VELS

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
NAAC ACCREDITED WITH 'A' GRADE
Marching Beyond 25 Years Successfully

B.E
Electrical and Electronics

Engineering

Curriculum and Syllabus
(Based on Choice Based Credit System)
Effective from the Academic Year
2018-2019

Department of
Electrical and Electronics
Engineering

School of Engineering

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To impart quality higher education in the field of Electrical and Electronics Engineering and to create globally competent engineers with aptitude for research, innovation and entrepreneurship and prepare them to serve the industrial and societal needs.

MISSION

Mission No.	Mission Statements
M1	To fortify the students with sound technical competency by providing state of the art teaching and learning.
M2	To impart industry oriented training to enable students to meet day-to-day changes of the field.
M3	To increase the employability and entrepreneurship skills of students through personality development programmes and soft-skills training.
M4	To provide good research atmosphere that would enable students and faculties with opportunities to do research, consultancy and constructive contribution and to be of ethical value to the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

After few years of completion of B.E Electrical and Electronics Engineering Programme, the graduates will

PEO No.	Program Educational Objective Statements
PEO 1	Demonstrate their knowledge in Analysis, Design and Configuring of Electrical, Electronics and other allied systems.
PEO 2	Keep up with technological developments, acquire software and hardware proficiency in the field of Electrical and Electronics Engineering to provide scientific solution to future challenges.
PEO 3	Upgrade the potential to pursue higher education and research in his/her professional career.
PEO 4	Possess befitting technical skills to contribute to nurturing society in the ethical, economical and environmental contexts.

PROGRAMME OUTCOMES (POs):

PO1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analyses:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO No.	Program Specific Outcome Statements
PSO 1	Learners can apply the knowledge acquired in the field of Electrical and Electronics Engineering to Analyze, Design, and solve problems in various systems.
PSO 2	Graduates can develop sustainable solutions for societal requirements by choosing future ready methods.

BOARD OF STUDIES

S. No	NAME	AFFILIATION	ROLE
1	Dr. R. Krishnakumar	Professor & Head, Department of EEE, Vels Institute of Science, Technology & Advanced Studies, Chennai.	Chair Person
2	Dr. C. Umayal	Associate Professor, Department of EEE, VIT University, Chennai.	Academic Expert
3	Dr. T.Thandapani	Director-Technical, RRT Electro Power(P) Ltd, Chennai.	Industrial Expert
4	Mr. R. Sridhar	Engineer – Lighting Domain, Enlighted Energy Systems Pvt. Ltd, Chennai.	Alumni
5	Dr.N.Shanmuga sundaram	Associate Professor, Department of EEE, Vels Institute of Science, Technology & Advanced Studies, Chennai.	Internal Member
6	Mrs. T. R. Premilla,	Assistant Professor, Department of EEE, Vels Institute of Science, Technology & Advanced Studies, Chennai.	Internal Member

B.E. – ELECTRICAL AND ELECTRONICS ENGINEERING
COURSES OF STUDY AND SCHEME OF ASSESSMENT
(MINIMUM CREDITS TO BE EARNED: 170)

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER I								
BSC	Chemistry	3	1	0	4	40	60	100
BSC	Mathematics – I (Calculus and Differential Equations)	3	1	0	4	40	60	100
ESC	Programming for Problem solving	3	0	0	3	40	60	100
BSC	Chemistry Laboratory	0	0	4	2	40	60	100
ESC	Programming for problem solving Laboratory	0	0	4	2	40	60	100
ESC	Workshop/Manufacturing Practices	1	0	4	3	40	60	100
Total		**10**	**2**	**12**	**18**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER II								
HSC	English	2	0	0	2	40	60	100
BSC	Physics (Waves and Optics and introduction to quantum mechanics)	3	1	0	4	40	60	100
BSC	Mathematics-II (Linear Algebra, Transform, Calculus and Numerical Methods)	3	1	0	4	40	60	100
ESC	Basic Electrical Engineering	3	1	0	4	40	60	100
ESC	Engineering Graphics and Design	1	0	4	3	40	60	100
BSC	Physics Laboratory	0	0	4	2	40	60	100
ESC	Electrical Engineering Laboratory	0	0	2	1	40	60	100
HSC	English Laboratory	0	0	2	1	40	60	100
Total		**12**	**3**	**12**	**21**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER III								
BSC	Mathematics III(Fourier series and transforms)	3	0	0	3	40	60	100
PCC	Electromagnetic Theory	3	0	0	3	40	60	100
ESC	Engineering Mechanics	3	0	0	3	40	60	100
PCC	Electrical Circuit Analysis	3	0	0	3	40	60	100
PCC	Analog Electronics	3	0	0	3	40	60	100
PCC	Electrical Machines – I	3	1	0	4	40	60	100
PCC	Electrical Machines- I Laboratory	0	0	3	1	40	60	100
PCC	Electric Circuits Laboratory	0	0	3	1	40	60	100
HSC	Personality Development- I	2	0	0	2	40	60	100
MC	National Service Scheme	2	0	0	2	40	60	100
Total		**22**	**1**	**6**	**25**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER IV								
BSC	Mathematics IV (Probability and statistics)	3	0	0	3	40	60	100
PCC	Measurements and Instrumentation	3	0	0	3	40	60	100
PCC	Digital Electronics	3	0	0	3	40	60	100
PCC	Electrical Machines – II	3	1	0	4	40	60	100
PCC	Linear Integrated Circuits	3	0	0	3	40	60	100
MC	Environmental Science and Engineering	3	0	0	3	40	60	100
HSC	Personality Development II	2	0	0	2	40	60	100
PCC	Analog and Digital Electronics Laboratory	0	0	3	1	40	60	100
PCC	Electrical Machines – II Laboratory	0	0	3	1	40	60	100
BSC	Basic Life Skills	0	0	2	1	40	60	100
Total		**20**	**1**	**8**	**24**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER V								
PCC	Power Electronics	3	0	0	3	40	60	100
PCC	Transmission and Distribution	3	0	0	3	40	60	100
PCC	Control Systems	3	0	0	3	40	60	100
PCC	Special Electrical Machines	3	0	0	3	40	60	100
OEC	Open Elective – I	3	0	0	3	40	60	100
PEC	Professional Elective – I	3	0	0	3	40	60	100
HSC	Personality Development III	2	0	0	2	40	60	100
PCC	Power Electronics Laboratory	0	0	3	1	40	60	100
PCC	Measurements and Control Systems Laboratory	0	0	3	1	40	60	100
Total		**20**	**0**	**6**	**22**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER VI								
PCC	Power System Analysis	3	0	0	3	40	60	100
PCC	Solid State Drives	3	0	0	3	40	60	100
PCC	Microprocessors and Micro Controllers	3	0	0	3	40	60	100
PEC	Professional Elective – II	3	0	0	3	40	60	100
PEC	Professional Elective – III	3	0	0	3	40	60	100
OEC	Open Elective – II	3	0	0	3	40	60	100
HSC	Personality Development IV	2	0	0	2	40	60	100
PCC	Power Systems Laboratory	0	0	3	1	40	60	100
PCC	Electrical Drives Laboratory	0	0	3	1	40	60	100
SI	Summer Internship	0	0	2	1	40	60	100
Total		**20**	**0**	**8**	**23**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER VII								
PEC	Professional Elective– IV	3	0	0	3	40	60	100
PEC	Professional Elective – V	3	0	0	3	40	60	100
PEC	Professional Elective – VI	3	0	0	3	40	60	100
OEC	Open Elective – III	3	0	0	3	40	60	100
PCC	Microprocessors and Micro Controllers Laboratory	0	0	3	1	40	60	100
HSC	Professional Ethics in Engineering	2	0	0	2	40	60	100
PROJ	Project Phase I	0	0	10	5	40	60	100
Total		**14**	**0**	**13**	**20**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER VIII								
PEC	Professional Elective – VII	3	0	0	3	40	60	100
OEC	Open Elective – IV	3	0	0	3	40	60	100
OEC	Open Elective – V	3	0	0	3	40	60	100
PROJ	Project Phase II	0	0	16	8	40	60	100
	Total	**9**	**0**	**16**	**17**			

CA   -   Continuous Assessment, SEE   -   Semester End Examination

LIST OF COURSES

Basic Science Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
BSC-01	Chemistry	3	1	0	4
BSC-02	Mathematics – I (Calculus and Differential Equations)	3	1	0	4
BSC-03	Chemistry Laboratory	0	0	4	2
BSC-04	Physics (Waves and Optics, and Introduction to Quantum Mechanics)	3	1	0	4
BSC-05	Mathematics – II (Linear Algebra, Transform Calculus and Numerical Methods)	3	1	0	4
BSC-06	Physics Laboratory	0	0	4	2
BSC-07	Mathematics – III (Fourier Series and Transforms)	3	0	0	3
BSC-08	Mathematics – IV (Probability and Statistics)	3	0	0	3
BSC-09	Basic Life Skills	0	0	2	1

Humanities and Social Sciences Including Management

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
HSC-01	English	2	0	0	2
HSC-02	English Laboratory	0	0	2	1
HSC-03	Personality Development I	2	0	0	2
HSC-04	Personality Development II	2	0	0	2
HSC-05	Personality Development III	2	0	0	2
HSC-06	Personality Development IV	2	0	0	2
HSC-07	Professional Ethics in Engineering	2	0	0	2

Engineering Science Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
ESC-01	Programming for Problem Solving	3	0	0	3
ESC-02	Programming for Problem Solving Laboratory	0	0	4	2
ESC-03	Workshop/Manufacturing Practices	1	0	4	3
ESC-04	Engineering Graphics and Design	1	0	4	3
ESC-05	Basic Electrical Engineering	3	1	0	4
ESC-06	Electrical Engineering Laboratory	0	0	2	1
ESC-07	Engineering Mechanics	3	0	0	3

Professional Core Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
PCC-01	Electromagnetic Theory	3	0	0	3
PCC-02	Electrical Circuit Analysis	3	0	0	3
PCC-03	Analog Electronics	3	0	0	3
PCC-04	Electrical Machines – I	3	1	0	4
PCC-05	Electrical Machines- I Laboratory	0	0	3	1
PCC-06	Electric Circuits Laboratory	0	0	3	1
PCC-07	Measurements and Instrumentation	3	0	0	3
PCC-08	Digital Electronics	3	0	0	3
PCC-09	Electrical Machines – II	3	1	0	4
PCC-10	Linear Integrated Circuits	3	0	0	3

PCC-11	Analog and Digital Electronics laboratory	0	0	3	1
PCC-12	Electrical Machines - II Laboratory	0	0	3	1
PCC-13	Power Electronics	3	0	0	3
PCC-14	Transmission and Distribution	3	0	0	3
PCC-15	Control Systems	3	0	0	3
PCC-16	Special Electrical Machines	3	0	0	3
PCC-17	Power Electronics Laboratory	0	0	3	1
PCC-18	Measurements and Control Systems Laboratory	0	0	3	1
PCC-19	Power System Analysis	3	0	0	3
PCC-20	Solid State Drives	3	0	0	3
PCC-21	Microprocessors and Micro Controllers	3	0	0	3
PCC-22	Power Systems Laboratory	0	0	3	1
PCC-23	Electrical Drives Laboratory	0	0	3	1
PCC-24	Microprocessors and Micro Controllers Laboratory	0	0	3	1

Professional Elective Course

Code No	Course Name	Hours/Week			Credits
		Lecture	Tutorial	Practical	
PEC-01	Wind and Solar Energy Systems	3	0	0	3
PEC-02	Line Commutated and Active Rectifiers	3	0	0	3
PEC-03	Electrical and Hybrid Vehicles	3	0	0	3
PEC-04	Electrical Machine Design	3	0	0	3
PEC-05	Power System Protection and Switch Gear	3	0	0	3
PEC-06	Power System Operation and Control	3	0	0	3
PEC-07	HVDC Transmission Systems	3	0	0	3
PEC-08	Power Quality and FACTS	3	0	0	3
PEC-09	High Voltage Engineering	3	0	0	3
PEC-10	Electrical Energy	3	0	0	3

	Conservation and Auditing				
PEC-11	Industrial Electrical Systems	3	0	0	3
PEC-12	Power System Dynamics and Control	3	0	0	3
PEC-13	Digital Control Systems	3	0	0	3
PEC-14	Computer Architecture	3	0	0	3
PEC-15	Computational Electromagnetics	3	0	0	3
PEC-16	Control Systems Design	3	0	0	3
PEC-17	Advanced Electric Drives	3	0	0	3
PEC-18	Computer aided Power system Analysis	3	0	0	3
PEC-19	Power Electronics for renewable energy system	3	0	0	3
PEC-20	Optimization Techniques	3	0	0	3
PEC-21	Advanced control systems	3	0	0	3
PEC-22	Biomedical Instrumentation	3	0	0	3
PEC-23	Power system transients	3	0	0	3
PEC-24	Fibre Optics and Laser Instruments	3	0	0	3
PEC-25	System identification and adaptive control	3	0	0	3
PEC-26	Renewable energy systems	3	0	0	3
PEC-27	Power plant Engineering	3	0	0	3
PEC-28	Energy Management and Auditing	3	0	0	3
PEC-29	Modern power converters	3	0	0	3
PEC-30	Modern Control Theory	3	0	0	3
PEC-31	Distributed Generation and Microgrid	3	0	0	3

Open Elective Course

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
OEC-01	Electronic Devices and circuits	3	0	0	3
OEC-02	Data Structures and Algorithms	3	0	0	3
OEC-03	Analog and Digital Communication	3	0	0	3
OEC-04	Computer Networks	3	0	0	3
OEC-05	Embedded Systems	3	0	0	3
OEC-06	VLSI circuits	3	0	0	3
OEC-07	Image Processing	3	0	0	3
OEC-08	Wavelet Transforms	3	0	0	3
OEC-09	Thermal and Fluid Engineering	3	0	0	3
OEC-10	Strength of Materials	3	0	0	3
OEC-11	Fluid Machinery	3	0	0	3
OEC-12	Automobile Engineering	3	0	0	3
OEC-13	Electrical Materials	3	0	0	3
OEC-14	Modern Manufacturing Processes	3	0	0	3
OEC-15	Internet of Things	3	0	0	3
OEC-16	Big Data Analysis	3	0	0	3
OEC-17	communication engineering	3	0	0	3
OEC-18	Principles of management and professional ethics	3	0	0	3
OEC-19	Total Quality Management	3	0	0	3
OEC-20	Digital Signal Processing	3	0	0	3
OEC-21	Fundamentals of nano science	3	0	0	3
OEC-22	Micro Electro Mechanical System	3	0	0	3
OEC-23	Advanced Digital Signal Processing	3	0	0	3

Code No	Course	Lecture	Tutorial	Practical	Credits
OEC-24	Robotics and Automation	3	0	0	3
OEC-25	Digital system Design	3	0	0	3
OEC-26	Applied Soft computing	3	0	0	3
OEC-27	Microcontroller based System Design	3	0	0	3
OEC-28	Neural Networks and Fuzzy Systems	3	0	0	3
OEC-29	PLC and distributed Control Systems	3	0	0	3
OEC-30	Object Oriented Programming	3	0	0	3
OEC-31	Electric Vehicle Mechanics and Control	3	0	0	3

Mandatory Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
MC-01	Environmental Science and Engineering	3	0	0	3
MC-02	National Service Scheme	2	0	0	2

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
MC	Mandatory courses
PROJ	Project

Syllabus

BASIC SCIENCE COURSES

BSC-01	CHEMISTRY	3	1	0	4

COURSE OBJECTIVES:

1. To learn about the molecular orbitals, ionic interactions and periodic properties.
2. To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electro negativity.
3. To list major chemical reactions that are used in the synthesis of molecules.

UNIT I   ATOMIC AND MOLECULAR STRUCTURE, INTERMOLECULAR FORCES AND POTENTIAL ENERGY SURFACES   12

Molecular orbitals of diatomic molecules and plots of the multicentre orbitals.Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity.Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties.Ionic, dipolar and van Der Waals interactions.Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN.

UNIT II   SPECTROSCOPIC TECHNIQUES AND APPLICATIONS   12

Principles of spectroscopy and selection rules. Electronic spectroscopy.Vibrational and rotational spectroscopy of diatomic molecules.Applications. Diffraction and scattering

UNIT III   USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA   12

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies.Free energy and emf.Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria.Water chemistry. Corrosion.

UNIT IV   PERIODIC PROPERTIES   12

Variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

UNIT IV   ORGANIC REACTIONS AND SYNTHESIS OF A DRUG MOLECULE   12

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings.Synthesis of a commonly used drug molecule.

TOTAL: 60 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Explain the relation between the intermolecular forces present within a substance and the temperatures associated with changes in its physical state.	K5
CO2	Apply formalisms based on molecular symmetry to predict spectroscopic properties.	K3
CO3	Determine and understand the operation of electrochemical systems for the production of electric energy, i.e. batteries and fuel cells	K2,K5
CO4	Explain general corrosion in terms of electrochemistry	K5
CO5	Explain the arrangement of elements in the periodic table and relate the arrangement to electronic configuration, bonding and properties.	K5

TEXT BOOKS:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.
2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.

REFERENCE BOOKS:

1. Physical Chemistry, by P. W. Atkins.
2. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp.
3. University chemistry, by B. H. Mahan.

BSC-02	Mathematics-I (Calculus and Differential Equations)	3	1	0	4

COURSE OBJECTIVES:

1. The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra.
2. To equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

UNIT I   CALCULUS   12

Evolutes and involutes; Beta and Gamma functions and their properties; Rolle's theorem, Mean value theorems, Taylor's and Maclaur in theorems with remainders; Indeterminate forms and L'Hospital's rule

UNIT II   SEQUENCES AND SERIES   12

Convergence of sequence and series, tests for convergence, power series ,Taylor's series. Series for exponential, trigonometric and logarithmic functions

UNIT III   MULTIVARIABLE CALCULUS: DIFFERENTIATION   12

Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line;Maxima, minima and saddle points Method of Lagrange multipliers.

UNIT IV   MULTIVARIABLE CALCULUS: INTEGRATION   12

Multiple Integration:double and triple integrals(Cartesian and polar),change of order of integration in double integrals, Change of variables (Cartesian to polar)-Theorems of Green, Gauss and Stokes(statement only)

UNIT V   ORDINARY DIFFERENTIALEQUATIONS   12

Differential equation of first order and Higher degree- equations solvable forp, solvable for x, solvable for y and Clairaut's type-Second order linear differential equations with constant and variable coefficients, method of variation of parameters.

TOTAL: 60 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Apply integration for more complicated functions using standard methods of integration, including integration by parts, trigonometric substitutions, partial fractions.	K3
CO2	Develop few application of analysis to Engineering problems	K3
CO3	Discover the volume of solids by calculating appropriate double integrals in rectangular and polar coordinates.	K4
CO4	Apply the fundamental theorem of calculus to calculate integrals involving algebraic and transcendal functions	K3
CO5	Develop the essential tool of differential equations in Engineering.	K3

TEXTBOOKS:

1. G.B.Thomas andR.L.Finney, Calculusand Analytic geometry, 9thEdition,Pearson, Reprint,2002

2. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11th th reprint 2010

REFERENCE BOOKS:

1. Erwinkreyszig,AdvancedEngineeringMathematics,9th Edition,JohnWiley&Sons, 2006.

2. VeerarajanT.,EngineeringMathematicsforfirstyear,TataMcGraw-Hill,NewDelhi,2008.

3. D.Poole,LinearAlgebra:A ModernIntroduction,2nd Edition, Brooks/Cole,2005.

4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications,Reprint,2008.

5. B.S.Grewal,HigherEngineeringMathematics,KhannaPublishers,36[th]Edition,2010.

BSC-03	CHEMISTRY LABORATORY	0	0	4	2

COURSE OBJECTIVE:

1. To help students estimate rate constants of reactions from concentration of reactants/products as a function of time.
2. To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
3. To synthesize a small drug molecule and analyse a salt sample.

LIST OF EXPERIMENTS (Choice of 10-12 experiments from the following)

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions
8. Potentiometry - determination of redox potentials and emfs
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Models of potential energy surfaces
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids
16. Adsorption of acetic acid by charcoal
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg .

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Estimate the rate constants of reactions, freezing point depression and partial coefficient of immiscible liquids.	K5
CO2	To develop a small drug molecule and analyze a salt sample	K3,K4
CO3	To find the viscosity and partition coefficient of a substance.	K4
CO4	To determine the saponification value of an oil	K4
CO5	Apply formalisms based on molecular symmetry to predict spectroscopic properties	K3

TEXT BOOKS:

1. S. Sundaram and K. Raghavan "Practical Chemistry", S. Viswanathan. Co. 3rd edition 2011.

2. Gnanaprakasam, Ramamurthy, "Organic Chemistry Lab Manual" S. Viswanathan Pvt. Ltd. 3rd edition 2011;

REFERENCE BOOKS:

1. Vogel's – "Textbook of qualitative organic Analysis", Longmann, 12th edition, 2011

2. J. N. Gurtu and R. Kapoor "Advanced experimental Chemistry", S. Chand and Co. 6th edition, 2010

BSC-04	PHYSICS (WAVES AND OPTICS AND INTRODUCTION TO QUANTUM MECHANICS)	3	1	0	4

COURSE OBJECTIVES:

1. To learn the basics of oscillations, wave-optics, lasers and to apply these fundamental principles to solve practical problems related to optical systems used for engineering applications. .

UNIT I: OSCILLATIONS, NON-DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES12

Harmonic oscillator – Simple harmonic oscillator – Damped harmonic oscillator – Forced mechanical and electrical oscillators. Waves, travailing waves example of waves, characteristics of a waves - longitudinal and transverse waves–Examples - Transverse wave on a string, the wave equation on a string- longitudinal waves and the wave equation.

UNIT II: LIGHT AND WAVE OPTICS   12

Light as an electromagnetic wave - Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection - Huygens' Principle, superposition of waves - Young's double slit experiment - Newton's rings - Michelson interferometer, Mach Zehnder interferometer - Fraunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision - Dispersion of a diffraction of grating and their resolving power

UNIT III: LASERS   12

Einstein's theory of matter radiation interaction and A and B coefficients; amplification oflight by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity

UNIT IV: INTRODUCTION TO QUANTUM MECHANICS   12

Blackbody radiation–Planck's radiation law (derivation)–Deduction of Wien's displacement law and Rayleigh – Jeans Law from Planck's theory – Compton effect – Theory and experimental verification– Matter waves–Schrödinger's wave equation–Time independent and time dependent equations –Physical significance of wave function –Particle in a one-dimensional box and three-dimensional box.

UNIT V: INTRODUCTION TO SOLIDS AND SEMICONDUCTORS   12

Free electron theory of metals, Fermi level, density of states. Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature(equilibrium carrier statistics) - Hall effect – Determination of Hall coefficient – Applications.

TOTAL: 60 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the basic concepts of characteristics of waves.	K2
CO2	Demonstrate thedispersion of a diffraction of grating and their resolving power.	K2
CO3	Apply the laser operation principles to atom and molecular physics, solid state physics, quantum mechanics and physical optics	K3
CO4	Solve the time independent Schrodinger wave equation for a particle in a box to obtain the Eigen values and Eigen functions	K3
CO5	Identify different kinds of electronic materials and their energy band structures	K3

TEXT BOOKS:

Text Book
1. A text book of waves and oscillations, BrijLal and N. Subrahmanyam, Vikas Publishing, New Delhi.
2. A text book of optics, M. N. Avadhanulu, BrijLal and N. Subrahmanyam, S. Chand & Co. Pvt Ltd. New Delhi.
3. Modern Physics, R. Murugesan and KiruthigaSivaprakash, S. Chand & Co. Pvt Ltd. New Delhi.

