearson Education, 6th Edition, 2011, ISBN No.9789332518544.

E- Learning

- VTU, E- learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

ADVANCED VIBRATIONS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Vibrations	15ME754	03	3-0-0	80	20	3 Hrs

Course objectives:

1. To enable the students to understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.
2. To enable the studentsto understand the importance of vibrations in mechanical design of machine parts subject to vibrations.

MODULE -1

Forced vibrations (1DOF): Introduction, analysis of forced vibration with constant harmonic excitation, MF, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, energy dissipated due to damping and numerical problems.

Systems with 2DOF: Principal modes of vibrations, normal mode and natural frequencies of systems (Damping is not included), simple spring-mass systems, masses on tightly stretched strings, double pendulum, tensional systems, combined rectilinear and angular systems, geared systems and numerical problems. 10 Hours

MODULE -2

Numerical methods for multi DOF systems: Maxwell's reciprocal theorem, influence coefficients, Rayleigh's method, Dunkerley's method, stodola method, orthogonality principle, method of matrix iteration and numerical.

Modal analysis and condition monitoring: signal analysis, dynamic testing of machines and structures, experimental modal analysis, machine condition monitoring and diagnosis.10 Hours

MODULE -3

Vibration measuring instruments and whirling of shafts: seismic instruments, vibrometers, accelerometer, frequency measuring instruments and numerical. Whirling of shafts with and without damping.

Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers and Vibration dampers. 10 Hours

MODULE -4

Transient Vibration of single Degree-of freedom systems: Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation.

Random Vibrations: Random phenomena Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response. 10 Hours

MODULE -5

Non Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations.

Continuous Systems: Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.

10 Hours

Course outcomes:

On completion of this subject, students will be able to:

4. Understand and characterize the single and multi degrees of freedom systems subjected to free and forced vibrations with and without damping.
5. Understand the method of vibration measurements and its controlling.
6. Understand the concept of dynamic vibrations of a continuous systems.

TEXT BOOKS:

1. S. S. Rao, “Mechanical Vibrations”, Pearson Educ ation.
2. S. Graham Kelly, “Fundamentals of Mechanical Vib ration” - McGraw-Hill.
3. “Theory of Vibration with Application” - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education.
4. “Mechanical Vibrations”, V. P. Singh, Dhanpat Ra i & Company.
5. Mechanical Vibrations, W.T. Thomson W.T.- Prentice Hill India

REFERENCE BOOKS:

1. S. Graham Kelly, “Mechanical Vibrations”, Schaum ’s Outlines, Tata McGraw Hill.
2. C Sujatha, “Vibraitons and Acoustics – Measureme nts and signal analysis”, Tata McGraw Hill.
3. “Mechanical Vibrations”, G. K. Grover, Nem Chand and Bros.

E- Learning

- VTU, E- learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

DESIGN LABORATORY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Design Laboratory	15MEL76	02	1-0-2	80	20	3Hrs

Prerequisites: Knowledge of Dynamics and Machines and Design of Machine Elements

COURSE OBJECTIVES:

Students are expected-

1. To understand the natural frequency, logarithmic decrement, damping ratio and damping.
2. To understand the balancing of rotating masses.
3. To understand the concept of the critical speed of a rotating shaft.
4. To understand the concept of stress concentration using Photo elasticity.
5. To understand the equilibrium speed, sensitiveness, power and effort of Governor.

PART –A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Determination of critical speed of rotating shaft.
3. Balancing of rotating masses.
4. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)
5. Determination of stress concentration using Photo elasticity for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.

PART –B

1. Determination of equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor. (at least one)
2. Determination of pressure distribution in Journal bearing
3. Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes.
4. Determination of stresses in curved beam using strain gauge.
5. Experiments on Gyroscope (Demonstration only)

COURSE OUTCOMES

At the end of the course, the students will be able to:

1. To understand the working principles of machine elements such as Governors, Gyroscopes etc.,
2. To identify forces and couples in rotating mechanical system components.
3. To identify vibrations in machine elements and design appropriate damping methods and to determine the critical speed of a rotating shaft.
4. To measure strain in various machine elements using strain gauges.
5. To determine the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.
6. To determine strain induced in a structural member using the principle of photo-elasticity.

Scheme of Examination:

One question from Part A:	**32 Marks**
One question from part B:	**32 Marks**
Viva- Voce:	**16 Marks**
Total:	**80 Marks**

Reference Books:

[1] "Shigley's Mechanical Engineering Design", Rich ards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015.

[2] "Design of Machine Elements", V.B. Bhandari, TM H publishing company Ltd. New Delhi, 2nd Edition 2007.

[3] "Theory of Machines", Sadhu Singh, Pearson Educ ation, 2nd Edition, 2007.

[4] "Mechanical Vibrations", G.K. Grover, Nem Chand and Bros, 6th Edition, 1996.

COMPTER INTEGRATED MANUFACTURING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Computer Integrated Manufacturing LAB	15MEL77	02	1-0-2	80	20	3Hrs

Course Objectives:

CLO1	To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
CLO2	To educate the students on the usage of CAM packages.
CLO3	To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

Part-A

Manual CNC part programming for 2 turning and 2 milling parts.Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path.

CNC part programming using CAM packages. Simulation of Turning, Drilling, Milling operations.

3 typical simulations to be carried out using simulation packages like:**CademCAMLab-Pro, Master- CAM.**

Program generation using software. Optimize spindle power, torque utilization, and cycle time. Generation and printing of shop documents like process and cycle time sheets, tool list, and tool layouts.Cut the part in single block and auto mode and measure the virtual part on screen. Post processing of CNC programs for standard CNC control systems like FANUC, SINUMERIC and MISTUBISHI.

Part B

(Only for Demo/Viva voce)

FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.

(Only for Demo/Viva voce)

Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs).

Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.

Course Outcomes:

After studying this course, students will be able to:

CLO1	Generate CNC Lathe part program for Turning, Facing, Chamfering, Grooving, Step turning, Taper turning, Circular interpolation etc.
CLO2	Generate CNC Mill Part programming for Point to point motions, Line motions, Circular interpolation, Contour motion, Pocket milling- circular, rectangular, Mirror commands etc.
CLO3	Use Canned Cycles for Drilling, Peck drilling, Boring, Tapping, Turning, Facing, Taper turning Thread cutting etc.
CLO4	Simulate Tool Path for different Machining operations of small components using CNC Lathe & CNC Milling Machine.
CLO5	Use high end CAM packages for machining complex parts; use state of art cutting tools and related cutting parameters; optimize cycle time.
CLO6	Understand & write programs for Robotcontrol;understand the operating principles of hydraulics, pneumatics and electropneumatic systems. Apply this knowledge to automate & improve efficiency of manufacturing.

Scheme for Examination:

Two Questions from Part A - 60 Marks (30 +30)
Viva-Voce - 20 Marks
Total: 80 Marks

Project Work, Phase I

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Project Work, Phase I	15MEP78	2	0-3-0	100	-	-