References:
1. Vibrations and waves in physics, I. G. Main, Cambridge University Press, 1993.
2. The physics of vibrations and waves, H. J. Pain, Wiley, 2006.
3. Optics,E. Hecht, Pearson Education, 2008.
4. Optics, A. Ghatak, McGraw Hill Education, 2012.
5. Principles of Lasers, O. Svelto, Springer Science & Business Media, 2010.
6. The Physics of Waves and Oscillations,N.K. Bajaj, Tata McGraw-Hill, 1988
7. Fundamentals of Waves & Oscillations, K. Uno Ingard, Cambridge University Press, 1988

BSC-05	MATHEMATICS – II (LINEAR ALGEBRA, TRANSFORM CALCULUS AND NUMERICAL METHODS)	3	1	0	4

COURSEOBJECTIVE:

1. The objective of this course is to familiarize the prospective engineers with techniques in calculus and linear algebra.
2. To equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

UNIT I Matrices   12

Algebra of matrices-Inverse and rank of a matrix-System of linear equations-Symmetric,skew-symmetric and orthogonal matrices-Eigen values and eigen vectors- Diagonalization of matrices-Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms.

UNIT II Numerical Methods-I   12

Solution of polynomial and transcendental equations –Bisection method, Newton-Raphson method and Regula- Falsi method. Finite differences, Interpolation using Newton's forward and backward difference formulae. Numerical integration :Trapezoidal rule andSimpson's 1/3rdand3/8 rules.

UNITIII Numerical Methods-II   12

Ordinary differential equations: Taylor's series-Euler and modified Euler's methods-Runge- Kutta method of fourth order for solving first and second order equations.

UNIT IVNumerical Methods-III   12

Partial differential equations: Finite difference solution two dimensional Laplace equation and Poisson equation-Implicit and explicit methods for one dimension al heat equation(Bender-Schmidt and Crank-Nicholson methods),trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT V TransformCalculus   12

Laplace Transform-Properties of Laplace Transform-Laplace transform of periodic functions. Find inginverse Laplace transform by different methods-convolution theorem. Evaluation of integrals by Laplace transform,solving ODEs by LaplaceTransform method.

TOTAL: 60 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	To develop the essential tool of Matrices in Engineering.	K3
CO2	Attain the Knowledge on solution of equations and eigen value problems	K3
CO3	Describe the applications of interpolation, numerical differentiation and numerical integration	K4
CO4	Attain the Knowledge on numerical solution of ordinary differential equations	K3
CO5	Understands the Laplace Transforms and its properties	K2

TEXT BOOKS:

1. D.Poole,"LinearAlgebra:AModernIntroduction",Brooks/Cole,2005.N.P.Balian dM.Goyal,"AtextbookofEngineeringMathematics",LaxmiPublications,2008.

2. B.S.Grewal,"HigherEngineeringMathematics",KhannaPublishers,2010.

3. Sivaramakrishna Das.P and Vijayakumari.C, Numerical Analysis, 2014, Pearson Eduaction limited in south Asia

REFERENCEBOOKS:

1. V.Krishnamurthy,V.P.MainraandJ.L.Arora,"AnintroductiontoLinearAlgebra", AffiliatedEast-Westpress,2005.

2. Chapra, S. C and Canale, R. P., "Numerical Methods for Engineers",Tata McGraw-Hill, New Delhi, 5th Edition, 2007.

3. Sankara Rao K, "Numerical Methods for Scientisits and Engineers",Printice Hall of India, New Delhi, 3rd Edition,2007 .

BSC-06	PHYSICS LABORATORY	0	0	4	2

COURSE OBJECTIVES:

1. To introduce different experiments to test basic understanding of physics concepts applied in properties of matter, waves, oscillations and optics.

LIST OF EXPERIMENTS ((Choice of 8 experiments from the following)

1. Spectrometer –Dispersive Power of prism
2. Spectrometer – Grating
3. Semiconductor Laser – To find Wavelength and particle size.
4. Ultrasonic Interferometer
5. Torsional Pendulum
6. Hooke's Law
7. Compound pendulum- To determine 'g'
8. Newtons' Ring
9. Air wedge
10. Bifilar Pendulum

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Calculate the wavelength and particle size of semiconductor diode laser.	K4
CO2	Analyze the wavelength of spectral lines using spectrometer	K4
CO3	Examine the thickness of a given thin wire by Air wedge method.	K4
CO4	Measure the velocity of ultrasonic waves and compressibility of the liquid using ultrasonic interferometer.	K5
CO5	Predict the various physical parameters in the areas of optics, fluid mechanics and quantum mechanics	K5

TEXT BOOKS:

1. Dr. P. Mani, Engineering Physics Practicals, VRB Publishers.
2. Prof. Jyoti D. Deshpande, Physics Practical handbook, Target Publications Pvt. Ltd.
3. C.C. Ouseph, U.J. Rao, V. Vijayendran, Practical Physics and Electronics, Viswanathan S, Publishers Pvt. Ltd.

BSC-07	MATHEMATICS-III (FOURIER SERIES AND TRANSFORMS)	3	0	0	3

COURSE OBJECTIVE:

1. To understand Fourier series representation of periodic signals. The analysis of signal is far more convenient in the frequency domain.

UNIT I   FOURIER SERIES   9

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.

UNIT II   FOURIER TRANSFORM   9

Fourier integral theorem (without proof) – Fourier transform pair – Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT III   PARTIAL DIFFERENTIAL EQUATIONS   9

Formation of partial differential equations - singular integrals- Solutions of standard types of first order partial differential equations – Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of homogeneous functions.

UNIT IV   APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS   9

Classification PDE-Method of separation of variables – One dimensional wave and heat equation – Steady state solution of two-dimensional heat equation (square plate only) .

UNIT V   Z -TRANSFORM AND DIFFERENCE EQUATIONS   9

Z-transform –Introduction- properties – Inverse Z-transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Apply fourier series in analyzing waveforms	K3
CO2	Apply fourier transform to convert the function from amplitude to time domain and amplitude to frequency domain	K3
CO3	Evaluate the partial differential equations	K5
CO4	Apply the partial differential equation to describe the steady state distribution of electrical charge in a body,and heat in a body	K3
CO5	Analyze the discrete time signals	K4

TEXTBOOKS:

1. Grewal. B.S, "Higher Engineering Mathematics", Khanna Publications ,Delhi,43rd Edition, 2013.

2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 6th reprint,2008.

3. SivaramakrishnaDas.P & Vijayakumari.C , A Text book of Engineering Mathematics-III

REFERENCE BOOKS:

1. Bali.N.P. and Manish Goyal 'A Textbook of Engineering Mathematics', Laxmi Publications, 9th edition,2011.

2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 9th Edition, 2011.

3. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education ,3rd Edition, 2012.

4. Transforms and partial differential equations- A.Singravelu

BSC-08	MATHEMATICS-IV (PROBABILITYANDSTATISTICS)	3	0	0	3

COURSEOBJECTIVE:

1. Theobjectiveofthiscourseistofamiliarizethestudentswithstatisticaltechniques.
2. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

UNIT I   BASIC PROBABILITY   9

Introduction to Probability- Conditional probability – Baye's Theorem- Random Variables-Discrete random variables-Continuous Random Variables –Probability mass function-Probability density function.

UNIT II   STANDARDDISTRIBUTIONS   9

Discrete Distributions- Binomial, Poisson, Geometric Distributions-Continuous Distribution-Uniform, Normal , Exponential and Gamma distribution-Properties.

UNIT III   TWO DIMENSIONAL RANDOM VARIABLE   9

Joint Distributions- Marginal & Conditional Distributions –Covariance-Correlation and Regression Analysis

UNIT IV   BASICSTATISTICS   9

Measures of Central tendency:Mean, Median and Mode- Measure of Dispersion- Range, Standard Deviation and coefficient of variation-Moments Skewness and Kurtosis (Simple Problems)

UNIT V   APPLIEDSTATISTICS   9

Introduction to Large and small sample – t-test-Single mean, difference of means and Paired t-test . Small samples:Test for single mean, difference of means -F-test-Chi-square test for goodness of fit an independence of attributes.

TOTAL : 45h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the fundamental knowledge of the basic probability concepts.	K2
CO2	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions	K2
CO3	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.	K2
CO4	Understand the basic concepts of statistics	K2
CO5	Apply the statistics to various applications	K3

Text Books

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications,Reprint,2010.

2. veerarajanT., Engineering Mathematics(for semester III),Tata Mc Graw-Hill,New Delhi,2010.

3. S.Ross,A First Course in Probability,6thEd.,PearsonEducationIndia,2002.

References

1. Erwin Kreyszig, Advanced Engineering Mathematics,9th Edition, John Wiley & Sons, 2006.

2. P.G.Hoel,S.C.Port and C.J.Stone, Introduction to Probability Theory, Universal Book Stall, 2003(Reprin).

3. W.Feller, An Introduction to Probability Theory and its Applications,Vol.1,3rdEd., Wiley,1968.

4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 35thEdition,2000.

BSC-09	BASIC LIFE SKILLS	0	0	2	1

COURSE OBJECTIVE:

Providing value education to improve the students' character - understanding of principled life and physical health - maintaining youthfulness - measures and methods in five aspects of life

UNIT I   PHYSICAL HEALTH   6

1. Manavalakalai (SKY) Yoga: Introduction - Education as a means for youth empowerment - Greatness of Education - Yoga for youth Empowerment.
2. Simplified Physical Exercises: Hand, Leg, Breathing, Eye exercises - Kapalabathi, Makarasana Part I, Makarasana Part II, Body Massage, Acu pressure, Relaxation exercises - Benefits.
3. Yogasanas: Pranamasana - Hastha Uttanasana - Pada Hasthasana – AswaSanjalana Asana - Thuvipatha asva Sanjalana asana - Astanga Namaskara - Bhujangasana - Atha Muktha Savasana - Aswa Sanjalana Asana - Pada Hasthasana - Hastha Uttanasana - Pranamasana.
4. Pranayama : Naddi suddi - Clearance Practice - Benefits.

UNIT II   LIFE FORCE   6

1. Reasons for Diseases - Natural reasons (Genetic / imprints, Planetary Position, Natural calamities and climatic changes) - Unnatural reasons (Food habits, Thoughts, Deeds)
2. Philosophy of Kaya kalpa - Physical body - Sexual vital fluid - Life force - Bio-Magnetism - Mind.
3. Maintaining youthfulness : Postponing old age - Transformation of food into seven components - Importance of sexual vital fluid –
4. Measure and method in five aspects of life - Controlling undue Passion.
5. Kayakalpa practice - Aswini Mudra - Ojas breath - Benefits of Kaya Kalpa.

UNIT III   MENTAL HEALTH   6

1. Mental Frequencies - Beta, Apha, Theta and Delta wave - Agna Meditation explanation - benefits.
2. Shanthi Meditation explanation - Benefits
3. Thuriya Meditation explanation - Benefits
4. Benefits of Blessing - Self blessing (Auto suggestion) - Family blessing - Blessing the others - World blessing - Divine protection

UNIT   VALUES   6
IV

- Human Values:
1. Self control - Self confidence - Honesty

2. Contentment - Humility - Modesty
3. Tolerance - Adjustment - Sacrifice - Forgiveness
4. Purity (Body, Dress, Environment) - Physical purity - Mental purity - Spiritual purity

- Social Values:
  1. Non violence - Service
  2. Patriotism - Equality
  3. Respect for parents and elders - care and protection - Respect for teacher
  4. Punctuality - Time Management

UNIT V   MORALITY (VIRTUES)   6

1. Importance of Introspection - I - Mine (Ego, Possessiveness).
2. Six Evil Temp eraments - Greed - Anger - Miserliness - Immoral sexual passion - Inferiority and superiority Complex – Vengeance.
3. Maneuvering of Six Temperaments - Contentment - Tolerance - Charity - Chastity - Equality - Pardon (Forgiveness).

Total:45h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand youth empowerment through Yoga.	K2
CO2	Improve and Maintaining youthfulness through Kayakalpa practice	K6
CO3	Understand the concept of negative and positive energies	K2
CO4	Examine human values and social values principles for success in life.	K4
CO5	Understand the importance of Introspection stress and its impact on individual behavior and the techniques to manage them	K2

Syllabus

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT

HSC-01	ENGLISH	2	0	0	2

COURSE OBJECTIVE:

1. To help students acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

UNIT I   VOCABULARY BUILDING   6

General Vocabulary –Nouns- Compound nouns, Word borrowing & Word making, Foreign machinery in English, Dictionary and Thesaurus usages, Synonyms , Antonyms, Prefixes and Suffixes, Homonyms, Homographs and Homophones, Changing words from one form to another, Acronyms and Abbreviations.

UNIT II   BASIC WRITING   6

Sentences structures –Kinds of sentences, Types of sentences, Clauses and Phrases, Punctuations, Word Links and Connectives, Summarizing, Precise writing, Paragraph Writing.

UNIT III   IDENTIFYING COMMON ERRORS IN ENGLISH   6

Articles, Prepositions, Subject-verb Agreement, Pronouns - Relative pronouns, Demonstrative pronouns, Misplaced Modifiers, Redundancies, Clichés, Infinitives& Gerund

UNIT IV   NATURE AND STYLE OF SENSIBLE WRITING   6

Describing people, place and situations, Process description, Definitions, Numerical Expressions, Information Transfer- Flow chart Bar chart and Pie chart, Checklists, Writing introduction and conclusion.

UNIT V   WRITING PRACTICES   6

Letter Writing- Formal & Informal Letters, Report Writing- Letter Report, Accident Report, Investigation Report and Survey, Essay writing, Comprehension Passages.

TOTAL: 30 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Learners should be able to speak clearly confidently and comprehensively using appropriate vocabulary and communicative strategies.	K3
CO2	Learners should be able to communicate with one or many listeners using appropriate sentences in oral and written communication	K3
CO3	Analyze and write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, and organize their ideas logically on a topic.	K4
CO4	Read with interpretive and analytical proficiency in different genres of texts adopting various reading strategies.	K4
CO5	Respond to peers' work in one or more creative literary forms with constructively critical proficiency. Should be able to listen/view and comprehend different spoken and written discourses/excerpts in different accents.	K4

TEXT BOOKS:

1. English for Scientists, Prof. K. R. Lakshminarayanan, Former Head, Department of Humanities and Social sciences, Sri Venkateshwara College of Engineering, Pennalur, Sriperumbudur, Tamilnadu SCITECH PUBLICATIONS (INDIA PVT.LTD)2014

2. Department of English, Anna University, Mindscapes, 'English for Technologists and Engineers', Orient Longman Pvt. Ltd, Chennai: 2012.

3. Department of Humanities and Social Sciences, Anna University, 'English for Engineers and Technologists' Combined Edition (Volumes 1 and 2), Chennai: Orient Longman Pvt. Ltd., 2006.

4. Department of English, Anna University, Mindscapes, 'English for Technologists and Engineers', Orient Longman Pvt. Ltd, Chennai: 2012.

5. Department of Humanities and Social Sciences, Anna University, ''English for Engineers and Technologists'' Combined Edition (Volumes 1 and 2), Chennai: Orient Longman Pvt. Ltd., 2006.

6. M.Ashraf Rizvi, "Effective Technical Communication", Tata McGraw-Hill Publishing Company Limited, New Delhi.2009.

REFERENCE BOOKS:

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

HSC-02	ENGLISH LABORATORY	0	0	2	1

COURSE OBJECTIVE:

1. The student will attain the ability to possess basic English language proficiency in both oral and written communication in real life situation .

LIST OF EXPERIMENTS:

1. Listening comprehensions
2. Pronunciation
3. Phonology
4. Intonation
5. Stress and Rhythm
6. Situational Dialogues
7. Communication in workplace
8. Interviews
9. Seminar
10. Formal Presentations
11. Group Discussions
12. Debates
13. JAM sessions

TOTAL: 30 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Distinguish various listening & written contexts for understanding the implied meanings and rrdingly.esponding to them acco	K4
CO2	Use appropriate pronunciation and rhythm of spoken language in oral communication	K3
CO3	Draft and interpret the written communication in officialcontexts like narrative, descriptive, creative, critical and analytical reports	K3
CO4	Infer implied meanings of different genres of texts and critically analyze and evaluate them for ideas, as well as for method of oral presentation	K3
CO5	Make use of suitable communicative strategies to express their point of views convincingly in any type of discussions , negotiation and conversations	K3

TEXT BOOKS:

1. Anderson, P.V, Technical Communication, Thomson Wadsworth, Sixth Edition, New Delhi, 2007.
2. Prakash, P, Verbal and Non-Verbal Reasoning, Macmillan India Ltd., Second Edition, New Delhi, 2004.
3. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
4. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011. N

REFERENCE BOOKS:

1. John Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi, 2004.
2. Evans, D, Decision maker, Cambridge University Press, 1997.
3. Thorpe, E, and Thorpe, S, Objective English, Pearson Education, Second Edition, New Delhi, 2007.
4. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford UniversityPress

HSC-03	**PERSONALITY DEVELOPMENT I**	2	0	0	2

COURSE OBJECTIVE:

1. To nurture & develop winning personalities, eventually leading them to become dynamic and socially responsible leaders.

2. To avoid negative spiritual experiences and it's importance to keep the balance between spiritual and physical life.

3. To guide and orient students into becoming effective and exceptional communicators

UNIT I   SOFT SKILLS   I   6

Introduction to Personality Development – Meaning-Features of personality=Dimensions of Personality=Determinants of Personality-Features and Traits- Components of self concept-Barriers-Self analysis

UNIT II   SOFT SKILLS   II   6

Importance of Soft Skills – First impression-Work Place requirements-Discipline-Cleanliness-Hygiene-general Appearance--Building Confidence—Concept of Thinking and Usage-Value of Time-Focus & Commitment.

UNIT III   SOFT SKILLS IN ACTION   6

Grooming – Attire – Understanding others- – Stability & Maturity Development – Strength s – Weakness – Opportunities-threats -Merits of SWOT Analysis-Components-how to convert weakness into strengths-Goal settings

UNIT IV SELF AWARENESS AND SELF ESTEEM   6

Definitions-Components of self awareness-Developing Self awareness -Self esteem-meaning-Steps to improve self esteem

UNIT V SELF MOTIVATION   6

Motivation –Meaning-Techniques of self motivation-Motivation & goal setting – Motivation and emotion – Motivation at work.

Total :30h

COURSE OUTCOMES:

At the end of this course the students will be able to,

CO1	Develop the soft skills through personality features and get rid of barriers.	K6
CO2	Build the basic characters such as cleanliness, hygiene and appearance.	K6
CO3	Creating the soft skills in disciplinary actions.	K6
CO4	Understand the concept of self awareness and self esteem	K2
CO5	Adapt with concepts of self motivation	K6

REFERENCE BOOKS

i.   Personality Development And Soft Skills---Barun K Mitra, Oxford Publication

ii. Seven habits of Higly Effective people – Stephen R. covey

iii. Emotion, motivation and Self regulation - **Nathan C. Hall** , McGill University, Canada **Thomas Goetz**, University of Konstanz, Germany http://www.emeraldgrouppublishing.com/

iv. Psychology of Selfesteem – Nathaniel Branden, Nash (1st edition), Jossey-Bass (32nd anniversary edition

HSC-04	PERSONALITY DEVELOPMENT II	2	0	0	2

COURSE OBJECTIVE:

1. To improve leadership quality, physical aspects of personality/posture and good team spirit.
2. To inculcate the need to lead a healthy lifestyle and manage stress. To be a socially responsible and ethical citizen.

UNIT I   Soft Skills   III   **6**

Basic Etiquette – Email etiquette – Business etiquette – Telephone etiquette – Meeting etiquette – Adjustment of Role & Leadership – Team Management & Development

UNIT II   QUANTITATIVE APTITUDE I   6

Percentage – Profit Loss -Discount – Ratio Proportion – Time & Work – Time, Speed & Distancel. Problems relating to ages- Permutation & Combination-Probability

UNIT III QUANTITATIVE APTITUDE II   **6**

Mensuration   Clocks and Calendars- Boats-Simple Interest –Compound Interest- Fractions and Decimals – Square roots – Functions.

UNIT IV ANALYTICAL PROBLEMS   **6**

Introduction – Linear Sequencing – Seating Arrangements – Distribution/Double Line Up – Selection – Ordering and Sequencing – Binary Logic – Venn Diagrams –Directions.

UNIT V LOGICAL PROBLEMS   **6**

Introduction to Logical problems – Cause and Effect – Course of Action – Statement and Assumption – Letter and Symbol series – Analogies.

COURSE OUTCOMES:

At the end of this course the students will be able to,

CO1	Develop the soft skills and basic etiquette	K6
CO2	Develop the quantitative aptitude skills	K6
CO3	Build the advanced aptitude skills	K6
CO4	Learn to Apply the analytical problem solving skills to various applications	K3
CO5	Build the knowledge on logical problem solving skills	K6

TOTAL :30h

REFERENCE BOOKS

1. Personality Enrichment--K R Dhanalakshmi And N S Raghunathan, Margham Publications

2. Personality Development --Dr V M SelvarajBhavani Publications

3. Quantitative Aptitude – R. S Aggarwal

4. Logical and Analytical Reasoning (English) 30th Edition – A.K Gupta

HSC-05	**PERSONALITY DEVELOPMENT III**	2	0	0	2

COURSE OBJECTIVE:

1. To enhance the corporate readiness and continuous employability
2. To provide a proper verbal, written communication skills and interpersonal & group skills

UNIT I   VERBAL APPTITUDE I   6

Phonetics/Neutral   Accent/Pronunciation – Speech Mechanism/Mouth & Face Exercise – Vowels & Consonants – Sounds – Syllable and Syllable Stress/ Word Stress – Sentence Stress & Intonation – Articulation Exercise – Rate of Speech / Flow of Speech / Idiomatic Phrases.

UNIT II   VERBAL APTITUDE II   6

Singular/plural-present tense/past tense—gendersPrepositions-conjunctionsChoice of words—simple sentences—compound sentences---summarizing   phrases— synonyms—Antonyms—Analogies—Similar Words

UNIT III   SOFT SKILLS   6

Attitude—Meaning-Features of attitude-Formation-Personality Factors-Types of attitude-change in attitude-Developing Positive attitude.

UNIT IVTIME MANAGEMENT   6

Definition –Meaning-Importance, Value of time as an important resource- comparison of Time and Money-Circle of influence and circle of control—Definition of URGENT and IMPORTANT—Time Wasters and how to reduce—Procrastination—meaning and impact- 4 Quadrants.

UNIT V TEAM BUILDING   6

Meaning—Aspects of team building—Process of team building—Types of Teams-Team ethics and Understanding-Team trust and commitment

TOTAL: 30h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the importance of verbal aptitude	K2
CO2	Understand and learn the verbal aptitudes	K2
CO3	Developing and maintaining a positive attitude and being assertive.	K2
CO4	Understand the importance of time management.	K2
CO5	Focus on team learning to solve problems collectively.	K3

REFERENCE BOOKS

1. Managing Soft Skills And Personality--B N Ghosh Mcgraw Hill Publications

2. Principles and Practices of Management Shejwalkar and Ghanekar McGraw Hill Latest

3. Time management for Busy people – Roberta roesch, TatamcGraw-Hill Edition

4. Personality Development --Dr V M Selvaraj, Bhavani Publications

HSC-06	PERSONALITY DEVELOPMENT IV	2	0	0	2

COURSE OBJECTIVE:

1. To develop awareness of different job search techniques, including how to employ practical networking techniques. To begin to recognize the skills developed during research and analyse how to present these effectively in written application.

2. To critique the strengths and weaknesses of their own and colleagues' current CVs.

3. To understand interview processes and practice being interviewed in a supportive environment

UNIT I   Soft SKILLS V   **6**

Assertiveness—Meaning—Importance of assertiveness- Characteristics of assertive communication-Merits –forms of assertion—Causes of misunderstanding

UNIT II Communication Skills   **6**

Meaning—Elements of communication—Functions of communication—Principles of communication—Formal and Informal communication—Barriers in Communication—Characteristics of good communication—Feedback—communication systems.

UNIT III Presentation Skills I   **6**

Meaning—Importance of Presentation—Concept of 5 w's   and one H--- understanding the audience—Types of presentations—How to make effective presentation

UNIT IV Presentation Skills II   **6**

Use of slide, PPT's. and visuals—Rules for slide presentation—precautions ---seminars and conferences-Steps to eliminate Stage fear.

UNIT V Change Management   **6**

Definition – Necessity - Resistance towards Change – 10 Principles of Change Management – Leaders approach – Effective Change management.

TOTAL:30h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the Assertiveness, Meaning, Importance of assertiveness, Characteristics of assertive communication, Merits, forms of assertion, Causes of misunderstanding	K2
CO2	Build Elements of communication, Functions of communication, Principles of communication, Formal and Informal communication, Barriers in Communication, Characteristics of good communication, Feedback, communication systems	K6
CO3	Understand Importance of Presentation, Concept of 5 w' s and one H , understanding the audience, Types of presentations, How to make effective presentation	K5
CO4	Utilize the power point slides and visual presentation. Understand the Rules for slide presentation, precautions, seminars and conferences.	K3
CO5	Explain the Principles of Change management, leaders approach	K5

REFERENCE BOOKS

1. Helping employees embrace change - LaClair, J. and Rao, R. Helping Employees Embrace Change, McKinsey Quarterly, 2002, Number 4.
2. Who Moved My Cheese by Spencer Johnson published by vermilion first edition
3. Effective Communication. Adair, John. London: Pan Macmillan Ltd., 2003.
4. Business Communication Today: Bovee, Courtland L, John V. Thill & Barbara E. Schatzman. Tenth Edition. New Jersey: Prentice Hall, 2010

HSC-07	PROFESSIONAL ETHICS IN ENGINEERING	2	0	0	2	

COURSE OBJECTIVE:

To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I   HUMAN VALUES   10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II   ENGINEERING ETHICS   9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III   ENGINEERING AS SOCIAL EXPERIMENTATION   9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV   SAFETY, RESPONSIBILITIES AND RIGHTS   8

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - 105 Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V   GLOBAL ISSUES   8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories.	K2
CO2	Understand responsibilities of an engineer for safety and risk benefit analysis, professional rights and responsibilities of an engineer.	K2
CO3	Acquire knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives	K3
CO4	Apply the core values that shape the ethical behavior of an engineer and Exposed awareness on professional ethics and human values.	K3
CO5	Understand the nature of professional responsibility and be able to identify the ethical elements in decisions.	K2

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCE BOOKS:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.

2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.

3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003

4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.

5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.

6. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011.

Syllabus

ENGINEERING SCIENCE COURSES

ESC-01	PROGRAMMING FOR PROBLEM SOLVING	3	0	0	3

COURSE OBJECTIVES:

1. To understand the basic concepts of programming – Flow chart, Pseudocode.
2. To learn the fundamentals of C programming - declarations, operators, expressions and control statements.
3. To learn the manipulation of strings, functions, pointers and file operations.
4. To understand the concepts of arrays, basic sorting and searching algorithms.
5. To find the order of time complexity of basic algorithms.

UNIT I   INTRODUCTION TO PROGRAMMING   9

Introduction to Programming (Flow chart / pseudo code, compilation etc.), Variables   (including data types) -Arithmetic expressions and precedence, Conditional Branching and Loops - Writing and evaluation of conditionals and consequent branching Iteration and loops.

UNIT II   ARRAYS AND BASIC ALGORITHMS   9

Arrays (1-D, 2-D), Character arrays and Strings, Searching, Basic Sorting Algorithms, finding roots of equations, Notion of order of time complexity through example programs.

UNIT III   FUNCTION AND POINTERS   9

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion with example programs such as Finding Factorial, Fibonacci series, etc. Pointers - Defining pointers, Use of Pointers in self-referential structures.

UNIT IV   STRUCTURES AND UNIONS   9

Structures - Defining structures and Array of Structures, Structures containing Pointers, Unions - Storage classes: auto, static, extern, register – Dynamic memory allocation.

UNIT V   STRING FUNCTIONS AND FILES   9

Strings - library string functions, pointers in strings, pointers and function arguments, Files - file Operations, processing a file, Pre-processors directives, use of typedef, Command line arguments, Enumerated data types.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Construct a pictorial representation with a stepwise procedure for solving complex problems.	K3
CO2	Develop a high level programming code using c languages.	K3
CO3	Evaluate the various functional operations for solving problem	K5
CO4	Make use of various c operations like array, pointer, strings and searching method.	K3
CO5	Develop a C module for a given set of instruction.	K6

TEXT BOOKS:

1. Byron Gottfried, "Schaum's Outline of Programming with C", McGraw-Hill.
2. E. Balaguruswamy, "Programming in ANSI C", Tata McGraw-Hill.

REFERENCE BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Prentice Hall of India.
2. Yashavant Kanetkar, "Let Us C", BPB Publications.
3. Ashok. N. Kamthane, "Computer Programming", Pearson Education (India).

ESC-02	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	0	0	4	2

COURSE OBJECTIVES:

1. To design and develop C Programs for various application.

LIST OF EXPERIMENTS

1. Simple computational problems using arithmetic expressions
2. Problems involving if-then-else structures
3. Iterative problems
4. 1D Array manipulation
5. Matrix problems
6. String operations
7. Simple functions
8. Solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Determine the advanced features of the C language	K5
CO2	Develop the model data using primitive and structured types.	K5
CO3	Construct programs that demonstrate effective use of C features including arrays, structures, pointers and files.	K3
CO4	Develop the ability to analyze a problem, develop an algorithm to solve it.	K3
CO5	Develop the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general.	K6

ESC-03	MANUFACTURING PRACTICES	1	0	4	3

COURSE OBJECTIVE:

1. To study bench fitting drawings for making male and female fittings as per the given dimensions and Tolerances.
2. To study Arc welding drawings for making common weld joints as per the given dimensions.
3. To study sheet metal development drawings for making common metal parts/components as per the given dimensions.

DETAILED CONTENTS

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods

   (3 lectures)
2. CNC machining, Additive manufacturing   (1 lecture)
3. Fitting operations & power tools   (1 lecture)
4. Electrical &Electronics   (1 lecture)
5. Carpentry   (1 lecture)
6. Plastic moulding, glass cutting   (1 lecture)
7. Metal casting   (1 lecture)
8. Welding (arc welding & gas welding), brazing   (1 lecture)

WORKSHOP PRACTICE

1. **Machine shop**   **10**

   To make Facing and plain turning, step turning, drilling in the lathe

2. **Fitting shop**   **8**

   To make square, V joint in bench fitting as per the given dimension   and tolerances

3. **Carpentry**   **6**

   To make half lap joint, dovetail, TEE Lap joint

4. **Electrical & Electronics**   **8**
   i. To make fluorescent lamp wiring.
   ii. To make stair case wiring.
   iii. To make residential wiring.
   iv. To measure Peak-peak, rms, period, frequency using CRO.
   v. To solder components devices and circuits by using general purpose PCB.

5. **Welding shop (Arc welding 4 hrs + gas welding 4 hrs)**   **8**

   To make single, butt, lap and T fillet joint by arc welding with the back hand and fore hand welding techniques as per the given dimensions.

6. **Plumbing Works**

   Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

7. **Sheet Metal Work**

   To make simple Dust pan, Rectangular trays in sheet metal with the jigs as perthe given Dimensions.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the various type of welding joints ,fitting work and plumbing works	K2
CO2	Develop operating skill in turning and shaper machine	K3
CO3	Develop simple Cubical blocks, Rectangular trays in sheet metal with the jigs as per the given dimensions.	K3
CO4	Measure the electrical quantities in the given circuit	K5
CO5	Demonstrate staircase wiring, fluorescent lamp wiring and residential wiring.	K2

TEXT/REFERENCE BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

ESC-04	ENGINEERING GRAPHICS AND DESIGN	1	0	4	3

COURSE OBJECTIVE:

1. To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2. To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I   INTRODUCTION TO ENGINEERING DRAWING AND PLANE CURVES   12

Curves used in engineering practices: Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method – Construction of cycloid, Epicycloid, Hypocycloid – construction of involutes of squad and circle – Drawing of tangents and normal to the above curves. Scales – Plain, Diagonal and Vernier Scales.

UNIT II   PROJECTION OF POINTS, LINES AND PLANE SURFACES   12

Projection of points and straight lines located in the first quadrant – Determination of true lengths and true inclinations – Projection of polygonal surface and circular lamina inclined to both reference planes - Auxiliary Planes

UNIT III   PROJECTION OF SOLIDS   12

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method - Auxiliary Views

UNIT IV   SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES   12

Sectioning of above solids in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section - Auxiliary Views. Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones – Development of lateral surfaces of solids with cylindrical cutouts, perpendicular to the axis.

UNIT V   ORTHOGRAPHIC PROJECTION AND ISOMETRIC PROJECTION   12

Free hand sketching: Representation of Three Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement - layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects.

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.

TOTAL: 60 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the theory of projection. Able to know and understand the conventions and the methods of engineering drawing	K3
CO2	Improve their visualization skills so that they can apply these skills in developing new products. Able to prepare the simple layout of factory buildings	K4
CO3	Impart and inculcate a proper understanding of the theory of projection. Improve the visualization skills	K4
CO4	Understand the various concepts like dimensioning, conventioning and standards related to working drawings in order to become professionally efficient.Impart the knowledge for understanding and drawing of simple residential/office buildings	K4
CO5	Ability to produce engineered drawings will improve. Ability to convert sketches into engineered drawings will increase	K3

.

TEXT BOOKS:

1. N.D. Bhatt, "Engineering Drawing" Charotar Publishing House, 46 th Edition, (2003).

REFERENCE BOOKS:

1. K. V. Natrajan, "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai (2006).
2. M.S. Kumar, "Engineering Graphics", D.D. Publications, (2007).
3. K. Venugopal & V. Prabhu Raja, "Engineering Graphics", New Age International (P) Limited (2008).
4. M.B. Shah and B.C. Rana, "Engineering Drawing", Pearson Education (2005).
5. K. R. Gopalakrishnana, "Engineering Drawing" (Vol.I&II), Subhas Publications (1998).
6. Dhananjay A.Jolhe, "Engineering Drawing with an introduction to AutoCAD" Tata McGraw Hill Publishing Company Limited (2008).
7. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, (2008).

ESC-05	**BASIC ELECTRICAL ENGINEERING**	3	1	0	4

COURSEOBJECTIVE:

To obtain basic knowledge on electrical quantities such as current, voltage, power and energy.

1. To provide adequate working knowledge on basic DC and AC circuits used in electrical and electronic devices.
2. To understand the working principle, construction, applications of DC machines, AC machines & measuring instruments.
3. To emphasize the importance of transformers in transmission and distribution of electric power.

UNIT I   DC Circuits   12

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, Mesh and Nodal analysis, Analysis of simple circuits with dc excitation, Wye↔Delta Transformation, Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

UNIT II   AC Circuits   12

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III   Transformers   12

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT IV   Electrical Machines & Power Converters   12

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Construction of Single phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. DC-DC buck and boost converters, duty ratio control. Single phase Bridge Rectifier, Single Phase voltage source inverters.

UNIT V   Electrical Installations   12

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of
Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

TOTAL:60h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand and analyze DC circuits	K2,K4
CO2	Understand and analyze AC circuits	K2,K4
CO3	Explain the construction, operation and characteristics of transformer and classify the types of three –phase transformer connections.	K2,K5
CO4	Understand and Examine the various electrical machines and converter circuits	K2,K4
CO5	Identify the use of low tension switchgears and Classify the various types of wires, cables, batteries and earthing.	K3,K4

TEXT/ REFERENCE BOOKS:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989

ESC-06	**ELECTRICAL ENGINEERING LABORATORY**	0	0	2	1

COURSEOBJECTIVE:

1. To provide comprehensive idea about AC and D C circuit analysis, working principles and applications of basic machines in electrical engineering.

LIST OF EXPERIMENTS

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter,ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification.
3. Loading of a transformer: measurement of primary and secondary voltages and currents, and power
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents).
5. Load Characteristics of a DC Motor
6. Torque - Slip Characteristic of an Induction motor
7. Three phase induction motors – Direction reversal by change of phase-sequence of connections.
8. Demonstration of DC-DC Converter.
9. Demonstration of DC-AC converter.
10. Demonstration of AC-DC converter.

TOTAL: 30 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the basic safety precautions and learn to make use of measuring instruments	K2,K3
CO2	Analyze the steady state response of R-L, R-C circuits and Resonance in RLC circuits	K4
CO3	Experiment with loading of transformer to measure the primary and secondary voltages, currents and power and classify the different types of transformer connections	K4
CO4	Understand and Experiment with single phase induction motor and three phase induction motor	K2,K4
CO5	Demonstrate DC-DC, DC-AC and AC-DC converters	K2

TEXT BOOKS:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals",

ESC-07	ENGINEERING MECHANICS	3	0	0	3

COURSE OBJECTIVE:

1. At the end of this course the student should be able to understand the vectorial and scalar representation of forces and moments, static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions.

2. He should understand the principle of work and energy. He should be able to comprehend the effect of friction on equilibrium. He should be able to understand the laws of motion, the kinematics of motion and the interrelationship. He should also be able to write the dynamic equilibrium equation. All these should be achieved both conceptually and through solved examples.

UNIT I   BASICS AND STATICS OF PARTICLES   9

Introduction – Units and Dimensions – Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II   EQUILIBRIUM OF RIGID BODIES   9

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III   PROPERTIES OF SURFACES AND SOLIDS   9

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, Angle section, Hollow section by using standard formula – second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Derivation of mass moment of inertia for rectangular section, prism, sphere from first principle – Relation to area moments of inertia.

UNIT IV   DYNAMICS OF PARTICLES   9

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

Frictional force – Laws of Coulomb friction – simple contact friction – Rolling resistance – Belt friction. Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion.

TOTAL : 45 h

COURSE OUTCOMES:

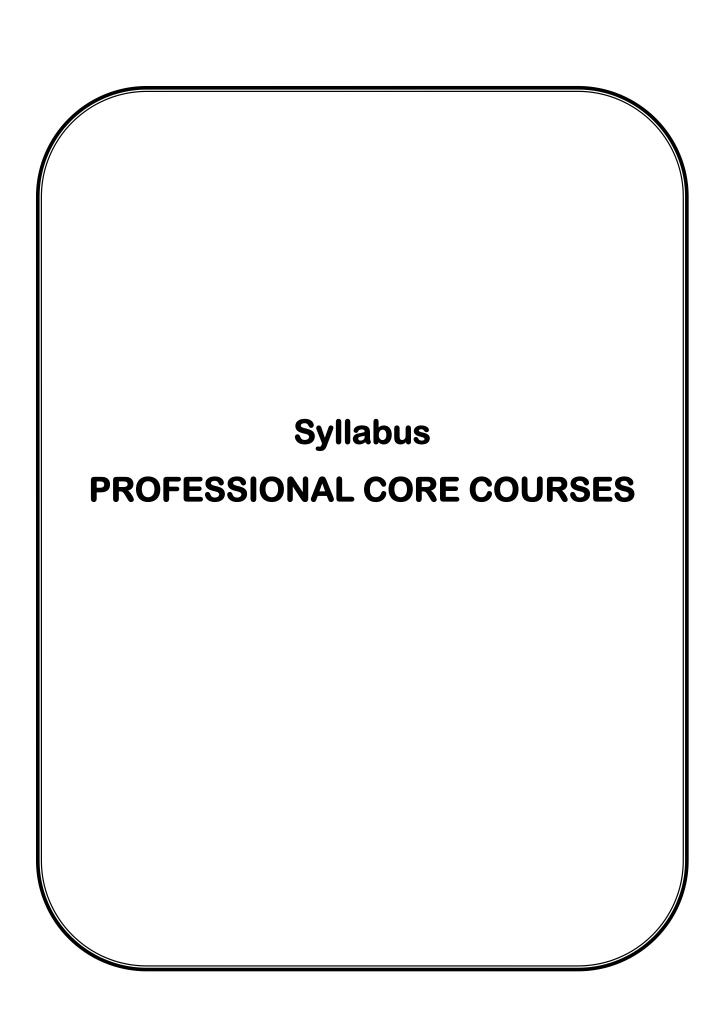After successful completion of the Engineering Mechanics course, the students have the ability to

CO1	Solve engineering problems dealing with force, displacement, velocity and acceleration	K3
CO2	Evaluate problems on equilibrium of rigid bodies	K5
CO3	Determine the areas and volumes of surface and solids	K5
CO4	Explain dynamics of particles and their relationships between motions	K5
CO5	Analyze friction and elements of rigid body dynamics	K4

TEXT BOOKS:

1. Beer, F.P and Johnson Jr. E.R. "Vector Mechanics for Engineers", Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 1997.
2. Rajasekaran. S, Sankarasubramanian. G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., 2000.

REFERENCES:

1. Hibbeller, R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2000.
2. Palanichamy, M.S., Nagam, S., "Engineering Mechanics – Statics and Dynamics", Tata McGraw-Hill, 2001.
3. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", IV Edition – Pearson Education Asia Pvt. Ltd., 2003.
4. Ashok Gupta, "Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Pvt., Ltd., 2002.

Syllabus

PROFESSIONAL CORE COURSES

PCC-01	ELECTROMAGNETIC THEORY	3	0	0	3

COURSE OBJECTIVE:

1. Understand the concept of electric fields. Understand the concept of magnetic fields Develop the theory of electrical machines.

2. To know the application of Gauss law and ampere's circuit law.

UNIT I   ELECTROSTATICS-I   9

Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields – Gradient,Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Fielddue to discrete and continuous charges – Gauss's law and applications.

UNIT II   ELECTROSTATICS – II   9

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization –Dielectric strength - Electric field in multiple Dielectrics – Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

UNIT III   MAGNETOSTATICS   9

Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due tostraight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in freespace, conductor, magnetic materials Magnetization, Magnetic field in multiple media –Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

UNIT IV   ELECTRODYNAMIC FIELDS   9

Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current -Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

UNIT V   ELECTROMAGNETIC WAVES   9

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the basic mathematical concepts related to electromagnetic vector fields.	K2
CO2	Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.	K3
CO3	Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.	K3
CO4	Understand the concepts related to Faraday's law, induced emf and Maxwell's equations.	K2
CO5	Apply Maxwell's equations to solutions of problems relating to transmission lines and uniform plane wave propagation.	K3

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition,2015.

2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.

3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.

REFERENCE BOOKS:

1. V.V.Sarwate, 'Electromagnetic fields and waves', First Edition, Newage Publishers, 1993.

2. J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications',Second Edition, Khanna Publishers.

3.Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), McGraw Hill, 2010.

4. S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education(India) Private Limited, 2012.

5. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Eighth Reprint : 2015

PCC-02	ELECTRICAL CIRCUIT ANALYSIS	3	0	0	3

COURSE OBJECTIVE:

1. To impart knowledge on solving circuit equations using network theorems and to understand the phenomenon of resonance in coupled circuits.

2. To educate on obtaining the transient response of circuit and analysis of three phase circuits

UNIT I   NETWORK THEOREMS   9

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Concept of duality and dual networks.

UNIT II   RESONANCE AND COUPLED CIRCUITS   9

Series and parallel resonance – their frequency response – Quality factor and Bandwidth – Selfand mutual inductance – Coefficient of coupling – Dot Rule – Conductively Coupled coils - Analysis of coupled circuits - Tuned circuits – Single tuned circuits – Doubled tuned Circuits

UNIT III   TRANSIENT RESPONSE ANALYSIS   9

L and C elements -Transient response of RL, RC and RLC Circuits using Laplace transform forDC input and A.C. sinusoidal input.

UNIT IV   THREE PHASE CIRCUITS   9

Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads,balanced & un balanced – phasor diagram of voltages and currents – power measurement inthree phase circuits.

UNIT V   TWO PORT NETWORK AND NETWORK FUNCTIONS   9

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters,admittance parameters, transmission parameters and hybrid parameters, interconnections oftwo port networks.
TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Apply network theorems to reduce the AC and DC network	K3
CO2	Understand and Develop resonance and coupled circuits	K2,K3
CO3	Analyse the transient response for DC and AC circuits	K4
CO4	Examine 3- phase circuits for calculating impedance, voltage, current, power, phase shift and power factor.	K4
CO5	Construct and analyze two port networks and its parameters	K3

TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits
2. Analysis", McGraw Hill publishers, edition, New Delhi, 2013.
3. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits",
4. Second Edition, McGraw Hill, 2013.
5. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage
6. Learning India, 2013.

REFERENCE BOOKS:

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 1999.
2. Jegatheesan, R., "Analysis of Electric Circuits," McGraw Hill, 2015.
3. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, McGraw- Hill, New Delhi, 2010.
4. M E Van Valkenburg, "Network Analysis",Prentice-Hall of India Pvt Ltd, New Delhi,2015.
5. Mahadevan, K., Chitra, C., "Electric Circuits Analysis," Prentice-Hall of India Pvt Ltd., New Delhi, 2015.
6. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley & Sons, Inc. 2015.
7. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill, 2015.

PCC-03	ANALOG ELECTRONICS	3	0	0	3

COURSE OBJECTIVE:

1. Be familiar with the structure of basic electronic devices.
2. Exposed to the operation and application of electronic devices.
3. To explain about the working and usage of Transistors ,amplifiers & oscillators

UNIT I   DIODE CIRCUITS   9

PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier,– Display devices- LED, Laser diodes,Zener Diode characteristics - Zener Reverse characteristics – Zener as regulator

UNIT II   BJT CIRCUITS   9

Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits; common-emitter, common-base and common collector configuration; Power Transistors, opto couplers.

UNIT III   MOSFET CIRCUITS   9

MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, transconductance, high frequency equivalent circuit.

UNIT IV   DIFFERENTIAL, MULTI-STAGE AND OPERATIONAL AMPLIFIERS   9

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

UNIT V   FEEDBACK AMPLIFIERS AND OSCILLATORS   9

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien Bridge, Hartley, Colpitts and Crystal oscillators.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to,

CO1	Explain the structure and working operation of basic electronic devices.	K2
CO2	Explain the transistor structure, characteristics, configurations, and model its small signal equivalent circuits	K2,K3
CO3	Explain the MOSFET structure, characteristics, configurations, and model its small signal equivalent circuits.	K2,K3
CO4	Compare the working of Differential amplifier, multistage amplifier and operational amplifier.	K4
CO5	Understand the working and analysis of various types of feedback amplifiers and oscillator circuits.	K2,K4

TEXT BOOKS:

1. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
2. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
3. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
4. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.
5. S. Sedra and K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.

REFERENCE BOOKS:

1. Theodre F.Boghert, "Electronic Devices & Circuits" Pearson Education, VI Edition, 2003
2. Rashid, "Microelectronic circuits" Thomson Publication, 1999.
3. Singh, B.P. and Rekha Sing, "Electronic Devices and Integrated Circuits" Pearson Education, 2006.
4. Salivahanan.S,Suresh kumar.N "Electronic Devices & Circuits" Tata McGraw-Hill Education, 2011.

PCC-04	ELECTRICAL MACHINES – I	3	1	0	4

COURSE OBJECTIVE:

1. Provide the students a detailed knowledge regarding energy conversion processes(Mechanical Energy into Electrical Energy and vice versa) and Energy Balance Equation.

2. Provide the students a detailed knowledge regarding electrical DC machines. Strengthening knowledge of students regarding the construction and working principle of   DC machines which will help them in design field.

UNIT I   MAGNETIC CIRCUITS AND MAGNETIC MATERIALS   12

Magnetic circuits –Laws governing magnetic circuits - Flux linkage, Inductance and energy –Statically and Dynamically induced EMF - Torque – Properties of magnetic materials,Hysteresis and Eddy Current losses - AC excitation, introduction to permanent magnets-Transformer as a magnetically coupled circuit.

UNIT II   TRANSFORMERS   12

Construction – principle of operation – equivalent circuit parameters – phasor diagrams, losses – testing – efficiency and voltage regulation-all day efficiency-Sumpner's test, per unit representation – inrush current - three phase transformers-connections – Scott Connection– Phasing of transformer– parallel operation of three phase transformers-auto transformer –tap changing transformers- tertiary winding.

UNIT III   ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS   12
**   IN ROTATING MACHINES**

Energy in magnetic system – Field energy and co energy-force and torque equations –singly and multiply excited magnetic field systems-mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines – rotating mmf waves – magnetic saturation and leakage fluxes.

UNIT IV   DC GENERATORS   12

Construction and components of DC Machine – Principle of operation - Lap and wave windings-EMF equations– circuit model – armature reaction –methods of excitation commutation- inter poles compensating winding –characteristics of DC generators.

UNIT V   DC MOTORS   12

Principle and operations - types of DC Motors – Speed Torque Characteristics of DC Motors starting and speed control of DC motors –Plugging, dynamic and regenerative brakingtestingand efficiency –

Retardation test- Swinburne's test and Hopkinson's test – PermanentMagnet DC (PMDC)motors- applications of DC Motor

TOTAL : 60 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the properties of magnetic materials and the laws governing magnetic circuits	K2
CO2	Understand the fundamentals of a practical Transformer's operating principle and construction.	K2
CO3	Understand the concept of electromechanical energy conversion system in rotating machines.	K2
CO4	Analyze the different types of DC Generators' design, operation, and characteristics.	K4
CO5	Analyze the operation and applications of various DC motors.	K4

TEXT BOOKS:

1. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.
2. P.C. Sen'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd Edition 2013.
3. Nagrath, I.J. and Kothari.D.P., Electric Machines', McGraw-Hill Education, 2004

REFERENCE BOOKS

1. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", PearsonEducation., (5th Edition)**,** 2002**.**
2. B.R. Gupta ,'Fundamental of Electric Machines' New age International Publishers,3[rd]Edition ,Reprint 2015.
3. S.K. Bhattacharya, 'Electrical Machines' McGraw - Hill Education, New Delhi, 3[rd]Edition,2009.
4. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.Surinder Pal Bali, 'Electrical Technology Machines & Measurements, Vol.II, Pearson,2013.
5. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Sixthedition, McGraw Hill Books Company, 2003.

PCC-05	**ELECTRICAL MACHINES -I LABORATORY**	0	0	3	1

COURSE OBJECTIVE:

1. To have knowledge about the working of various types of motors using loads.
2. To understand the operation of transformer with and without applying load and determine its efficiency.To gain knowledge in the operation of three phase transformer.
3. To perform hopkinsons and sumpner's test to determine the efficiency of the motor.

LIST OF EXPERIMENTS

1. Load test on DC shunt Motor
2. Load test on DC series Motor
3. Load test on DC compound Motor
4. Open circuit and load characteristics of DC shunt Generator
5. Load test on single-phase Transformer
6. Speed control of DC shunt Motor
7. Load characteristics of DC compound Generator
8. Open circuit and short circuit test on single phase Transformer
9. Swinburne's test on DC Motor
10. Hopkinson's test on DC Machine

TOTAL: 30 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand and determine the load characteristics of DC Generator	K2
CO2	Understand and determine the load characteristics of DC Motor	K2
CO3	Analyze the speed of DC motor under various load condition	K4
CO4	Analyze the performance of single phase transformer under load condition.	K4
CO5	Analyze the efficiency of transformers under various tests performed.	K4

PCC-06	ELECTRIC CIRCUITS LABORATORY	0	0	3	1

COURSE OBJECTIVE:

1. To simulate various electric circuits using Simulation Software
2. To gain practical experience on electric circuits and verification of theorems.

LIST OF EXPERIMENTS

1. Simulation and experimental verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
3. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
4. Simulation and experimental verification of electrical circuit problems using Superposition theorem.
5. Simulation and experimental verification of Maximum Power transfer Theorem.
6. Study of oscilloscopes and measurement of sinusoidal voltage, frequency and time period.
7. Simulation of R- L and R-C electric circuit transients.
8. Design and Simulation of series resonance and parallel resonance circuit.
9. Experimental determination of power in three phase circuits by two-watt meter method
10. Simulation of three phase balanced and unbalanced star, delta networks circuits

TOTAL: 45 h

COURSE OUTCOMES:

CO1	Analyze the various electrical circuits using circuit laws	K4
CO2	Understand and apply network theorems to various electrical circuits	K2
CO3	Determine transient response of RL and RC electrical circuit	K5
CO4	Determine power and power factor in three phase circuits	K5
CO5	Design and Simulate series resonance , parallel resonance and three phase balanced, unbalanced, star and delta circuits.	K6

PCC-07	MEASUREMENTS AND INSTRUMENTATION	3	0	0	3

COURSE OBJECTIVE:

1. To introduce the basic functional elements of instrumentation. To introduce the fundamentals of electrical and electronic instruments.

2. To educate on the comparison between various measurement techniques. To introduce various storage and display devices. To introduce various transducers and the data acquisition systems.

UNIT I   INTRODUCTION   9

Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration.

UNIT II   ELECTRICAL AND ELECTRONICS INSTRUMENTS   9

Principle and types of analog and digital voltmeters, ammeters, multimeters – Single and three phase wattmeters and energymeters – Magnetic measurements – Determination of B-H curve and measurements of iron loss –Measurements using Instrument transformers – Instruments for measurement of frequency and phase.

UNIT III   COMPARISON METHODS OF MEASUREMENTS   9

D.C & A.C potentiometers - D.C & A.C bridges, transformer ratio bridges, self-balancing bridges. Interference & screening – Multiple earth and earth loops - Electrostatic and electromagnetic interference – Grounding techniques.

UNIT IV   STORAGE AND DISPLAY DEVICES   9

Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & dot matrix display – Data Loggers

UNIT V   TRANSDUCERS AND DATA ACQUISITION SYSTEMS   9

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive transducers – Piezoelectric, optical and digital transducers – Elements of data acquisition system - A/D, D/A converters – Smart sensors.

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the functional elements of an instrument and analyze the static and dynamic characteristics of an instrument	K2
CO2	Classify the measuring instruments based on the measuring quantity and explain its working principle	K4
CO3	Determine the unknown component value using the bridge circuits	K5
CO4	Classify the display devices and able to explain their working principle and uses	K4
CO5	Classify different types of transducers and their principle of operation	K4

TOTAL: 45 h

TEXT BOOKS

1. Doebelin, E.O., "Measurement Systems – Application and Design", Tata McGraw Hill PublishingCompany,2003.
2. Sawhney, A.K.,"A Course in Electrical & Electronic Measurements and Instrumentation", Dhanpat Rai and Co,2004.

REFERENCE BOOKS:

1. Bouwens, A.J.,"Digital Instrumentation", Tata McGraw Hill, 1997.
2. Moorthy, D.V.S., "Transducers and Instrumentation", Prentice Hall of India Pvt Ltd, 2007.
3. Kalsi, H.S.,"Electronic Instrumentation", Tata McGraw Hill, II Edition 2004.
4. Martin Reissland, 'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001.
5. Gupta, J. B.,"A Course in Electronic and Electrical Measurements", S. K. Kataria & Sons, Delhi, 2003.

PCC-08	DIGITAL ELECTRONICS	3	0	0	3

COURSE OBJECTIVE:

1. To study various number of systems and simplify the logical expressions using Boolean Functions and to study combinational circuits.
2. To design various synchronous and asynchronous circuits. To introduce asynchronous sequential circuits and PLDs.

UNIT I   FUNDAMENTALS OF DIGITAL SYSTEMS AND LOGICFAMILIES   9

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital ICs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

UNIT II   COMBINATIONAL DIGITALCIRCUITS   9

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices,Q-M method of function realization.

UNIT III   SEQUENTIAL CIRCUITS AND SYSTEMS   9

Sequential   Logic   -   SR,   JK,   T andDflipflops,applicationsofflipflops,shiftregisters,applicationsofshiftregisters,serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters

UNIT IV   A/D and D/A Converters   9

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter,A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs

UNIT V   SEMICONDUCTOR MEMORIES AND PROGRAMMABLE LOGIC DEVICES.   9

Memory organization and operation, expanding memory size, classification And characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

TOTAL : 45h

COURSEOUTCOMES:

At the end of this course the students will be able to,

CO1	Simplify the mathematical expressions using Boolean functions and understand logic families	K2
CO2	Design, implement and analyze combinational logic circuits	K2,K3
CO3	Apply the design procedures to design basic sequential circuits	K2,K3
CO4	Understand and classify analog to digital and digital to analog converters	K4
CO5	Understand the concept of memory devices and classify different semiconductor memories	K2,K4

TEXT BOOKS:

1. M. Morris Mano, "Digital Design", 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.

REFERENCE BOOKS:

1. John F.Wakerly, "Digital Design", Fourth Edition, Pearson/PHI, 2008
2. John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006

PCC-09	ELECTRICAL MACHINES – II	3	1	0	4

COURSE OBJECTIVE:

1. To impart knowledge on Construction and performance of salient and non salient type synchronous generators.
2. To impart knowledge on Principle of operation and performance of synchronous motor. To impart knowledge on Construction, principle of operation and performance of induction machines. To impart knowledge on Starting and speed control of three-phase induction motors.
3. To impart knowledge on Construction, principle of operation and performance of single phase induction motors and special machines.

UNIT I   SYNCHRONOUS GENERATOR   12

Constructional details – Types of rotors –winding factors- emf equation – Synchronous reactance – Armature reaction – Phasor diagrams of non salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF and A.S.A methods – steady state power angle characteristics– Two reaction theory –slip test -short circuit transients - Capability Curves

UNIT II   SYNCHRONOUS MOTOR   12

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed-Hunting – natural frequency of oscillations –damper windings- synchronous condenser.

UNIT III   THREE PHASE INDUCTION MOTOR   12

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling-Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses –Double cage induction motors – Induction generators – Synchronous induction motor.

UNIT IV   STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR   12

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star-delta starters– Speed control – Voltage control, Frequency control and pole changing – Cascaded connection-V/fcontrol – Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamicbraking and regenerative braking.

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods ofsingle-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole inductionmotor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor- Servo motors-Stepper motors - introduction to magnetic levitation systems.

TOTAL: 60h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Analyze the performance of synchronous generator and compute the emf,mmf equation and voltage regulation by different methods	K4
CO2	Analyze the performance characteristics of synchronous motor by conducting suitable tests	K4
CO3	Analyze the characteristics ,equivalent circuit and circuit diagram of three phase induction motor	K4
CO4	Apply suitable starting control methods to improve the performance of the three phase induction motor	K3
CO5	Understand various starting methods of single phase induction motor	K2

TEXT BOOKS:

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D.Umans, 'Electric Machinery', Tata Mc Graw Hill publishing Company Ltd, 2003.
2. D.P. Kothari and I.J. Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2002.
3. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.

REFERENCEBOOKS:

1. M.N.Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD.,New Delhi, 2009.
2. Charless A. Gross, "Electric /Machines, "CRC Press, 2010.
3. K. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002.
4. Syed A. Nasar, Electric Machines and Power Systems: Volume I, Mcgraw -Hill College; International ed Edition, January 1995.
5. Alexander S. Langsdorf, Theory of Alternating-Current Machinery, Tata McGraw Hill Publications, 2001.

PCC-10	LINEAR INTEGRATED CIRCUITS	3	0	0	3

COURSE OBJECTIVES:

To impart knowledge on the following topics

1. Signal analysis using Op-amp based circuits.
2. Applications of Op-amp.
3. Functional blocks and the applications of special ICs like Timers, PLL circuits, regulatorCircuits.
4. IC fabrication procedure.To design various synchronous and asynchronous circuits. To introduce asynchronous sequential circuits and PLDs.

UNIT I   IC FABRICATION   9

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realisation of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance, FETs and PV Cell.

UNIT II   CHARACTERISTICS OF OPAMP   9

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-V/I & I/V converters.

UNIT III   APPLICATIONS OF OPAMP   9

Instrumentation amplifier and its applications for transducer Bridge, Log and AntilogAmplifiers- Analog multiplier & Divider, first and second order active filters, comparators,multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/Aconverter (R- 2R ladder and weighted resistor types), A/D converters using opamps.

UNIT IV   SPECIAL ICs   9

Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltagecontrolled oscillator IC; 565-phase locked loop IC, AD633 Analog multiplier ICs.

UNIT V   APPLICATION ICs   9

AD623 Instrumentation Amplifier and its application as load cell weight measurement – ICvoltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linearpower supply - LM317, 723 Variability voltage regulators, switching regulator- SMPS – ICL8038 function generator IC.

TOTAL: 45h

COURSEOUTCOMES:

At the end of this course the students will be able to,

CO1	Classify the different types of IC's and its fabrication techniques	K4
CO2	Analyze the characteristics of Op-amp and perform basic arithmetic functions.	K4
CO3	Apply Op-amp circuits to perform various applications and choose appropriate ADC & DAC for applications	K3
CO4	Explain the special function ICs and its application (IC555, IC566, VCO & IC565).	K5
CO5	Examine about the various Application ICs(IC voltage regulators, switching regulator- SMPS ,function generator IC)	K4

TEXT BOOKS:

1. David A. Bell, 'Op-amp & Linear ICs', Oxford, 2013.
2. D. Roy Choudhary, Sheil B. Jani, 'Linear Integrated Cir
3. cuits', II edition, New Age,2003.
4. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition,Pearson Education, 2003 / PHI. 2000.

REFERENCES

1. Fiore,"Opamps & Linear Integrated Circuits Concepts & applications", Cengage,2010.
2. Floyd ,Buchla,"Fundamentals of Analog Circuits, Pearson, 2013.
3. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system', McGraw Hill, 2003.
4. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition,2012.
5. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', Mc Graw Hill, 2016.
6. Muhammad H. Rashid,' Microelectronic Circuits Analysis and Design' Cengage Learning, 2011

PCC-11	ANALOG AND DIGITAL ELECTRONICS LABORATORY	0	0	3	1

COURSE OBJECTIVE:

1. To enable the students to understand the behavior of semiconductor device based on experimentation.

2. To learn design, testing and characterizing of circuit behavior with digital and analog ICs

LIST OF EXPERIMENTS

1. Characteristics of Semiconductor diode and Zener diode.
2. Characteristics of a NPN Transistor.
3. Study of Logic Gates.
4. Implementation of Adder and Subtractor circuits.
5. Code converters: Binary to Gray code converter and vice-versa
6. Encoders and Decoders.
7. Multiplexers and Demultiplexers
8. Counters: Design and implementation of 3-bit synchronous and Asynchronous counters.
9. Timer IC application: Study of NE/SE 555 timer in Astability, Monostability operation.
10. Operational Amplifier : Inverting and Non Inverting.

TOTAL :30h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Assess the characteristics of semiconductor diode , zener diode and transistor.	K5
CO2	Understand and apply boolean functions to implement adder, subtractor and Code Conversion Circuits. Examine logic gates as well as Encoder and Decoder	K3,K4
CO3	Examine logic gates as well as Encoder and Decoder and also experiment with Multiplexer and Demultiplexer	K3,K4
CO4	Examine the working of synchronous and asynchronous counters and understand the concept of Timer IC	K2,K4
CO5	Experiment with inverting and non-inverting amplifiers	K3

PCC-12	ELECTRICAL MACHINES -II LABORATORY	0	0	3	1

COURSE OBJECTIVE:

To expose the students to the operation of synchronous machines and induction motors and give them experimental skill.

LIST OF EXPERIMENTS:

1. Load test on three phase Induction Motor.
2. No load and blocked rotor test on three phase Induction Motor.
3. Load test on single phase Induction Motor
4. No load and blocked rotor test on a single phase Induction Motor
5. Load test on three phase Synchronous Motor
6. Regulation of three phase Alternator by EMF and MMF methods
7. Regulation of three phase Alternator by ZPF Method
8. Load test on three phase Alternator
9. Separation of no load losses of three phase Induction Motor.
10. V and inverted V curves of three phase Synchronous Motor

TOTAL :30h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Analyze and determinethe load characteristics of Induction motor	K4,K5
CO2	Analyze and determine the load characteristics of Synchronous motor	K4,K5
CO3	Analyze and determine the load characteristics of Alternator	K4,K5
CO4	Determine the regulation of Alternator	K5
CO5	Analyze losses in three phase induction and synchronous motors.	K4

PCC-13	POWER ELECTRONICS	3	0	0	3

COURSE OBJECTIVE:

1. To get an overview of different types of power semiconductor devices and their switching characteristics.To understand the operation, characteristics and performance parameters of controlled rectifiers

2. To study the operation, switching techniques and basics topologies of DC-DC switching regulators.To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.To study the operation of AC voltage controller and various configurations.

UNIT I   POWER SEMI-CONDUCTOR DEVICES   9

Study of switching devices, - Frame, Driver and snubber circuit of SCR, TRIAC, IGBT, MOSFET, - Turn-on and turn-off characteristics, switching losses, Commutation circuits for SCR

UNIT II   PHASE-CONTROLLED CONVERTERS   9

2-pulse, 3-pulse and 6-pulse converters – Effect of source inductance – performance parameters – Reactive power control of converters – Dual converters - Battery charger.

UNIT III   DC TO DC CONVERTER   9

Step-down and step-up chopper - Time ratio control and current limit control – Buck, boost, buck-boost converter, concept of Resonant switching - SMPS.

UNIT IV   INVERTERS   9

Single phase and three phase (both 120^0 mode and 180^0 mode) inverters - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM - multiple PWM – Introduction to space vector modulations - Voltage and harmonic control - Series resonant inverter - Current source inverter - Induction Heating.

UNIT V   AC TO AC CONVERTERS   9

Single – phase AC voltage controllers – Multistage sequence control   - single and three   phase cycloconverters – Integral cycle control for Temperature control – Powerfactor control – Matrix converters

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the fundamental concepts and techniques used in power electronics.	K2
CO2	Ability to analyze various single phase and three phase power converter circuits and understand their applications.	K4
CO3	Identify basic requirements for power electronics based design application.	K3
CO4	Develop skills to build, and troubleshoot power electronics circuits.	K6
CO5	Understand the use of power converters in commercial and industrial applications	K2

TEXT BOOKS:

1. Rashid, M.H. 'Power Electronics: Circuits, Devices and Applications', Pearson Education, PHI Third edition, New Delhi, 2004.
2. Philip T.Krein, "Elements of Power Electronics" Oxford University Press, 2004

REFERENCE BOOKS:

1. Ashfaq Ahmed ,"Power Electronics for Technology", Pearson Education, Indian reprint, 2003.
2. Bimbra, P.S. "Power Electronics" Khanna Publishers, Third Edition 2003.
3. Ned Mohan, Tore.M.Undeland, William.P.Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, Third edition, 2003.

PCC-14	**TRANSMISSION AND DISTRIBUTION**	3	0	0	3

COURSE OBJECTIVE:

1. To develop expressions for the computation of transmission line parameters.To obtain the equivalent circuits for the transmission lines based on distance and operating voltage for determining voltage regulation and efficiency. Also to improve the voltage profile of the transmission system.

2. To analyses the voltage distribution in insulator strings and cables and methods to improve the same. To understand the operation of the different distribution schemes.

UNIT I   GENERATION AND TRANSMISSION SYSTEMS   9

Generation, Transmission & Distribution Scenario of India - Types of generation: Conventional and Non-conventional, Thermal Power Plant, Hydro Power Plant, Gas Power Plant, Nuclear Power Plant, Non-conventional Energy Sources - Load capacity factor - Connected load factor - Load duration curve - Selection of units. Various systems of transmission – Advantages of high transmission voltages - Comparison of conductor materials required for various overhead systems.

UNIT II   OVERHEAD LINES PARAMETERS   9

Electrical constants - Resistance, Inductance and capacitance of Single and 3 Phase lines - Effects of earth on capacitance - Skin effect - Proximity effect - Transposition - Bundled conductors - Corona – Factors affecting corona - Line supports.

UNIT III   OVERHEAD LINES PERFORMANCE   9

Short and medium transmission lines - Phasor diagrams - Nominal T and Pi methods - Line regulation - Efficiency. Rigorous solution for long line - ABCD constants - Ferranti effect - Tuned power lines - Surge impedance and surge impedance loading.

UNITIV   LINE INSULATORS AND UNDERGROUND CABLES   9

Types of overhead line insulators- Potential distribution over a string of suspension insulators - Methods of increasing string efficiency.   Types of cables- Capacitance and insulation resistance - Sheath effects - Grading - Stresses - Loss angle – Power loss - Breakdown voltage - Optimum cable length -Comparison between overhead lines and underground cables.

Classification, functions and major components of substations - Feeders, distributors and service mains - Radial and ring main systems - Calculation of voltage in distributors with concentrated and distributed loads, AC 1-phase and 3-phase distribution systems.

TOTAL: 45h

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Design and analyze the parameters of transmission lines and explain the structure of electric power system.	K4,K6
CO2	Illustrate and Estimate the transmission linesparameters.	K2,K5
CO3	Classify the Nominal T and PI model of transmission lines and explain ABCD constants	K4
CO4	Determine the voltage distribution in insulators string and explain types and construction of underground cables	K5
CO5	Classify the types of sub-stations and calculatethe voltage in distributors with concentrated and distributed loads	K4

TEXT BOOKS:
1. Mehta V K, Rohit Mehta , "Principles of Power Systems", S.Chand & Co. Pvt. Ltd., New Delhi, 2004.
2. Singh S N," Electric Power Generation, Transmission and Distribution", Prentice-Hall of India Pvt., Ltd, Delhi, 2003.

REFERENCE BOOKS:
1. Soni M L, Gupta P V, Bhatnagar U S and Chakrabarthi A, "A Text Book on Power System Engineering", Dhanpat Rai & Co., New Delhi, 1997.
2. Uppal S L, "Electrical Power", Khanna Publishers, New Delhi, Thirteenth Edition, 1995.
3. Wadhwa C L, "Electrical Power Systems", New Age International Publishers, Delhi, 2006 Fourth Edition Reprint Aug, 2007.
4. Gupta J B, "A Course in Electrical Power", S. K. Kataria & Sons, 2003.
5. Gupta B R, "Generation of Electrical Energy", S.Chand & company New Delhi, Revised edition 2006
6. Kothari D P and Nagrath J," Power System Engineering", Tata McGraw-Hill Publishing Company New Delhi, second Edition, 2007.
7. Despande M V, 'Electrical Power Systems Design', Tata McGraw-Hill Publishing Company New Delhi, 2004

PCC-15	CONTROL SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To understand the use of transfer function models for analysis physical systems and introduce the control system components.
2. To provide adequate knowledge in the time response of systems and steady state error analysis. To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
3. To introduce stability analysis and design of compensators
4. To introduce state variable representation of physical systems and study the effect of state feedback

UNIT I   INTRODUCTION TO CONTROL PROBLEM   9

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems.Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

UNIT II   TIME RESPONSE ANALYSIS   9

Standard test signals. Time response of first and second order systems for standard test inputs. Design specifications for second-order systems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

UNIT III   FREQUENCY-RESPONSE ANALYSIS   9

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stabilitycriterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loopfrequency response.

UNIT IV   INTRODUCTION TO CONTROLLER DESIGN   9

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs.

Module 5: State variable Analysis (6 hours)   9

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution ofstate equations. Eigenvalues and Stability Analysis. Concept of controllability andobservability

Total: 45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Develop various transfer function model of system.	K3
CO2	Analysis of system in time-domain	K4
CO3	Analysis of system in frequency domain	K4
CO4	Choose appropriate compensator for the given specifications.	K3
CO5	Understand state variable representation of physical systems and infer the stability of the system	K2

TEXT BOOKS:

1. Nagrath, I.J. and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2003.

2. Benjamin C. Kuo, "Automatic Control systems", Pearson Education, New Delhi, 2003.

REFERENCE BOOKS:

1. Ogata, K. 'Modern Control Engineering', 4th edition, PHI, New Delhi, 2002.
2. Norman S. Nise, "Control Systems Engineering", 4th Edition, John Wiley, New Delhi, 2007.
3. Samarajit Ghosh," Control systems", Pearson Education, New Delhi, 2004
4. Gopal, M. 'Control Systems, Principles and Design', Tata McGraw Hill, New Delhi, 2002.

PCC-16	SPECIAL ELECTRICAL MACHINES	3	0	0	3

COURSE OBJECTIVE

1. To impart knowledge on Construction, principle of operation and performance of synchronous reluctance motors. To impart knowledge on the Construction, principle of operation, control and performance of stepping motors.

2. To impart knowledge on the Construction, principle of operation, control and performance of switched reluctance motors.

3. To impart knowledge on the Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.

4. To impart knowledge on the Construction, principle of operation and performance of permanent magnet synchronous motors.

UNIT I   SYNCHRONOUS RELUCTANCE MOTORS   9

Constructional features – Types – Axial and Radial flux motors – Operating principles – VariableReluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics –Applications.

UNIT II   STEPPER MOTORS   9

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Singleand multi stack configurations – Torque equations – Modes of excitation – Characteristics – Drivecircuits – Microprocessor control of stepper motors – Closed loop control-Concept of lead angle–Applications.

UNIT III   SWITCHED RELUCTANCE MOTORS   9

Constructional features – Rotary and Linear SRM - Principle of operation – Torque production –Steady state performance prediction- Analytical method -Power Converters and their controllers –Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control– Applications.

UNIT IV   PERMANENT MAGNET BRUSHLESS D.C. MOTORS   9

Permanent Magnet materials – Minor hysteresis loop and recoil line-Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation - Power Converter Circuits and their controllers – Motor characteristics and control– Applications.

UNIT V   PERMANENT MAGNET SYNCHRONOUS MOTORS   9

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements– Applications.

TOTAL : 45 h

COURSE OUTCOME:

CO1	Understand and explain the construction, operation and performance characteristics of synchronous reluctance motor	K2
CO2	Understand the construction and principle of operation of stepper motor	K2
CO3	Analyze the operation of switched reluctance motor with and without sensors and control of SRM drive using controllers	K4
CO4	Analyze the magnetic circuit and understand the operation, characteristics and control of PMBLDC motor	K4
CO5	Understand the construction, operation ,performance characteristics of PMSM and its power controllers	K2

TEXT BOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.

2. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press,Oxford, 1989.

3. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.

REFERENCE BOOKS:

1. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design andApplication', CRC Press, New York, 2001.

2. P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter PerengrinusLondon, 1982.

3. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press,London, 1988.

4. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

PCC-17	**POWER ELECTRONICS LABORATORY**	0	0	3	1

COURSE OBJECTIVE:

To provide hands on experience with power electronic converter design and testing

LIST OF EXPERIMENTS:

1. Characteristics of SCR and TRIAC
2. Characteristics of MOSFET and IGBT
3. AC to DC half Controlled converter
4. AC to DC fully Controlled converter
5. MOSFET based step up and step down Chopper
6. IGBT based single phase PWM inverter
7. IGBT based three phase PWM Inverter
8. AC Voltage Controller with R and RL load
9. Single Phase Cycloconverter
10. Simulation of Power Electronic Circuits.

TOTAL : 30h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand and analyse the characteristics of switching devices SCR, TRIAC, MOSFET and IGBT.	K2,K4
CO2	Analyse and understand the characteristics of half and fully controlled converter.	K2,K4
CO3	Understand the characteristics of Step up and Step down chopper	K2
CO4	Analyse and understand the characteristics of IGBT based single and three phase PWM inverter	K2,K4
CO5	Explain the working of AC voltage Controller and cycloconverters.	K5

PCC-18	MEASUREMENTS AND CONTROL SYSTEMS LABORATORY	0	0	3	1

COURSE OBJECTIVE:

1. To provide knowledge on analysis and design of control system along with basics of instrumentation

LIST OF EXPERIMENTS:

1. Calibration of 1-Phase Energy Meter

2. Measurement of linear displacement using LVDT
3. Measurement of strain using strain gauge
4. Measurement of resistance using Wheatstone bridge.
5. Measurement of capacitance using Schering bridge
6. Measurement of inductance using Maxwell's bridge
7. Transfer function of AC Servomotor.
8. Stability analysis of a given system using Root locus
9. Frequency response analysis using Bode and Polar for given transfer function
10. Frequency response analysis of Nyquist plot for given transfer function
11. Study of response of 2nd order system with PID Controller using Simulink
12. Design of Lag, Lead and Lag-Lead Compensators

TOTAL :30h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Test the calibration of energy meter and determine the linear displacement and strain using LVDT and strain gauge respectively	K4
CO2	Experiment with various bridges and determine the unknown quantity.	K3
CO3	Perform an experiment with AC servo Motor to determine its Transfer Function	K3
CO4	Analysis of given system using Root locus, Bode plot, Polar plot and Nyquist Plot	K4
CO5	Develop and analyze the response of 2nd order system with PID Controller using Simulink and also develop lag, lead and lag-lead compensators using Matlab	K4,K5

PCC-19	**POWER SYSTEM ANALYSIS**	3	0	0	3

COURSE OBJECTIVE

1. To model the power system under steady state operating condition. To apply efficient numerical methods to solve the power flow problem.

2. To model and analyze the power systems under abnormal (or) fault conditions. To model and analyze the transient behavior of power system when it is subjected to a fault.

UNIT I   INTRODUCTION   9

Need for system planning and operational studies – basic components of a power system.-Introduction to restructuring - Single line diagram – per phase and per unit analysis – Generator - transformer – transmission line and load representation for different power system studies.- Primitive network - construction of Y-bus using inspection and singular transformation methods – z-bus.

UNIT II   POWER FLOW ANALYSIS   9

Importance of power flow analysis in planning and operation of power systems - statement of powerflow problem - classification of buses - development of power flow model in complex variables form -iterative solution using Gauss-Seidel method - Q-limit check for voltage controlled buses – power flowmodel in polar form - iterative solution using Newton-Raphson method .

UNIT III   FAULT ANALYSIS – BALANCED FAULTS   9

Importance of short circuit analysis - assumptions in fault analysis - analysis using Thevenin's theorem- Z-bus building algorithm - fault analysis using Z-bus – computations of short circuit capacity, postfault voltage and currents

UNIT IV   FAULT ANALYSIS – UNBALANCED FAULTS   9

Introduction to symmetrical components – sequence impedances – sequence circuits of synchronous machine, transformer and transmission lines - sequence networks analysis of single line to ground,line to line and double line to ground faults using Thevenin's theorem and Z-bus matrix.

UNIT V   STABILITY ANALYSIS   9

Importance of stability analysis in power system planning and operation - classification of powersystem stability - angle and voltage stability – Single Machine Infinite Bus (SMIB) system:Development of swing

equation - equal area criterion - determination of critical clearing angle and time– solution of swing equation by modified Euler method.

TOTAL : 45h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the nature of the modern power system, including the behavior of the components and sub-systems.	K2
CO2	Apply load flow analysis to an electrical power network and interpret the results for analysis	K3
CO3	Analyze a network under balanced fault conditions and interpret the results	K4
CO4	Analyze a network under unbalanced fault conditions and interpret the results	K4
CO5	Analyze the transient stability of a single machine/infinite bus system using both analytical and time simulation methods	K4

TEXT BOOKS:

1. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition,2011.
2. John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth
3. reprint, 2010.
4. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, ' Electrical Power Systems-
5. Analysis, Security and Deregulation', PHI Learning Private Limited, New Delhi, 2012.

REFERENCE BOOKS:

1. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st
2. reprint, 2010.
3. Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.
4. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing
5. Company Ltd., New Delhi, Second Edition, 2007.
6. J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, ' Power System Analysis & Design',Cengage Learning, Fifth Edition, 2012.
7. Olle. I. Elgerd, 'Electric Energy Systems Theory – An Introduction', Tata McGraw Hill PublishingCompany Limited, New Delhi, Second Edition, 2012.
8. C.A.Gross, "Power System Analysis," Wiley India, 2011.

PCC-20	**SOLID STATE DRIVES**	3	0	0	3

COURSE OBJECTIVE:

1. To understand steady state operation and transient dynamics of a motor load system. To study and analyze the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively.

2. To study and understand the operation and performance of AC motor drives.

3. To analyze and design the current and speed controllers for a closed loop solid state DC motor drives.

UNIT I   DRIVE CHARACTERISTICS   9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

UNIT II   CONVERTER / CHOPPER FED DC MOTOR DRIVE   9

Steady state analysis of the single and three phase converter fed separately excited DC motor drive– continuous and discontinuous conduction– Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive.

UNIT III   INDUCTION MOTOR DRIVES   9

Stator voltage control–energy efficient drive–v/f control–constant airgap flux–field weakening mode 68 – voltage / current fed inverter – closed loop control.

UNIT IV   SYNCHRONOUS MOTOR DRIVES   9

V/f control and self control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

UNIT V   DESIGN OF CONTROLLERS FOR DRIVES   9

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode – Design of controllers; current controller and speed controller- converter selection and characteristics.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand about the steady state operation and dynamics of a motor load system and select suitable motor for different load profiles	K2
CO2	Analyze the operation of the converter and chopper fed dc drive.	K4
CO3	Analyze the operation o f the induction motor drives	K3
CO4	Analyze the operation of the synchronous motor drives	K4
CO5	Model the current and speed controllers for a closed loop solid state drive	K3

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 1992.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002.
3. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice Hall of India, 2001.

REFERENCEBOOKS:

1. John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System," Elsevier 2012.
2. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press(Taylor and Francis Group), 2013.
3. S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 1993.
4. S. Sivanagaraju, M. Balasubba Reddy, A. Mallikarjuna Prasad "Power semiconductor drives" PHI, 5th printing, 2013.
5. N.K.De., P.K.SEN"Electric drives" PHI, 2012. 6. Vedam Subramanyam, "Thyristor Control of Electric Drives", Tata McGraw Hill, 2007.

PCC-21	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3

COURSE OBJECTIVE:

1. To impart knowledge on the following Architecture of μP8085 & μC 8051, Addressing modes & instruction set of 8085 & 8051, Need & use of Interrupt structure 8085 & 8051, Simple applications development with programming 8085 & 8051.

UNIT I   8085 PROCESSOR   9

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memoryorganization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

UNIT II   PROGRAMMING OF 8085 PROCESSOR   9

Instruction -format and addressing modes – Assembly language format – Data transfer, datamanipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up tability - Subroutine instructions - stack..

UNIT III   8051 MICRO CONTROLLER   9

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memoryorganization – I/O ports and data transfer concepts– Timing Diagram – Interrupts- DataTransfer, Manipulation, Control Algorithms& I/O instructions, Comparison to Programmingconcepts with 8085

UNIT IV   PERIPHERAL INTERFACING   9

Study on need, Architecture, configuration and interfacing, with ICs: 8255, 8259, 8254 8279, - A/D and D/A converters &Interfacing with 8085& 8051

UNIT V   DESIGN OF CONTROLLERS FOR DRIVES   9

Simple programming exercises- key board and display interface –Control of servo motorsteppermotor control- Application to automation systems.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand Functional Building Blocks, Pin Details of 8085 Processor and Classify the Function of data transfer concepts, Interrupt structure and timing diagram	K2
CO2	Acquire the knowledge of assembly language programme and addressing modes and study the Function of Look up table and Subroutine instructions	K3
CO3	Understand Functional Building Blocks, Pin Details of 8051 controller and Classify the use of data transfer concepts, Interrupt structure, timing diagram, , data Manipulation, Control Algorithms& I/O instructions	K2
CO4	Understand the Architecture and configuration of interfacing, with ICs and study the function of A/D and D/A converters &Interfacing with 8085& 8051	K2
CO5	Understand the key board and display interface and study the function of servo motor stepper motor control	K2

TEXT BOOKS:

1. Sunil Mathur &Jeebananda Panda, "Microprocessor and Microcontrollers", PHI Learning Pvt. Ltd, 2016.
2. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.

REFERENCE BOOKS:

1. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition,Prentice Hall of India, New Delhi, 2007.
2. B.RAM," Computer Fundamentals Architecture and Organization" New age International Private Limited, Fifth edition, 2017.
3. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
4. Ajay V.Deshmukh, 'Microcontroller Theory &Applications', McGraw Hill Edu,20165. Douglas V.Hall, 'Microprocessor and Interfacing', McGraw Hill Edu, 2016.

PCC-22	**POWER SYSTEMS LABORATORY**	0	0	3	1

COURSE OBJECTIVE:

1. To apply efficient numerical methods to solve the power flow problem.

2. To model and analyze the power systems under abnormal (or) fault conditions.

3. To model and analyze the transient behavior of power system when it is subjected to a fault

LIST OF EXPERIMENTS:

1. Computation of Parameters and Modeling of Transmission Lines

2. Formation of Bus Admittance and Solution of Networks

3. Formation of Bus impedance and solution of networks

4. Load Flow Analysis - I : Solution of Load Flow And Related Problems Using Gauss-Seidel Method

5. Load Flow Analysis - II: Solution of Load Flow and Related Problems Using Newton-Raphson Methods

6. Load Flow Analysis - II: Solution of Load Flow and Related Problems Using Fast-Decoupled - Methods

7. Symmetrical Fault Analysis

8. Unsymmetrical fault Analysis

9. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System

10. Transient Stability Analysis of Multi-machine Power Systems

11. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems

12. Economic Dispatch in Power Systems

TOTAL :30h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Develop programs for Computation of parameters and modeling of transmission lines.	k4
CO2	Develop programs for formation of bus admittance and impedance matrices	k3
CO3	Develop programs for Power flow solution using iteration methods and evaluate the results	k5
CO4	Design and develop for fault analysis using MATLAB	k6
CO5	Develop load frequency dynamics of single-area and two-area systems using MATLAB	k6

PCC-23	ELECTRICAL DRIVES LABORATORY	0	0	3	1

COURSE OBJECTIVE

To provide hands on experience with the working and operational control of both DC and AC motors.

LIST OF EXPERIMENTS:

1. Simulation of closed loop control of converter fed DC Motor

2. Simulation of closed loop control of chopper fed DC Motor

3. Simulation of VSI fed 3 phase induction Motor

4. Speed control of PMDC motor using 3 phase fully controlled converter

5. Speed control of 3 phase induction motor using PWM inverter

6. DSP based closed loop drive for Induction motor

7. DSP based chopper fed DC drive

8. PLC based drives

9. Speed control of DC shunt Motor using chopper

10. Speed control of BLDC motor using inverter

TOTAL :30h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Analyze closed loop control of converter and chopper fed DC Motor	K4
CO2	Analyze three phase synchronous motor and induction motor drives	K4
CO3	Analyze closed loop speed control of ac and dc drives using converters	K4
CO4	Experiment with DSP based AC drive and DC drive	K3
CO5	Experiment with PLC based drives	K3

PCC-24	MICROPROCESSORS AND MICRO CONTROLLERS LABORATORY	0	0	3	1

COURSE OBJECTIVE:

1. To provide training on programming of microprocessors and microcontrollers and understand the interface requirements.

LIST OF EXPERIMENTS:

1. Simple arithmetic operations: addition / subtraction / multiplication / division using 8085

2. Multibyte BCD addition &subtraction in 8085.

3. Programming with control instructions using microprocessor

    i.   Ascending / Descending order, Maximum / Minimum of numbers.
    ii. Hex / BCD code conversions.

4. Table Processing using 8085.   .

5. Traffic light controller.

6. Interfacing and Programming of 8255 using 8085

7. Interfacing and Programming of 8279 using 8085

8. Programming basic instructions with 8051 Micro controller execution including Conditional jumps & looping.

9. Study on interface with A/D & D/A

10. Interfacing stepper motor using 8051

TOTAL :30h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Explain the concepts of 8085 Microprocessor, its architecture and programming	K2,K5
CO2	Apply 8085 Microprocessor algorithm to develop simple programs	K3
CO3	Examine the interfacing of Microprocessors with various peripheral devices using Assembly Language Programs	K4
CO4	Apply 8051 Microcontroller algorithm to develop simple programs	K3
CO5	Examine the interfacing of Microcontrollers with various peripheral devices using Assembly Language Programs	K4

Syllabus

PROFESSIONAL ELECTIVE COURSES

PEC-01	WIND AND SOLAR ENERGY SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

Introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application.

UNIT I   PHYSICS OF WIND POWER: 9

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

UNIT II   WIND GENERATOR TOPOLOGIES: 9

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

UNIT III   THE SOLAR RESOURCE AND THERMAL POWER GENERATION   9

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

UNIT IV   SOLAR PHOTOVOLTAIC   9

Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

UNIT V   NETWORK INTEGRATION ISSUES   9

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Total:45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the fundamentals of wind energy system.	K2
CO2	Understand and select the drive system in the wind energy generation.	K2
CO3	Understand the concept of solar energy and equipments for the power generation.	K2
CO4	Apply the control techniques in the solar power generation.	K3
CO5	Understand the issues related to the grid-integration of solar and wind energy systems	K2

TEXT BOOKS:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004. \

REFERENCE BOOKS:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
2. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
4. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

PEC-02	LINE COMMUTATED AND ACTIVE RECTIFIERS	3	0	0	3

COURSE OBJECTIVE:

1. To introduce students to the basic theory of rectifiers with passive filters, their practical applications in power electronics.

2. To familiarize students to the principle of operation, design and synthesis of different power converter circuits and their applications..Providing the usage of the converter circuits and the filtering methods in the circuit.

UNIT I   DIODE RECTIFIERS WITH PASSIVE FILTERING   9

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape, effect of source inductance; commutation overlap.

UNIT II   THYRISTOR RECTIFIERS WITH PASSIVE FILTERING   9

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3- phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

UNIT III   MULTI-PULSE CONVERTER   9

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6- pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

UNIT IV   SINGLE-PHASE AC-DC SINGLE-SWITCH BOOST CONVERTER   9

Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

UNIT V   AC-DC BIDIRECTIONAL BOOST CONVERTER   9

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Total:45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the operation of single phase and three phase uncontrolled rectifier with the effect of source inductance.	K2
CO2	Understand the operation of single phase and three phase controlled rectifier with the effect of source inductance	K2
CO3	Analyze the configuration and commutation of converter with transformer winding.	K4
CO4	Analyze the operation of single phase AC-DC unidirectional boost converter.	K4
CO5	Analyze the operation of single phase and three phase AC-DC bidirectional boost converter	K4

TEXT BOOKS:

1. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", Addison-Wesley, 1991.
3. L. Umanand, " Power Electronics: Essentials and Applications", Wiley India, 2009.

REFERENCE BOOKS:

1. N. Mohan and T. M. Undeland, " Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
2. R. W. Erickson and D. aksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2001

PEC-03	ELECTRICAL AND HYBRID VEHICLES	3	0	0	3

COURSE OBJECTIVE:

To present a broad view of Electric and hybrid vehicles. Introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles.

UNIT I   INTRODUCTION   9

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

UNIT II   INTRODUCTION TO HYBRID ELECTRIC VEHICLES   9

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT III   ELECTRIC TRAINS   9

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT IV   ENERGY STORAGE   9

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT V   ENERGY MANAGEMENT STRATEGIES   9

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy

management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Total:45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the fundamentals of conventional vehicles and vehicle performance	K2
CO2	Understand the basic concept and significance of hybrid electric vehicle	K2
CO3	Identify the suitable drive train system for developing an electric hybrid vehicle depending on resources.	K3
CO4	Analyze the energy storage with the supporting subsystem for hybrid vehicle application.	K4
CO5	Demonstrate the energy management system for Electric vehicle	K2

TEXT BOOKS:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

REFERENCE BOOKS:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

PEC-04	ELECTRICAL MACHINE DESIGN	3	0	0	3

COURSE OBJECTIVE:

1. To design armature and field systems for D.C. machines.

2. To design core, yoke, windings and cooling systems of transformers.

3. To design stator and rotor of induction machines. To design stator and rotor of synchronous machines and study their thermal behavior.

UNIT I   INTRODUCTION   9

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

UNIT II   TRANSFORMERS   9

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

UNIT III   INDUCTION MOTORS   9

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

UNIT IV   SYNCHRONOUS MACHINES   9

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

UNIT V   COMPUTER AIDED DESIGN (CAD):   9

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation.

Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Total:45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the important consideration in the design of electric machine and various factors which influence the design.	K2,K6
CO2	Understand the design feature associated with the transformer.	K2,K6
CO3	Design and estimate the operating characteristics of Induction motor.	K5,K6
CO4	Design and estimate the performance characteristics of synchronous machine.	K5,K6
CO5	Use software tools to do design calculations.	K3

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TEXT BOOK:

1. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.

REFERENCE BOOKS:

1. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.
2. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008. 7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package

PEC-05	POWER SYSTEM PROTECTION AND SWITCH GEAR	3	0	0	3

COURSE OBJECTIVE

1. To educate the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system. To introduce the characteristics and functions of relays and protection schemes.
2. To impart knowledge on apparatus protection.To introduce static and numerical relays. To impart knowledge on functioning of circuit breakers.

UNIT I   INTRODUCTION   9

Importance of protective schemes for electrical apparatus and power system – Qualitative review of faults and fault currents - relay terminology – definitions – essential qualities of protection.Protection against over voltages due to lightning and switching - arcing grounds - Peterson Coil - ground wires - surge absorber and divertersPower System earthling – Neutral earthing - basic ideas of insulation coordination

UNIT II   OPERATING PRINCIPLES AND RELAY CHARACTERISTICS   9

Electromagnetic relays – over current, directional and non-directional, distance, negative sequence, differential and under frequency relays – Introduction to static relays.

UNIT III   APPARATUS PROTECTION   9

Main considerations in apparatus protection - transformer, generator and motor protection - protection of bus-bars - Transmission line protection - zones of protection – CTs, PTs and their applications in protection schemes.

UNIT IV   THEORY OF CIRCUIT INTERRUPTION   9

Physics of arc phenomena and arc interruption. DC and AC circuit breaking – restriking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - interruption of capacitive current.

UNIT V   CIRCUIT BREAKERS   9

Types of circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breakers – comparative merits of different circuit breakers – testing of circuit breakers.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the requirement of protective relays and circuit breakers in power system.	K2
CO2	Understand the principles of different types of protective relays	K2
CO3	Analyze the functioning of various protective systems.	K4
CO4	Analyze the protective system for the given power system components.	K4
CO5	Compare the working, merit and demerits of different type of circuit breakers.	K4

TEXT BOOKS:

1. Soni, M.L. , P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co., 1998.
2. R.K.Rajput, "A Text book of Power System Engineering", Laxmi Publications, First Edition Reprint 2007.

REFERENCE BOOKS:

1. Sunil S. Rao, 'Switchgear and Protection', Khanna publishers, New Delhi, 1986.
2. Wadhwa, C.L. 'Electrical Power Systems', New Age International (P) Ltd., 2000.
3. Ravindranath, B. and N. Chander, 'Power System Protection & Switchgear', Wiley Eastern Ltd., 1977.
4. Badri Ram, Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw Hill, 2001.
5. Paithankar Y.G. and S.R. Bhide, 'Fundamentals of Power System Protection', Prentice Hall of India Pvt. Ltd., New Delhi, 2003

PEC-06	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3

COURSE OBJECTIVE:

To have an overview of power system operation and control. To model power-frequency dynamics and to design power-frequency controller.

1. To model reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
2. To study the economic operation of power system.

UNIT I   INTRODUCTION   9

System load – variation - load characteristics - load curves and load-duration curve (daily, weekly and annual) - load factor - diversity factor. Importance of load forecasting and simple techniques of forecasting. An overview of power system operation and control and the role of computers in the implementation. (Qualitative treatment with blockdiagram).

UNIT II   ACTIVE POWER - FREQUENCY CONTROL   9

Basics of speed governing mechanism and modeling - speed-load characteristics – load sharing between two synchronous machines in parallel. Control area concept LFC control of a single-area system. Static and dynamic analysis of uncontrolled and controlled cases. Integration of economic dispatch control with LFC. Two-area system – modeling - static analysis of uncontrolled case - tie line with frequency bias control of two-area system - state variable model.

UNIT III   REACTIVE POWER–VOLTAGE CONTROL   9

Basics of reactive power control. Excitation systems – modeling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node - method of voltage control – tapchanging transformer. System level control using generator voltage magnitude setting, tap setting of OLTC transformer and Mvar injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

UNIT IV   COMMITMENT AND ECONOMIC DISPATCH   9

Statement of economic dispatch problem – cost of generation – incremental cost curve - co-ordination equations without loss and with loss, solution by direct method and λ- iteration method. (No derivation of loss coefficients). Statement of Unit Commitment problem – constraints; spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. Solution methods - Priority-list methods - forward dynamic programming approach. Numerical problems only in priority-list method using full-load average production cost.

Need of computer control of power systems. Concept of energy control centre (or) load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions. Network topology – state estimation - security analysis and control. Various operating states (Normal, alert,emergency, in-extremis and restorative). State transition diagram showing various state transitions and control strategies.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the importance of load forecasting and other factors in the power system operation	K2
CO2	Analyze the modeling of single area and two area system.	K4
CO3	Understand and analyze the methods of voltage control	K2,K4
CO4	Solve the key issues related to economic dispatch and unit commitment.	K3
CO5	Understand the importance and usage of computer control for monitoring and data acquisition in power systems.	K2

TEXT BOOKS:

1. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2003.
2. Chakrabarti & Halder, "Power System Analysis: Operation and Control", Prentice Hall of India, 2004.

REFERENCES:

1. Kothari, D.P. and I.J. Nagrath, 'Modern Power System Analysis', Tata McGraw Hill Publishing Company Limited, New Delhi, Third Edition, 2003.
2. Grigsby, L.L. 'The Electric Power Engineering, Hand Book', CRC Press & IEEE Press, 2001.
3. Hadi Saadat, "Power System Analysis", 11th Reprint 2007.
4. Kundur, P. 'Power System Stability and Control' MC Craw Hill Publisher, USA, 1994.
5. Olle.I.Elgerd, 'Electric Energy Systems theory An introduction' Tata McGraw Hill Publishing Company Ltd. New Delhi, Second Edition 2003.
6. Wadhwa, C.L."Electric Power System", New Age International Publications, 4th Edition,2005.

PEC-07	HVDC TRANSMISSION SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To understand the concept, planning of DC power transmission and comparison with AC Power transmission. To analyze HVDC converters.
2. To study about the HVDC system control. To analyze harmonics and design of filters. To model and analyze the DC system under study state.

UNIT I INTRODUCTION 9

DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Planning for HVDC transmission – Modern trends in HVDC technology – DC breakers – Operating problems – HVDC transmission based on VSC – Types and applications of MTDC systems.

UNIT-II ANALYSIS OF HVDC CONVERTERS 9

Line commutated converter - Analysis of Graetz circuit with and without overlap - Pulse number – Choice of converter configuration – Converter bridge characteristics – Analysis of a 12 pulse converters – Analysis of VSC topologies and firing schemes.

UNIT III CONVERTER AND HVDC SYSTEM CONTROL

9

Principles of DC link control – Converter control characteristics – System control hierarchy – Firing angle control – Current and extinction angle control – Starting and stopping of DC link – Power control – Higher level controllers – Control of VSC based HVDC link.

UNIT IV REACTIVE POWER AND HARMONICS CONTROL 9

Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM – Generation of harmonics – Design of AC and DC filters – Active filters.

UNIT V POWER FLOW ANALYSIS IN AC/DC SYSTEMS 9

Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – case study.

TOTAL: 45

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand and explain the benefits, types and application of HVDC Transmission system.	K2,K5
CO2	Analyze the configuration and characteristics of HVDC converter.	K4
CO3	Understand and examine the Converter control characteristics, Firing angle control and extinction angle control schemes	K2,K4
CO4	Identify the requirements in HVDC for reactive power and harmonics control	K3
CO5	Analyze the power flow control in AC and DC system	K4

TEXT BOOKS:

1. Padiyar, K. R., "HVDC power transmission system", New Age International (P) Ltd., New Delhi, Second Edition, 2010.
2. Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley interscience, New York, London, Sydney, 1971.
3. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", New Age International (P) Ltd., New Delhi, 1990.

REFERENCE BOOKS:

1. Kundur P., "Power System Stability and Control", McGraw-Hill, 1993.
2. Colin Adamson and Hingorani N G, "High Voltage Direct Current Power Transmission", Garraway Limited, London, 1960.
3. Arrillaga, J., "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
4. S. Kamakshaiah, V. Kamaraju, 'HVDC Transmission', Tata McGraw Hill Education Private Limited, 2011.

PEC-08	POWER QUALITY AND FACTS	3	0	0	3

COURSE OBJECTIVE:

1. To introduce the power quality problem , To educate on production of voltages sags, over voltages and harmonics and methods of control, To study overvoltage problems ,To study the sources and effect of harmonics in power system .

2. To impart knowledge on various methods of power quality monitoring, To introduce the reactive power control techniques, To educate on static VAR compensators and their applications .

3. To provide knowledge on Thyristor controlled series capacitors and to educate on DSTATCOM devices

UNIT I   TRANSMISSION LINES AND SERIES/SHUNT REACTIVE POWER COMPENSATION   9

Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation, Shunt and series compensation at the mid-point of an AC line, Comparison of Series and Shunt Compensation.

UNIT II   THYRISTOR-BASED FLEXIBLE AC TRANSMISSION CONTROLLERS (FACTS)   9

Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch, Configurations/Modes of Operation, Harmonics and control of SVC and TCSC, Fault Current Limiter.

UNIT III   VOLTAGE SOURCE CONVERTER BASED (FACTS) CONTROLLERS   9

Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control, Working principle of Interphase Power Flow Controller, Other Devices: GTO Controlled Series Compensator, Fault Current Limiter.

UNIT IV   POWER QUALITY PROBLEMS IN DISTRIBUTION SYSTEMS   9

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve**.**

**UNIT V   DYNAMIC VOLTAGE RESTORER AND UNIFIED POWER QUALITY CONDITIONER   9
        AND DSTATCOM**

Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies. Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Analysis of uncompensated AC transmission lines	K4
CO2	Understand the configuration and modes of operation of thyristor based controllers	K2
CO3	Examine the facts controllers	K4
CO4	Analyze the Power Quality problems in distribution systems	K4
CO5	Evaluating the Capabilities and Control Strategies of distribution systems	K5

Text Books:

1. N. G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of FACTS Systems", Wiley-IEEE Press, 1999.

2. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. 2007.

3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 1983.

Reference Books:

1. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
2. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991

PEC-09	HIGH VOLTAGE ENGINEERING	3	0	0	3

COURSE OBJECTIVE:

1. To understand the various types of over voltages in power system and protection methods. To know about the generation of over voltages in laboratories.
2. To understand the measurement of over voltage, Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
3. To study about the testing of power apparatus and high voltage laboratories.

UNIT I   OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS   9

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary Over voltages, Corona and its effects – Reflection and Refraction of Travelling waves- Protection against over voltages.

UNIT II   DIELECTRIC BREAKDOWN   9

Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – BreakdownMechanisms in solid and composite dielectrics.

UNIT III   GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS   9

Generation of High DC, AC, impulse voltages and currents - Triggering and control of impulse generators.

UNIT IV   MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS   9

High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers – PeakVoltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.

**UNIT V   HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS AND HIGH VOLTAGE   9
              LABORATORIES**

Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the over voltage phenomenon and Protection against over voltages in electrical Power systems	K2
CO2	Understand and examine the various breakdown mechanisms of different dielectrics	K2,K4
CO3	Analyze the generation of high voltage and high currents	K4
CO4	Understand and apply the measurement techniques of high voltages & currents with their relative merits and demerits	K2, K3
CO5	Analyze and test the power apparatus and insulation coordination	K4

TEXT BOOKS

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013

2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.

3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.

REFERENCE BOOKS

1. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.

2. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.

3. L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.

PEC-10	ELECTRICAL ENERGY CONSERVATION AND AUDITING	3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on energy and its various forms, Energy management and audit, energy efficiency in electrical and industrial systems

UNIT I   BASICS OF ENERGY AND ITS VARIOUS FORMS   **9**

Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT II   ENERGY MANAGEMENT & AUDIT   **9**

Definition, energy audit, need, 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, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT III   ENERGY EFFICIENCY IN ELECTRICAL SYSTEMS   **9**

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT IV   ENERGY EFFICIENCY IN INDUSTRIAL SYSTEMS   **9**

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.,industrial and electrical systems.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Explain the construction, Layout and components of a Thermal power plant.	K5
CO2	Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.	K5
CO3	Explain the layout, construction and working of the components inside nuclear power plants	K5
CO4	Interpret the construction , layout of renewable energy power plants and its components	K3
CO5	Explain the knowledge to power plant economics and estimate the cost of electrical energy production	K5

TEXT BOOKS:

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
2. Wadhwa, C.L. 'Generation, Distribution and Utilization of Electrical Energy', New Age International Pvt. Ltd, 2003.

3. Gupta, B.R. 'Generation of Electrical Energy', Eurasia Publishing House (P) Ltd, New Delhi, 2003

REFERENCE BOOKS:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
 2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. Partab, H. 'Art and Science of Utilization of Electrical Energy', Dhanpat Rai and Co, New Delhi, 2004.

4. Openshaw Taylor, E. 'Utilization of Electrical Energy in SI Units', Orient Longman Pvt. Ltd, 2003.

5. Gupta, J.B.'Utilization of Electric Power and Electric Traction', S.K.Kataria and Sons, 2002

PEC-11	INDUSTRIAL ELECTRICAL SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on electrical system components, illumination systems, industrial electrical system and industrial automation.

UNIT I ELECTRICAL SYSTEM COMPONENTS 9

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

UNIT II RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS 9

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

UNIT III ILLUMINATION SYSTEMS 9

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

UNIT IV INDUSTRIAL ELECTRICAL SYSTEMS 9

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components,DG Systems, UPS System, Electrical Systems for the elevators, Battery banks.

UNIT V INDUSTRIAL ELECTRICAL SYSTEM AUTOMATION 9

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Identify and select the wiring materials and components	K3
CO2	Understand the electrical wiring for residential and commercial systems	K2
CO3	Understand the a lighting scheme for a residential and commercial premises	K2
CO4	Summarize Transformer selection, Industrial loads and starting of motors	K2
CO5	Understand the basics of PLC and SCADA system for distribution automation.	K2

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TEXT BOOKS:

1. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.

REFERENCE BOOKS:

1. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
2. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

PEC-12	POWER SYSTEM DYNAMICS AND CONTROL	3	0	0	3

COURSE OBJECTIVE:

To understand the about the power system stability, to analyze the linear dynamical system, to model synchronous machines and its controllers and to understand about the stability analysis.

UNIT I   INTRODUCTION TO POWER SYSTEM OPERATIONS   9

Introduction to power system stability, Power System Operations and Control, Stability problems in Power System, Impact on Power System Operations and control.

UNIT II   ANALYSIS OF LINEAR DYNAMICAL SYSTEM AND NUMERICAL METHODS   9

Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

UNIT III   MODELING OF SYNCHRONOUS MACHINES AND ASSOCIATED CONTROLLERS   9

Modeling of synchronous machine: Physical Characteristics., Rotor position dependent model, D-Q Transformation. Model with Standard Parameters, Steady State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine, Synchronization of Synchronous Machine to an Infinite Bus, Modeling of Excitation and Prime Mover Systems, Physical Characteristics and Model, Excitation System Control, Automatic Voltage Regulator, Prime Mover Control Systems, Speed Governors.

UNIT   MODELING OF OTHER POWER SYSTEM COMPONENTS   9
IV

Modeling of Transmission Lines and Loads, Transmission Line Physical Characteristics, Transmission Line Modeling. Load Models - induction machine model, Frequency and Voltage Dependence of Loads, Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

UNIT V   STABILITY ANALYSIS   9

Angular stability analysis in Single Machine Infinite Bus System, Angular Stability in multimachine systems – Intra-plant, Local and Inter-area modes, Frequency Stability: Centre of Inertia Motion, Load Sharing: Governor Droop, Single Machine Load Bus System: Voltage Stability, Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the basic considerations of stability	K2
CO2	Analyze synchronous machine mathematical expressions	K4
CO3	Understand the function of excitation system.	K2
CO4	Analyze the mathematical methods for Transient stability	K4
CO5	Analyze the mathematical methods for Dynamic stability	K4

TEXT BOOKS

1. K.R. Padiyar, "Power System Dynamics, Stability and Control", B. S. Publications, 2002
2. P. Kundur, "Power System Stability and Control", McGraw Hill, 1995.

REFERENCE BOOKS:

1. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall, 1997.

PEC-13	DIGITAL CONTROL SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To know about the basic control theories for digital systems.

2. To study about the design and stability of digital control system.

UNIT I   DISCRETE REPRESENTATION OF CONTINUOUS SYSTEMS   9

Basics of Digital Control Systems- Discrete representation of continuous systems - Sample and hold circuit- Mathematical Modeling of sample and hold circuit- Effects of Sampling and Quantization- Choice of sampling frequency- ZOH equivalent.

**UNIT II   DISCRETE SYSTEM ANALYSIS AND STABILITY OF DISCRETE TIME   9
                SYSTEM**

Z-Transform and Inverse Z Transform for analyzing discrete time systems- Pulse Transfer function- Pulse transfer function of closed loop systems- Mapping from s-plane to z plane- Solution of Discrete time systems- Time response of discrete time system- Stability analysis by Jury test- Stability analysis using bilinear transformation- Design of digital control system with dead beat response.

UNIT III   STATE SPACE APPROACH FOR DISCRETE TIME SYSTEMS   9

State space models of discrete systems- State space analysis- Lyapunov Stability-Controllability- reach-ability- Reconstructibility and observability analysis- Effect of pole zero cancellation on the controllability & observability.

UNIT IV   DESIGN OF DIGITAL CONTROL SYSTEM   9

Design of Discrete PID Controller- Design of discrete state feedback controller- Design of set point tracker- Design of Discrete Observer for LTI System- Design of Discrete compensator.

UNIT V   DISCRETE OUTPUT FEEDBACK CONTROL   9

Design of discrete output feedback control-Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course, students will demonstrate the ability to obtain discrete representation of LTI systems.

CO1	Explain discrete representation of continuous systems and modeling of sample and hold circuit.	K5
CO2	Apply Z-Transform and Inverse Z Transform for analysing discrete time systems.	K3
CO3	Understand the concepts of Controllability and observability in discrete time systems	K2
CO4	Design a digital PID controller,Discrete Observer for LTI System and Discrete	K6
CO5	Explain the design of periodic output feedback controller for discrete time systems	K5

Text Books:

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.

Reference Books:

1. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
2. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980

PEC-14	COMPUTER ARCHITECTURE	3	0	0	3

COURSE OBJECTIVE:

1. To learn the basic structure and operations of a computer.• To learn the arithmetic and logic unit and implementation of fixed-point and floating point arithmetic unit.
2. To learn the basics of pipelined execution. To understand parallelism and multi-core processors.
3. To understand the memory hierarchies, cache memories and virtual memories.
4. To learn the different ways of communication with I/O devices.

UNIT I   INTRODUCTION TO COMPUTER ORGANIZATION   9

Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

UNIT II   MEMORY AND INPUT – OUTPUT ORGANIZATION   9

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks. Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

UNIT III   16 AND 32 MICROPROCESSORS   9

 80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86.

UNIT IV   PIPELINING   9

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

UNIT V   DIFFERENT ARCHITECTURES   9

VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Describe the architecture and hardware implementation of a computer system.	K2
CO2	Categorize memory organization and Input – Output interfacing.	K4
CO3	Explain the architecture of 8086 Microprocessor and classify the instructions based on the functions used.	K5
CO4	Understand the concept of pipelining and its advantages.	K2
CO5	Compare various architectures available in computer organization	K4

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CO-2: Categorize memory organization and Input – Output interfacing.

CO-3: Explain the architecture of 8086 Microprocessor and classify the instructions based on the functions used.

CO-4: Understand the concept of pipelining and its advantages.

CO-5: Compare various architectures available in computer organization

TEXT BOOKS:

1. V. Carl, G. Zvonko and S. G. Zaky, "Computer organization", McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, "The Intel microprocessors", Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
4. W. Stallings, "Computer organization", PHI, 1987.
5. P. Barry and P. Crowley, "Modern Embedded Computing", Morgan Kaufmann, 2012.

REFERENCE BOOKS:

1. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice Hall, 2004.
2. Y. C. Lieu and G. A. Gibson, "Microcomputer Systems: The 8086/8088 Family", Prentice Hall India, 1986.
3. J. Uffenbeck, "The 8086/8088 Design, Programming, Interfacing", Prentice Hall, 1987.
4. B. Govindarajalu, "IBM PC and Clones", Tata McGraw Hill, 1991.
5. P. Able, "8086 Assembly Language Programming", Prentice Hall India

PEC-15	COMPUTATIONAL ELECTROMAGNETICS	3	0	0	3

COURSE OBJECTIVE:

1. To understand the about the fundamentals of electromagnetics,

2. To learn about the analytical methods of solving equations and to understand the applications of electromagnetics.

UNIT I   INTRODUCTION   9

Conventional design methodology, Computer aided design aspects – Advantages, Review of basic fundamentals of Electrostatics and Electromagnetics, Development of Helmhotz equation, energy transformer vectors- Poynting and Slepian, magnetic Diffusion-transients and time-harmonic.

UNIT II   ANALYTICAL METHODS   9

Analytical methods of solving field equations, method of separation of variables, Roth's method, integral methods- Green's function, method of images.

UNIT III FINITE DIFFERENCE METHOD   9

Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method- Uniqueness and convergence.

UNIT IV   FINITE DIFFERENCE METHOD   9

Overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.

UNIT V   SPECIAL TOPICS   9

Background of experimental methods-electrolytic tank, R-C network solution, Field plotting (graphical method), Hybrid Methods, Coupled Circuit - Field Computations, Electromagnetic - Thermal And Electromagnetic - Structural Coupled Computations, Solution Of Equations, Method Of Moments, Poisson's Fields.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the basic concepts of Electrostatics and Electromagnetics.	K2
CO2	Solve field equations using Roth's method, integral methods	K3
CO3	Explain finite difference methods and stability of FD Solutions.	K5
CO4	Study the overview of FEM and Understand 2D and 3D finite elements	K2
CO5	Explain Structural Coupled Computations, Method of Moments, and Poisson's Fields	K5

Text Books

1. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press, 1996.

Reference Books

1. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press, 2001.

PEC-16	CONTROL SYSTEMS DESIGN	3	0	0	3

COURSE OBJECTIVE:

1. To educate on model concepts and design of state and output feedback controllers and estimators.To design the controllers using the state space approach.

2. To design the compensators in time and frequency domain.

UNIT I   DESIGN SPECIFICATIONS   9

Introduction to time domain and frequency domain design specification and its physical relevance- Effect of gain on transient and steady state response- Effect of addition of pole on system performance-Effect of addition of zero on system response.

UNIT II   DESIGN OF CLASSICAL CONTROL SYSTEM IN THE TIME DOMAIN   9

Introduction to compensator- Design of Lag, lead lag-lead compensator in time domain- Feedback and Feed forward compensator design- Feedback compensation- Realization of compensators.

**UNIT III   DESIGN OF CLASSICAL CONTROL SYSTEM IN THE FREQUENCY   9
              DOMAIN**

Compensator design in frequency domain to improve steady state and transient response- Feedback and Feed forward compensator design using bode diagram.

UNIT IV   DESIGN OF PID CONTROLLERS   9

Design of P, PI, PD and PID controllers in time domain and frequency domain for first and second order systems - Control loop with auxiliary feedback – Feed forward control.

UNIT V   CONTROL SYSTEM DESIGN IN STATE SPACE   9

Review of state space representation-Concept of controllability & observability - effect of pole zero cancellation on the controllability & observability of the system- pole placement design through state feedback-Design of Observer. Reduced order observer- Separation Principle.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Analyze the design specification of frequency and time domain.	K4
CO2	Design of Lag, lead lag-lead compensator, Feedback and Feed forward compensator in time	K6
CO3	Design the Feedback and Feed forward compensator in frequency domain	K6
CO4	Design controllers to satisfy the desired specifications using simple controller structures	K6
CO5	Understand the concept of controllability and observability	K2

TEXT BOOKS:

1. N. Nise, "Control system Engineering", John Wiley, 2000.

2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.

3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.

4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.

REFERENCE BOOKS:

1. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.

2. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.

3. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 199.

PEC-17	ADVANCED ELECTRICAL DRIVES	3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on various drives such as induction motor drives, synchronous motor drives permanent magnet motor drives and switched reluctance motor drives and DSP based motion control.

UNIT I   POWER CONVERTERS FOR AC DRIVES   9

PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices, Control of CSI, H bridge as a 4-Q drive.

UNIT II   INDUCTION MOTOR DRIVES   9

Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).

UNIT III SYNCHRONOUS MOTOR DRIVES   9

Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

UNIT IV   PERMANENT MAGNET MOTOR DRIVES   9

Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

UNIT V   SWITCHED RELUCTANCE MOTOR DRIVES AND DSP BASED MOTION CONTROL   9

Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM, DSP based motion control, Use of DSPs in motion control; various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

Total:45h

COURSE OUTCOME:

At the end of this course the students will be able to

CO-1: Understand the concepts of CSI and VSI.

CO-2: Analyze voltage fed inverter control of induction motor drive.

CO-3: Analyze vector control, direct torque control, CSI fed synchronous motor drives.

CO-4: Compare the Speed -torque control in BLDC and PMSM

CO-5: Discuss the DSP based motion control for drive system.

Text Books:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

REFERENCE BOOKS:

1. Bin Wu, High-Power Converters and AC Drives, Wiley-IEEE Press.
2. Buxbaum, A.Schierau, and K.Staughen, A design of control systems for DC drives, Springer-Verlag, Berlin, 1990.
3. Bimal K. Bose, Modern Power Electronics and AC Drives, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
4. R. Krishnan, Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications, CRC press, 2001.
5. Werner Leonhard, Control of Electrical Drives, 3rd Edition, Springer, Sept., 2001.

PEC-18	COMPUTER AIDED POWER SYSTEM ANALYSIS	3	0	0	3

COURSE OBJECTIVE:

This course will cover the modeling issues and analysis methods for the power flow, short circuit, contingency and stability analyses, required to be carried out for the power systems. Necessary details of numerical techniques to solve nonlinear algebraic as well as differential equations and handling of sparse matrices will also be included.

UNIT I   NETWORK FORMULATION & MODELLING   9

Need for system analysis in planning and operation of power system- One line diagram- Per unit representation - Symmetrical components - short circuits analysis for fault on machine terminals. Primitive network and its representation – bus incidence matrix – Formation of Bus admittance matrix and bus impedance matrices.- modeling of synchronous machines , transformers, loads, Π-equivalent circuit of transformer with off-nominal tap ratio.

UNIT II   SHORT CIRCUIT STUDIES   9

Types of faults - Algorithms for fault calculations –– sequence impedance matrices - Symmetrical and unsymmetrical fault analysis using Z_{bus}.

UNIT III   LOAD FLOW STUDIES   9

Formulation of load flow problem - bus classification – Solution by Gauss - Seidal , Newton - Raphson and Fast decoupled methods - Comparison -. Computation of slack bus power, transmission loss and line flow.

UNIT IV   ECONOMICAL OPERATION OF GENERATING STATIONS   9

Optimal operation of generators – economical scheduling of thermal plant with and without transmission losses – Loss formula derivation- unit commitment - Elementary idea of optimal load scheduling of Hydro - Thermal plants.

UNIT V   STABILITY STUDIES   9

Steady state and transient stability   - Swing equation and its solution by modified Euler and Runge-Kutta methods - Equal area criterion - Factors affecting stability and methods of improving stability- Causes of voltage instability – voltage stability proximity indices for two-bus system.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Explain about modeling of network and its formulation.	K3
CO2	Discuss about short circuit studies.	K5
CO3	Solve the load flow problems for bus transmission.	K3
CO4	Explain economical operation of generating stations.	K4
CO5	Discuss about stability studies	K2

TEXT BOOKS:

1. Hadi Saadat,"Power System Analysis", Tata McGraw-Hill Editions ,2007

2. Gupta B R, "Power System Analysis and Design", S.Chand and company Ltd., New Delhi, 2005.

REFERENCE BOOKS:

1. PAI, M A,"Computer Techniques in Power System Analysis" Tata McGraw-Hill, Second edition, 2006

2. Wadhwa C L "Electrical Power Systems", New Age International (P) Ltd, New Delhi, Third Edition, 2003.

3. Kothari D P, Nagrath I J, "Power System Engineering "Tata McGraw-Hill, Second edition.

4. Nagsarkar T K, Sukhija M S, "Power system Analysis", Oxford University Press, 2007.

PEC-19	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To Provide knowledge about the stand alone and grid connected renewable energy systems. To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.

2. To analyze and comprehend the various operating modes of wind electrical generators and solar energy systems.

3. To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems. To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION   9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION   9

Reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III   POWER CONVERTERS   9

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV   ANALYSIS OF WIND AND PV SYSTEMS   9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar systemGrid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system

UNIT V   HYBRID RENEWABLE ENERGY SYSTEMS   9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Able to understand the fundamentals of electric energy conversion systems.	K2
CO2	Able to analyze the fundamental and principles of electrical machine operation in renewable energy	K4
CO3	Able to understand the design and operation of solar and wind power converters.t	K2
CO4	Able to examine the variable speed in wind energy conversion system	K4
CO5	Able to identify the need for hybrid systems.	K3

TEXT BOOKS:

1. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.

2. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi,2009.

REFERENCE BOOKS:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
5. Andrzej M. Trzynnadlowski, 'Introduction to Modern Power Electronics', Second edition, wiley India Pvt. Ltd, 2012.

PEC-20	OPTIMIZATION TECHNIQUES	3	0	0	3

COURSE OBJECTIVE:

To develop the ability to apply the concepts of Matrix theory and Linear programming in Electrical Engineering problems and to achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems.

UNIT I   LINEAR PROGRAMMING   9

Formulation-Graphical and simplex methods-Big-M method-Two phase method-Dual simplex method-Primal Dual problems.

UNIT II   UNCONSTRAINED ONE DIMENSIONAL OPTIMIZATION TECHNIQUES   9

Necessary and sufficient conditions –Unrestricted search methods-Fibonacci and golden section method-Quadratic Interpolation methods, cubic interpolation and direct root methods.

UNIT III   UNCONSTRAINED DIMENSIONAL OPTIMIZATION TECHNIQUES   9

Direct search methods –Random search –pattern search and Rosen brooch's hill claiming method-Descent methods-Steepest descent, conjugate gradient, quasi –Newton method.

UNIT IV   CONSTRAINED OPTIMIZATION TECHNIQUES   9

Necessary and sufficient conditions –Equality and inequality constraints-Kuhn-Tucker conditions-Gradient projection method-cutting planemethod- penalty function method.

UNIT V   DYNAMIC PROGRAMMING   9

Principle of optimality- recursive equation approach-application to shortest route, cargo-loading, allocation and production schedule problems.

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Formulate optimization problems.	K6
CO2	Solve various constrained and unconstrained problem in single variable.	K3
CO3	Solve various constrained and unconstrained problem in multi variable.	K3
CO4	Apply constrained optimization methods.	K3
CO5	Discuss applications of optimization techniques.	K6

TEXT BOOKS:

1. Rao, S.S.,'Optimization: Theory and Application' Wiley Eastern Press, 1978.
2. Taha, H.A., Operations Research –An Introduction, Prentice Hall of India.

REFERENCE BOOKS:

1. Fox, R.L.,'Optimization methods for Engineering Design', Addition Welsey, 1971

PEC-21	ADVANCED CONTROL SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To provide knowledge on design in state variable form

2. To provide knowledge in phase plane analysis To give basic knowledge in describing function analysis.

3. To study the design of optimal controller. To study the design of optimal estimator including Kalman Filter

UNIT I   STATE VARIABLE DESIGN   9

Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle- servo design: - State Feedback with integral control.

UNIT II   PHASE PLANE ANALYSIS   9

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT III   DESCRIBING FUNCTION ANALYSIS   9

Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT IV   OPTIMAL CONTROL   9

Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples.

UNIT V OPTIMAL ESTIMATION 9

Optimal estimation – Kalman Bucy Filter-Solution by duality principle-Discrete systems- Kalman Filter-Application examples..

TOTAL : 45 h

COURSE OUTCOME:

CO1	Design of state variable and state observer.	K6
CO2	Analyze linear and non linear systems.	K4
CO3	Analyze describing function for non linear systems.	K4
CO4	Explain time varying and LQR steady state optimal control	K5
CO5	Understand the optimal estimation using kalman filter using real time examples	K2

TEXT BOOKS :

1. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.

2. G. J. Thaler, " Automatic Control Systems", Jaico Publishing House, 1993.

3. M.Gopal, Modern Control System Theory, New Age International Publishers, 2002.

REFERENCE BOOKS:

1. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011.

2. Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.

3. K. Ogata, 'Modern Control Engineering', 4th edition, PHI, New Delhi, 2002.

4. T. Glad and L. Ljung,, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002.

5. D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009.

PEC-22	BIOMEDICAL INSTRUMENTATATION	3	0	0	3

COURSE OBJECTIVE:

1. To provide an acquaintance of the physiology of the heart, lung, blood circulation andcirculation respiration. Biomedical applications of different transducers used.

2. To introduce the student to the various sensing and measurement devices ofelectrical origin. To provide awareness of electrical safety of medical equipments To provide the latest ideas on devices of non-electrical devices. To bring out the important and modern methods of imaging techniques.

3. To provide latest knowledge of medical assistance / techniques and therapeutic equipments.

UNIT I PHYSIOLOGY AND TRANSDUCERS   9

Cell and its structure – Resting and Action Potential – Nervous system: Functional organisation of the nervous system – Structure of nervous system, neurons - synapse –transmitters and neural communication – Cardiovascular system – respiratory system –Basic components of a biomedical system - Transducers – selection criteria – Piezoelectric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors.

UNIT II ELECTRO – PHYSIOLOGICAL MEASUREMENTS   9

Electrodes –Limb electrodes –floating electrodes – pregelled disposable electrodes -Micro, needle and surface electrodes – Amplifiers: Preamplifiers, differential amplifiers,c hopper amplifiers – Isolation amplifier.ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms. Electrical safety in medical environment: shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipments

UNIT III NON-ELECTRICAL PARAMETER MEASUREMENTS   9

Measurement of blood pressure – Cardiac output – Heart rate – Heart sound –Pulmonary function measurements – spirometer – Photo Plethysmography, BodyPlethysmography – Blood Gas analysers : pH of blood –measurement of blood pCO_2,pO_2, finger-tip oxymeter - ESR, GSR measurements .

UNIT IV MEDICAL IMAGING   9

Radio graphic and fluoroscopic techniques – Computer tomography – MRI –Ultrasonography – Endoscopy – Thermography – Different types of biotelemetrysystems and patient monitoring – Introduction to Biometric system

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy –Heart – Lung machine – Audio meters – Dialysers – Lithotripsy

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	To understand the bioelectric potentials,the electrode theory, different types of electrodes and transducers.	K2
CO2	understand and explain the working and concepts of ECG,EMG,EEG, plethysmography, impedance cardiology, cardiac arrhythmia's, pace makers, defibrillators	K2
CO3	To explain pulmonary measurements, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, artificial kidney machine.	K2, K4
CO4	To understand and analyze Clinical Flame photometer ,spectrophotometer ,Colorimeter,chromatography, Blood Gas Analyz, Blood pH Measurement, Blood Cell Counters	K2, K4
CO5	To understand and explain Medical imaging, Xrays, laser applications, ultrasound scanner, echo cardiography, CT Scan MRI/NMR, cine angiogram, colour doppler systems, Holter monitoring, endoscopy.	K2, K4

TEXT BOOKS

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003.
2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002 / PHI.

REFERENCE BOOKS

1. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
2. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.
3. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
4. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2000.

PEC-23	POWER SYSTEM TRANSIENTS	3	0	0	3

COURSE OBJECTIVE:

1. To study the generation of switching transients and their control using circuit – theoretical concept. To study the mechanism of lighting strokes and the production of lighting surges.

2. To study the propagation, reflection and refraction of travelling waves. To study the impact of voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

UNIT I   INTRODUCTION AND SURVEY   9

Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning.

UNIT II   SWITCHING TRANSIENTS   9

Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current 86 suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients - ferro resonance.

UNIT III   LIGHTNING TRANSIENTS   9

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

UNIT IV   TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS   9

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.

UNIT V   TRANSIENTS IN INTEGRATED POWER SYSTEM   9

The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - over voltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the need of reactive power control in electrical power transmission lines	K2
CO2	Analyze the switching transients in power systems.	K6
CO3	Analyze lightening phenomena in transmission lines.	K2
CO4	Evaluate transient response of travelling waves in transmission line.	K6
CO5	Interpret the transients in integrated power system.	K4

TEXT BOOKS:

1. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2nd Edition, 1991.
2. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.
3. C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited, Second Edition, 2010.

REFERENCE BOOKS:

1. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.
2. R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.
3. Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.
4. J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012.

PEC-24	FIBRE OPTICS AND LASER INSTRUMENTS	3	0	0	3

COURSE OBJECTIVE:

To expose the basic concepts of optical fibers and their industrial applications. To provide adequate knowledge about Industrial application of optical fibres. To provide basic concepts of lasers. To provide knowledge about Industrial application of lasers To provide knowledge about Industrial application of Holography and Medical applications of Lasers.

UNIT I   OPTICAL FIBRES AND THEIR PROPERTIES   9

Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers – Fibre termination – Optical sources – Optical detectors.

UNIT II   INDUSTRIAL APPLICATION OF OPTICAL FIBRES   9

Fibre optic sensors – Fibre optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT III   LASER FUNDAMENTALS   9

Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.

UNIT IV   INDUSTRIAL APPLICATION OF LASERS   9

Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.

UNIT V   HOLOGRAM AND MEDICAL APPLICATIONS   9

Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

TOTAL : 45

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Analyze the theory and classification of fiber optics and fiber characteristics.	K4
CO2	Apply the gained knowledge on optical fibers for its use as communication medium and as sensor as well which have important applications in production, manufacturing and industrial applications.	K3
CO3	Analyze laser theory and laser generation system	K4
CO4	Apply and examine the gained knowledge on laser theory for its use in industrial applications.	K3,K4
CO5	Understand the basic principle of Holography and apply the acquired knowledge on laser in medical applications	K2,K3

TEXT BOOKS:

1. R.P.Khare, Fiber Optics and Optoelectronics, Oxford university press, 2008.
2. J. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2001.
3.

REFERENCE BOOKS:

1. Asu Ram Jha, Fiber Optic Technology Applications to commercial, Industrial, Military and Space Optical systems, PHI learning Private limited, 2009.
2. M. Arumugam, Optical Fibre Communication and Sensors, Anuradha Agencies, 2002.
3. John F. Read, Industrial Applications of Lasers, Academic Press, 1977

PEC-25	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	3	0	0	3

COURSE OBJECTIVE:

1. To impart knowledge about the concept of system identification and adaptive control. To understand the Black-box approach based system identification.
2. To learn about the batch and recursive identification. To study about the concept of adaptive control schemes.

UNIT I   MODELS FOR IDENTIFICATION   9

Models of LTI systems: Linear Models-State space Models-OE model- Model sets, Structures and Identifiability-Models for Time – varying and Non-linear systems:Models with Nonlinearities–Non-linear state-space models-Black box models, Fuzzy models.

UNIT II   NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON   9

Transient response and Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square– Recursive Least Square –Forgetting factor- Maximum Likelihood–Instrumental Variable methods.

UNIT III   NON-LINEAR IDENTIFICATION AND MODEL VALIDATION   9

Open and closed loop identification:Approaches– Direct and indirect identification– Joint input – output identification–Non-linear system identification–Wiener models– Power series expansions-State estimation techniques–Nonlinear identification using Neural Network and Fuzzy Logic.

UNIT IV   ADAPTIVE CONTROL AND ADAPTATION TECHNIQUES   9

Introduction – Uses – Auto tuning – Self Tuning Regulators (STR)–Model Reference Adaptive Control (MRAC).TypesSTR and MRAC– Different approaches to self- tuning regulators–Stochastic Adaptive control–Gain Scheduling.

UNIT V   CASESTUDIES   9

Inverted Pendulum, Robot arm, process control application: heat exchanger, types of heat exchangers, Distillation column, application to power system, Ship steering control.

Total:45h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Model Linear time in varying systems.	K3
CO2	Analyze the transient, frequency and spectral analysis for parametric and non parametric identification.	K4
CO3	Discuss about non linear system identification.	K6
CO4	Explain adaptive control and adaptive techniques.	K5
CO5	Discuss case studies on adaptive control.	K6

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TEXT BOOKS:

1. Ljung, "System IdentificationTheoryfor theUser",2nd edition, PHI, 1987.
2. T. Soderstrom and PetreStoica, System Identification, Prentice Hall International(UK) Ltd. 1989
3. Karl J. Astrom and Bjorn Witten mark, Adaptive Control, Pearson Education, Second edition, Fifth impression, 2009.

REFERENCE BOOKS:

1. William S. Levine, "ControlHandBook".
2. NarendraandAnnaswamy," StableAdaptiveControl Systems, PrenticeHall, 1989.
3. William S.Levine, "Control Systems Advanced Methods, the Control Handbook, CRCPress 2011.

PEC-26	RENEWABLE ENERGY SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To create awareness about the renewable Energy Sources and technologies. To get adequate inputs on a variety of issues in harnessing renewable Energy.
2. To recognize current and possible future role of renewable energy sources.

UNIT I   RENEWABLE ENERGY (RE) SOURCES   9

Environmental consequences of fossil fuel use, Importance of renewable sources of energy,Sustainable Design and development, Types of RE sources, Limitations of RE sources,Present Indian and International energy scenario of conventional and RE sources.

UNIT II   WIND ENERGY   9

Power in the Wind – Types of Wind Power Plants(WPPs)–Components of WPPs-Workingof WPPs- Siting of WPPs-Grid integration issues of WPPs.

UNIT III   SOLAR PV AND THERMAL SYSTEMS   9

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central ReceiverPower Plants, Solar Ponds.- Thermal Energy storage system with PCM- Solar Photovoltaicsystems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells,Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency &Quality of the Cell, series and parallel connections, maximum power point tracking,Applications.

UNIT IV   BIOMASS ENERGY   9

Introduction-Bio mass resources –Energy from Bio mass: conversion processes-BiomassCogeneration - Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification ofwater turbine, Turbine theory, Essential components of hydroelectric system.

UNIT V   OTHER ENERGY SOURCES   9

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. WaveEnergy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion(OTEC)- Hydrogen Production and Storage- Fuel cell : Principle of working- various types -construction and applications. Energy Storage System- Hybrid Energy Systems.

TOTAL : 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Explain about renewable energy sources and technologies.	K5
CO2	Understand and explain the components and working principle of wind power plants.	K2
CO3	Explain solar PV and thermal systems.	K5
CO4	Understand about the importance of biomass energy.	K2
CO5	Identify other energy resources.	K3

TEXT BOOKS:

1. Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt. Ltd, New Delhi, 2011.
2. D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
3. Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.

REFERENCE BOOKS:

1. A.K.Mukerjee and Nivedita Thakur," Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011
2. Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.
3. Chetan Singh Solanki, "Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011.
4. Bradley A. Striebig,Adebayo A.Ogundipe and Maria Papadakis," Engineering Applications in Sustainable Design and Development", Cengage Learning India Private Limited, Delhi, 2016.
5. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
6. Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.

PEC-27	POWER PLANT ENGINEERING	3	0	0	3

COURSE OBJECTIVE:

1. To understand components; layout of Steam power plant, diesel power plant , components; different cycles ; methods to improve thermal efficiency of gas power plant
2. To study the working principle, construction of power generation from non-conventional sources of energy.
3. To learn the different instrumentation in power plant and basics of economics of power generation.

UNIT I   COAL BASED THERMAL POWER PLANTS   9

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II   DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS   9

Otto, Diesel, Dual & Brayton Cycle - Analysis &Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III   NUCLEAR POWER PLANTS   9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of NuclearReactors : B*oiling Water Reactor* (BWR), P*ressurized Water Reactor* (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV   POWER FROM RENEWABLE ENERGY   9

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, *Solar* Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V   ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS   9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria,relative merits & demerits, Capital & Operating Cost of different power plants. Pollution controltechnologies including Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL : 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Explain the construction, Layout and components of a Thermal power plant.	K2,K5
CO2	Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.	K2,K5
CO3	Explain the layout, construction and working of the components inside nuclear power plants	K2,K5
CO4	Interpret the construction , layout of renewable energy power plants and its components	K2,K5
CO5	Explain the knowledge to power plant economics and estimate the cost of electrical energy production	K2,K5

TEXT BOOK:

1. P.K. Nag, Power Plant Engineering, Tata McGraw – Hill Publishing Company Ltd., Third Edition, 2008

REFERENCE BOOKS

1. M.M. El-Wakil, Power Plant Technology, Tata McGraw – Hill Publishing Company Ltd., 2010.

2. Black & Veatch, Springer, Power Plant Engineering, 1996.

3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Standard Handbook of Power Plant Engineering, Second Edition, McGraw – Hill, 1998.

4. Godfrey Boyle, Renewable energy, Open University, Oxford University Press in association with

the Open University, 2004.

PEC-28	ENERGY MANAGEMENT AND AUDITING	3	0	0	3

COURSE OBJECTIVE :

1. To impart basic knowledge to the students about current energy scenario, energy conservation, audit and management.
2. To inculcate among the students systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management

UNIT I   GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT   9

Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector -

Energy Conservation Act-2001 and its features - electricity tariff - Thermal Basics need and types of energy audit - Energy management/audit approach- understanding energy costs.

UNIT II   MATERIAL AND ENERGY BALANCE   9

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose location of energy management - roles and responsibilities of energy manager – employees training and planning - financial analysis techniques

UNIT III   ENERGY EFFICIENCY IN THERMAL UTILITIES   9

 Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil,

coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses Steam System: Properties of steam, assessment of steam distribution losses, steam trapping, condensate and flash steam recovery system – furnaces - temperature control, draft control, waste heat recovery – refractory – cogeneration – case study.

UNIT IV   ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM   9

Compressed Air System: Types of air compressors - compressed air system components - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle – refrigerants - factors affecting refrigeration and air conditioning system - Vapour absorption refrigeration system: working principle - types - cooling tower - flow control strategies and energy saving - Diesel Generating system: Factors affecting selection - energy performance assessment of diesel conservation avenues – case study.

UNIT V   ENERGY EFFICIENCY IN ELECTRICAL UTILITIES   9

 Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor

controllers - transformer losses - losses in induction motors - factors affecting motor performance - rewinding and motor replacement issues - soft starters with energy saver - variable speed drives – Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System: system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements – ballast - occupancy sensors - energy efficient lighting controls – case study.

TOTAL : 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Understand the basics of energy management and auditing.	K2
CO2	Analyze the financial techniques for energy management.	K4
CO3	Explain about the energy saving in thermal utilities.	K5
CO4	Identify the strategy for energy saving in compressed air system	K3
CO5	Explain about the electrical load management system.	K5

TEXT BOOKS:

1. Moncef Krati, Energy Audit of Building Systems : An Engineering Approach, Second Edition, CRC Press, 2016.

2. Sonal Desai, Handbook of Energy Audit, McGraw Hill Education (India) Private Limited, 2015

3. Michael P.Deru, Jim Kelsey, Procedures for Commercial Building Energy Audits, American Society of Heating, Refrigerating and Air conditioning Engineers, 2011

REFERENCES:

1. Thomas D.Eastop, Energy Efficiency: For Engineers and Technologists, Logman Scientific & Technical, 1990

2. Bureau of Energy Efficiency - Energy Managers and Energy Auditors Guide book, 2006

3. Larry C. Witte, Philip S.Schmidt, David R.Brown, Industrial Energy Management and Utilization, Springer Berlin Heidelberg, 1988

PEC-29	MODERN POWER CONVERTERS	3	0	0	3

COURSE OBJECTIVE :

1. Students will be able to understand the principle of Single phase bridge rectifiers and three phase bridge rectifiers with RL, RLE loads & effect of source impedance.

2. Teaching about design and analysis of dc –dc converters

3. To understand the operation of single phase and three phase cycloconverters.

UNIT I   SINGLE PHASE AC TO DC CONVERTERS   9

Single phase bridge rectifiers, half controlled and Fully controlled converters with RL, RLE loads, freewheeling diodes, Dual Converter, sequence control of converters-inverter operation, Input harmonics and output ripple, smoothing inductance-power factor, effect of source impedance and overlap ,reactive power and power balance in converter circuits.

UNIT II   THREE PHASE AC TO DC CONVERTERS   9

Semi and Fully controlled converters with R, RL, RLE loads, freewheeling diodes, Dual Converter, sequence control of converters-inverter operation, Input harmonics and output ripple, smoothing inductance-power factor, effect of source impedance and overlap, 12 pulse converter

UNIT III   DC TO DC CONVERTERS   9

Principle of operation, choice of communication circuit elements, Step down and step up choppers, classification, Voltage and current commutated choppers, effect of source Inductance, Filter circuits, multiphase chopper, resonant converters.

UNIT IV   AC VOLTAGE CONTROLLERS   9

Principle of phase control, single-phase bi-directional controllers with R, L and R-L loads, 3- phase controllers, different configurations, Analysis with pure R and L loads

UNIT V   CYCLOCONVERTERS   9

Principle of operation, single phase and three phase cyclo converters, Power circuits, gating signals-harmonics and analysis of power factor

TOTAL : 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Categorize the converters based on their working principle.	K4
CO2	Analyze the performancecharacteristics of three phase AC/DC converter for R, RL and RLE Loads.	K4
CO3	Interpret the different types of DC-DC converters and their working operations.	K2
CO4	Analyze the performance characteristics of single-phase bi-directional controllers for R and L loads.	K4
CO5	Construct single phase and three phase Cycloconverters.	K3

TEXT BOOKS:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Second Edition, New Delhi, 1995.

2. P.C Sen.," Modern Power Electronics ", Wheeler publishing Co, First Edition, New Delhi-1998.

REFERENCES:

1. Mohan N., Undeland and Robbins, "Power Electronics-Converters ", Applications and Design ", John Wiley and sons, Inc., New York, 1995.

PEC-30	MODERN CONTROL THEORY	3	0	0	3

COURSE OBJECTIVE:

1. To explain the concepts of basic and modern control system for the real time analysis and design of control systems.
2. To study and analyze non linear systems.
3. To apply the comprehensive knowledge of optimal theory for Control Systems.

UNIT I   MATHEMATICAL PRELIMINARIES AND STATE VARIABLE ANALYSIS: 9

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear systems – The concept of state – State space model of Dynamic systems – Time invariance and Linearity – Non uniqueness of state model – State diagrams for Continuous-Time State models – Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and it's properties. Complete solution of state space model due to zero input and due to zero state.

UNIT II   CONTROLLABILITY AND OBSERVABILITY   9

General concept of controllability – Controllability tests, different state transformations such as diagnolization, Jordon canonical forms and Controllability canonical forms for Continuous-Time Invariant Systems – General concept of Observability – Observability tests for Continuous-Time Invariant Systems – Observability of different State transformation forms.

UNIT III   STATE FEEDBACK CONTROLLERS AND OBSERVERS   9

State feedback controller design through Pole Assignment, using Ackkermans formula– State observers: Full order and Reduced order observers.

UNIT IV   STATE FEEDBACK CONTROLLERS AND OBSERVERS   9

Introduction – Non Linear Systems – Types of Non-Linearities – Saturation – Dead-Zone – Backlash – Jump Phenomenon etc; Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instability theorems – Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

TOTAL : 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Develop state variable analysis for any real time system.	K5
CO2	Apply controllability and observability to linear time variant systems.	K3
CO3	Design state feedback controller and state observer using reduced order model.	K6
CO4	Apply describing function to test stability analysis for Non linear Systems.	K3
CO5	Test the stability of a Linear Time invariant system using Lyapunov method.	K4

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TEXT BOOKS:

1. M. Gopal, Modern Control System Theory by – New Age International – 1984
2. Ogata. K, Modern Control Engineering by– Prentice Hall – 1997
3. N K Sinha, Control Systems– New Age International – 3rd edition.

REFERENCES:

1. Donald E. Kirk, Optimal Control Theory an Introduction, Prentice – Hall Network series – First edition.

PEC-31	DISTRIBUTED GENERATION AND MICROGRID	3	0	0	3

COURSE OBJECTIVE:

1. To impart knowledge about distributed generation technologies, their interconnection in grid, to understand relevance of power electronics in DG.
2. To study concept of Micro grid and its configuration

UNIT I   NEED FOR DISTRIBUTED GENERATION   9

Renewable sources in distributed generation – Current scenario in distributed generation – Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems

UNIT II   GRID INTEGRATION OF DGS   9

Different types of interfaces – Inverter based DGs and rotating machine based interfaces – Aggregation of multiple DG units – Energy storage elements – Batteries, ultracapacitors, flywheels.

UNIT III   TECHNICAL IMPACTS OF DGS   9

Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems

UNIT IV   ECONOMIC AND CONTROL ASPECTS OF DGS   9

Market facts, issues and challenges – Limitations of DGs – Voltage control techniques, Reactive powercontrol, Harmonics, Power quality issues – Reliability of DG based systems – Steady state and Dynamic analysis.

UNIT V   TYPES OF MICROGRIDS   9

Types of micro-grids – Autonomous and non-autonomous grids – Sizing of micro-grids – Modeling & analysis – Micro-grids with multiple DGs – Micro-grids with power electronic interfacing units – Transients in micro-grids – Protection of micro-grids – Case studies.

TOTAL : 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Choose the size and optimal displacement of Distributed Generation.	K3
CO2	Analyze the impact of grid integration technologies of DGs.	K4
CO3	Analyze the technical impacts of DGs in power systems	K4
CO4	Examine various control aspects of DGs.	K4
CO5	Analyze the microgrid with multiple distributed generators and power electronic interfacing Units.	K4

TEXT BOOKS:

1. H. Lee Willis, Walter G. Scott , 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.

2. M.Godoy Simoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.

3. Robert Lasseter, Paolo Piagi, ' Micro-grid: A Conceptual Solution', PESC 2004, June 2004.

REFERENCES:

1. F. Katiraei, M.R. Iravani, 'Transients of a Micro-Grid System with Multiple Distributed Energy Resources', International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005.

2. Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson, 'Facility Microgrids', General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

Syllabus

OPEN ELECTIVE COURSES

OEC-01	ELECTRONIC DEVICES AND CIRCUITS	3	0	0	3

COURSE OBJECTIVE:

1. Be familiar with the structure of basic electronic devices. Be exposed to the operation and application of electronic devices.
2. To explain about the working and usage of Transistors,amplifiers & oscillators.

UNIT I   PN DIODE AND ITS APPLICATIONS   **9**

PN junction diode - VI characteristics – temperature effects – Drift and diffusion currents – switching – Rectifiers: HWR, FWR, BR, filters - Zener diode – VI characteristics, Regulators (series and shunt), LED, LCD characteristics and applications.

UNIT II   BJT AND ITS APPLICATIONS   **9**

Junction transistor – Transistor construction – Input and output characteristics – CE, CB and CC configurations – hybrid model – Analytical expressions – switching – RF application – Power transistors – Opto couplers.

UNIT III   FET AND ITS APPLICATIONS   **9**

FET – VI characteristics, VP, JFET – small signal model – LF and HF equivalent circuits – CS and CD amplifiers –cascade and cascade – Darlington connection – MOSFET - Characteristics – enhancement and depletion.

UNIT IV   AMPLIFIERS AND OSCILLATORS   **9**

Differential amplifiers: CM and DM – condition for ofc-feedback amplifiers – stability – Voltage / current, series / shunt feedback – oscillators – LC, RC, crystal

UNIT V   PULSE CIRCUITS   **9**

RC wave shaping circuits – Diode clampers and clippers – Multivibrators – Schmitt triggers – UJT based saw tooth oscillators.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Explain the operation of Diode, Rectifiers and determine its efficiency.	K5
CO2	Compare the characteristics of CE, CB and CC configurations of Bipolar Junction Transistor.	K4
CO3	Compare MOSFET and JFET and analyse its operation at Low and High Frequency.	K4
CO4	Analyse various types of amplifiers, oscillators and estimate its gain and frequency.	K5
CO5	Analyse various types of waveshaping and multivibrator circuits.	K4

TEXT BOOKS:

1. Paynter, "Introductory Electronic Devices and Circuits, PHI, 2006.

2. David Bell "Electronic Devices and Circuits", PHI, 2007

REFERENCE BOOKS:

1. Theodre F.Boghert, "Electronic Devices & Circuits" Pearson Education, VI Edition, 2003

2. Rashid, "Microelectronic circuits" Thomson Publication, 1999.

3. Singh, B.P. and Rekha Sing, "Electronic Devices and Integrated Circuits" Pearson Education, 2006.

4.Salivahanan.S,Suresh kumar.N "Electronic Devices & Circuits"Tata McGraw-Hill Education, 2011

OEC-02	DATA STRUCTURES AND ALGORITHMS	3	0	0	3

COURSE OBJECTIVE:

1. To impart the basic concepts of data structures and algorithms. To understand concepts about searching and sorting techniques.

2. To understand basic concepts about stacks, queues, lists trees and graphs. To enable them to write algorithms for solving problems with the help of fundamental data structures.

UNIT I   INTRODUCTION   9

Introduction: Basic Terminologies: Elementary Data Organizations, Data StructureOperations: insertion, deletion, traversal etc.; Analysis of an Algorithm, AsymptoticNotations, Time-Space trade off. Searching: Linear Search and Binary Search Techniquesand their complexity analysis.

UNIT II   STACKS AND QUEUES   9

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexityanalysis, Applications of Stacks: Expression Conversion and evaluation – correspondingalgorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, CircularQueue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

UNIT III   LINKED LISTS   9

Linked Lists: Singly linked lists: Representation in memory, Algorithms of severaloperations: Traversing, Searching, Insertion into, Deletion from linked list; Linkedrepresentation of Stack and Queue, Header nodes, Doubly linked list: operations on it andalgorithmic analysis; Circular Linked Lists: all operations their algorithms and thecomplexity analysis.

UNIT IV   TREES   9

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and theiralgorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree:definitions, algorithms and analysis.

UNIT V   SORTING AND HASHING   9

Sorting and Hashing: Objective and properties of different sorting algorithms:Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort;Performance and Comparison among all the methods,

Hashing.Graph: Basic Terminologies and Representations, Graph search and traversal algorithms andcomplexity analysis.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Develop the algorithms to determine the time and computation, complexity and justify the correctness.	K5
CO2	Apply stacks, Queues and linked list concepts to determine the time and computation complexity.	K3
CO3	Develop an algorithm using Traversing, Searching, Insertion and Deletion concepts.	K5
CO4	Identify the complexity of different operations in trees.	K3
CO5	Develop an algorithm using Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.	K5

TEXT BOOKS:

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

REFERENCE BOOKS:

1. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-

    Wesley Publishing Company

2. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education 3.

OEC-03	ANALOG AND DIGITAL COMMUNICATION	3	0	0	3

COURSE OBJECTIVE:

1. To provide basic principles and techniques used in analog and digital communications. The subject will introduce analog and digital modulation techniques, communication receiver and transmitter design, baseband and band pass communication techniques, line coding techniques, noise analysis, and multiplexing techniques.

2. The subject also introduces analytical techniques to evaluate the performance of communication systems.

UNIT I   SIGANALS AND SYSTEMS   9

Review of signals and systems, Frequency domain representation of signals, Principles ofAmplitudeModulation Systems- DSB, SSB and VSB modulations. Angle Modulation,Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

UNIT II   PROBABILITY AND RANDOM PROCESS   9

Review of probability and random process. Gaussian and white noise characteristics,Noise inamplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and Deemphasis,Threshold effect in angle modulation.

UNIT III   PULSE MODULATION   9

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation(PCM),Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

UNIT IV   DETECTION THEORY   9

Elements of Detection Theory, Optimum detection of signals in noise,Coherent communicationwith waveforms- Probability of Error evaluations. BasebandPulse Transmission- Inter symbolInterference and Nyquist criterion.Pass band Digital Modulation schemes- Phase Shift Keying,Frequency Shift Keying,Quadrature Amplitude Modulation, Continuous Phase Modulation andMinimum Shift Keying.

UNIT V   DIGITAL COMMUNICATION   9

Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limitedchannels-Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques.Synchronization and Carrier Recovery for Digital modulation

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand and compare different analog modulation schemes for their efficiency and bandwidth	K2
CO2	Implement probability and random process technique in analyzing noises in amplitude and frequency modulation system.	K4
CO3	Identify pulsed modulation system and analyze their system performance	K3
CO4	Analyze on detection theory	K4
CO5	Evaluate the performance of Digital communication in the presence of noise.	K5

Text Book:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.

2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.

REFERENCEBOOKS:

1. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill,2001.

2. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering'',JohnWiley, 1965.

3. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication'', KluwerAcademic Publishers, 2004.

4. Proakis J.G., ``Digital Communications'', 4th Edition, McGraw Hill, 2000.

OEC-04	COMPUTER NETWORKS	3	0	0	3

COURSE OBJECTIVE:

1. To develop an understanding of modern network architectures from a design and performance perspective.
2. To introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs).
3. To provide an opportunity to do network programming. To provide a WLAN measurement ideas.

UNIT I   DATA COMMUNICATION COMPONENTS: 9

Data communication Components: Representation of data and its flow Networks , VariousConnection Topology, Protocols and Standards, OSI model, Transmission Media, LAN:Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidthutilization: Multiplexing - Frequency division, Time division and Wave division, Conceptson spread spectrum.

UNIT II   DATA LINK LAYER AND MEDIUM ACCESS SUB LAYER   9

Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction -Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error controlprotocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window,Piggybacking, Random Access, Multiple access protocols -Pure ALOHA,Slotted ALOHA, CSMA/CD,CDMA/CA

UNIT III   NETWORK LAYER   9

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP,RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

UNIT III   TRANSPORT LAYER   9

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP),Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoSimproving techniques: Leaky Bucket and Token Bucket algorithm.

UNIT V   APPLICATION LAYER   9

Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File TransferProtocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts ofCryptography.

Total :45h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the functions of each layer in OSI and TCP/IP model ,techniques of band width utilization	K2
CO2	Explain the Flow Control and Error control of Data link layer	K5
CO3	Understand the various functions and components of network layer	K2
CO4	Classify the protocols and techniques of transport layer	K4
CO5	Asses the importance of application layer	K3

Text Book:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw- Hill.

2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.

REFERENCE BOOKS

1. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.

2. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.

3. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

OEC-05	EMBEDDED SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To introduce the Building Blocks of Embedded System. To Educate in Various Embedded Development Strategies. To Introduce Bus Communication in processors, Input/output interfacing.
2. To impart knowledge in Various processor scheduling algorithms.
3. To introduce Basics of Real time operating system and example tutorials to discuss on one real time operating system tool.

UNIT I   INTRODUCTION TO EMBEDDED SYSTEMS   9

Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor , selection of processor & memory devices- DMA – Memory management 69 methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT II   EMBEDDED NETWORKING   9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols - RS232 standard – RS422 – RS485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.

UNIT III   EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT   9

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modeling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

UNIT IV   RTOS BASED EMBEDDED SYSTEM DESIGN   9

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communicationshared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: Vx Works, чC/OS-II, RT Linux.

UNIT V   EMBEDDED SYSTEM APPLICATION DEVELOPMENT   9

Case Study of Washing Machine- Automotive Application- Smart card System Application,.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Identify the structural units in embedded processor and memory and the I/O devices	K2
CO2	Analyze various protocols to establish communication between the embedded devices.	K4
CO3	Conclude the different stages involved in the development of an embedded product and various models in it.	K5
CO4	Explain the basic concepts of Real Time Operating Systems (RTOS).	K2
CO5	Analyze the working of Embedded system applications like washing machine, smart card and automotive application	K4

TEXT BOOKS:

1. Rajkamal, 'Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013.

2. Peckol, "Embedded system Design", John Wiley & Sons,2010

3. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013

REFERENCEBOOKS:

1. Shibu. K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill,2009.

2. Elicia White," Making Embedded Systems", O' Reilly Series,SPD,2011.

3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2006.

4. Han-Way Huang,"Embedded system Design Using C8051", Cengage Learning,2009. 5. Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007

OEC-06	**VLSI CIRCUITS**	3	0	0	3

COURSE OBJECTIVES:

1. To learn the basic CMOS circuits, To learn the CMOS process technology,

2. To learn techniques of chip design using programmable devices, To learn the concepts of designing VLSI subsystems .

3. To learn the concepts of modeling a digital system using Hardware Description Language.

UNIT I CMOS TECHNOLOGY 9

A brief History-MOS transistor, Ideal I-V characteristics, C-V characteristics, Non ideal IV effects, DC transfer characteristics - CMOS technologies, Layout design Rules, CMOS process enhancements, Technology related CAD issues, Manufacturing issues

UNIT II CIRCUIT CHARACTERIZATION AND SIMULATION 9

Delay estimation, Logical effort and Transistor sizing, Power dissipation, Interconnect, Design margin, Reliability, Scaling- SPICE tutorial, Device models, Device characterization, Circuit characterization, Interconnect simulation

UNIT III COMBINATIONAL AND SEQUENTIAL CIRCUIT DESIGN 9

Circuit families –Low power logic design – comparison of circuit families – Sequencing static circuits, circuit design of latches and flip flops, Static sequencing element methodology- sequencing dynamic circuits – synchronizers

UNIT IV CMOS TESTING 9

Need for testing- Testers, Text fixtures and test programs- Logic verification- Silicon debug principles- Manufacturing test – Design for testability – Boundary scan

UNIT V SPECIFICATION USING VERILOG HDL 9

Basic concepts- identifiers- gate primitives, gate delays, operators, timing controls, procedural assignments conditional statements, Data flow and RTL, structural gate level switch level modeling, Design hierarchies, Behavioral and RTL modeling, Test benches, Structural gate level description of decoder, equality detector, comparator, priority encoder, half adder, full adder, Ripple carry adder, D latch and D flip flop.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the characteristics and issues in CMOS Technology.	K2
CO2	Develop the device model and simulate it using SPICE	K5
CO3	Understand the Circuit families and Low power logic design.	K2
CO4	Understand the combinational and sequential circuit design techniques.	K2
CO5	Demonstrate various types of CMOS Testing Techniques..	K2

TEXT BOOKS:

1. Weste and Harris: CMOS VLSI DESIGN (Third edition) Pearson Education, 2005

2. Uyemura J.P: Introduction to VLSI circuits and systems, Wiley 2002.

REFERENCE BOOKS::

1. D.A Pucknell & K.Eshraghian Basic VLSI Design, Third edition, PHI, 2003

 2. Wayne Wolf, Modern VLSI design, Pearson Education, 2003

3. M.J.S.Smith: Application specific integrated circuits, Pearson Education, 1997

4. J.Bhasker: Verilog HDL primer, BS publication,2001

5. Ciletti Advanced Digital Design with the Verilog HDL, Prentice Hall of India.

OEC-07	IMAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES:

1. To become familiar with digital image fundamentals. To become familiar with digital image fundamental.
2. To get exposed to simple image enhancement techniques in Spatial and Frequency domain. To learn concepts of degradation function and restoration techniques.
3. To study the image segmentation and representation techniques. To become familiar with image compression and recognition methods

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – Color image fundamentals – RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms – DFT, DCT.

UNIT II IMAGE ENHANCEMENT 9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III IMAGE RESTORATION 9

Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

UNIT IV IMAGE SEGMENTATION 9

Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

UNIT V IMAGE COMPRESSION AND RECOGNITION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional

Descriptors – Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching.

TOTAL 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the digital image processing steps, such as digitalization, sampling, quantization, and 2D-transforms.	K2
CO2	Apply different types of transformations for smoothing, sharpening and enhancement of the image.	K3
CO3	Select appropriate filter for restoration of the image.	K3
CO4	Apply various techniques of image processing for erosion dilation and segmentation	K3
CO5	Formulate the coding on image compression	K6

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods,Digital Image Processing Pearson, Third Edition, 2010
2. Anil K. Jain, Fundamentals of Digital Image Processing Pearson, 2002

REFERENCE BOOKS:

1. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
3. D,E. Dudgeon and RM. Mersereau, Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, Digital Image Processing John Wiley, New York, 2002
5. Milan Sonka et al Image processing, analysis and machine vision Brookes/Cole, Vikas Publishing House, 2nd edition, 1999

OEC-08	**WAVELET TRANSFORMS**	3	0	0	3

COURSE OBJECTIVES:

1. To study the basics of signal representation and Fourier theory. To understand Multi Resolution Analysis and Wavelet concepts.

2. To study the wavelet transform in both continuous and discrete domain. To understand the design of wavelets using Lifting scheme. To understand the applications of Wavelet transform.

UNIT I   FUNDAMEMTALS   9

Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion, Fourier transform, Short time Fourier transform, Time-frequency analysis

UNIT II   MULTIRESOLUTION   9
**   ANALYSIS**

Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.

UNIT III   CONTINUOUS WAVELET TRANSFORMS   9

Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions (Daubechies Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal)– Tiling of Time – Scale Plane for CWT.

UNIT IV   DISCRETE WAVELET TRANSFORMS   9

Filter Bank and Sub Band Coding Principles – Wavelet Filters – Inverse DWT Computation by Filter Banks – Basic Properties of Filter Coefficients – Choice of Wavelet Function Coefficients – Derivations of Daubechies Wavelets – Mallat's Algorithm for DWT – Multi Band Wavelet Transforms Lifting Scheme-Wavelet Transform Using Polyphase Matrix Factorization – Geometrical Foundations of Lifting Scheme – Lifting Scheme in Z –Domain.

UNIT V   APPLICATIONS   9

Wavelet methods for signal processing- Image Compression Techniques: EZW–SPHIT Coding – Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions – Edge Detection and Object Isolation, Image Fusion, and Object Detection.

TOTAL 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand the fundamentals of vector and signal spaces.	K2
CO2	Analyze about the multi resolution analysis.	K4
CO3	Understand and describe continuous wavelet transform.	K2
CO4	Understand and describe discrete wavelet transform.	K2
CO5	Apply the wavelet transform to various applications.	K3

TEXT BOOKS:

1. Rao R M and A S Bopardikar, —Wavelet Transforms Introduction to theory and Applications, Pearson Education, Asia, 2000.
2. L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

REFERENCE BOOKS::

1. J. C. Goswami and A. K. Chan, "Fundamentals of wavelets: Theory, Algorithms and Applications" WileyInterscience Publication, John Wiley & Sons Inc., 1999.
2. M. Vetterli, J. Kovacevic, "Wavelets and subband coding" Prentice Hall Inc, 1995. 3. Stephen G. Mallat, "A wavelet tour of signal processing" 2 nd Edition Academic Press, 2000.
3. Soman K P and Ramachandran K I, —Insight into Wavelets From Theory to practiceǁ, Prentice Hall, 2004

OEC-09	**THERMAL AND FLUID ENGINEERING**	3	0	0	3

COURSE OBJECTIVE:

1. To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes.

2. To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems.

UNIT I GAS POWER CYCLES   **9**

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure and air standard efficiency, Actual and theoretical PV diagram of Four stroke engines, Actual and theoretical PV diagram of two stroke engines.

UNIT II INTERNAL COMBUSTION ENGINES   **9**

Classification of IC engine, IC engine components and functions. Valve timing diagram and port timing diagram. Comparison of two stroke and four stroke engines.Fuel supply systems, Ignition Systems, Performance calculation.Comparison of petrol & diesel engine.Fuels, Air-fuel ratio calculation, Knocking and Detonation.Lubrication system and cooling system. Exhaust gas analysis.

UNIT III STEAM NOZZLES AND TURBINES   **9**

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow.Impulse and reaction principles, compounding, velocity diagrams for simple and multistage turbines, speed regulations-governors and nozzle governors.

UNIT IV ROTO DYNAMIC MACHINES   **9**

Homologus units, Specific speed, Elementary cascade theory, Theory of turbo machines, Euler's equation, Hydraulic efficiency, Velocity components at the entry and exit of the rotor. Velocity triangle for single stage radial flow and axial flow machines, Centrifugal pumps, turbines, performance curves for pumps and turbines.

UNIT V POSITIVE DISPLACEMENT MACHINES   **9**

Positive displacement pumps and classification of pumps, Reciprocating pumps, characteristics of reciprocating pump, Indicator diagrams, Work saved by air vessels.Rotory pumps, Classification, Working and performance curves.

Total :45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Examine the Gas power cycles and PV diagram of two stroke engines	K4
CO2	Explain the performance of a two stroke and four stroke internal combustion engine.	K5
CO3	Analyze the flow of steam through the nozzle ,velocity diagram of single and multistage impulse turbines.	K4
CO4	To estimate the conservation laws to flow through pipes and hydraulic machines and the importance of various types of flow in pumps and turbines	K5
CO5	Classify the pumps and understand its performance curves.	K4

TEXT BOOKS:

1. Rajput, "Thermal Engineering", S. Chand publishers, 2000.

2. Rudramoorthy R, "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2003.

3. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1983

REFERENCE BOOKS::

1. Kothandaraman.C.P.,Domkundwar.S. and A.V.Domkundwar., "A course in Thermal Engineering", DhanpatRai& Sons, Fifth edition, 2002

2. Holman. J.P., "Thermodynamics", McGraw-Hill, 1985.

3. Rogers, Meyhew, "Engineering Thermodynamics", ELBS, 1992.

4. Arora.C.P., "Refrigeration and Air conditioning", TMH, 1994.

5. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi

OEC-10	**STRENGTH OF MATERIALS**	3	0	0	3

COURSE OBJECTIVE:

　　　　To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.

UNIT I　　STRESS, STRAIN AND DEFORMATION OF SOLIDS　　　　　　　　　9

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT II　　BEAMS - LOADS AND STRESSES　　　　　　　　　　　　　　9

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow.

UNIT III　　TORSION　　　　　　　　　　　　　　　　　　　　　　　9

Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads
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UNIT IV　　BEAM DEFLECTION　　　　　　　　　　　　　　　　　　9

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area Method –Columns and its types – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.

UNIT V　　ANALYSIS OF STRESSES IN TWO DIMENSIONS　　　　　　　9

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy in bending and torsion.
Total: 45h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Analyze the rigid bodies and deformable solids response when subjected to different stresses and measure the strain and the relationship of stress and strain	K4
CO2	Analyze the different types of beam response when subjected to different types of loads, shear stresses and evaluation of shear force and bending moment diagram.	K4
CO3	Analyze the different types of shaft and spring response when subjected to torsion forces axially and design of helical coil spring, analysis of deflection and stresses.	K4
CO4	Evaluation of beam deflection and slope using different mathematical methods and column subjected to different end conditions	K5
CO5	Analysis of stresses in two dimensions of thin cylindrical and spherical shells and solve stresses at a point and inclined planes	K4

TEXT BOOKS:

1. Popov E.P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 1997.
2. Beer F. P. and Johnston R, "Mechanics of Materials", McGraw-Hill Book Co, Third Edition, 2002.

REFERENCE BOOKS::

1. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 1995.
2. Kazimi S.M.A, "Solid Mechanics", Tata McGraw-Hill Publishing Co, New Delhi, 1981.
3. Ryder G.H, "Strength of Materials", Macmillan India Ltd., Third Edition, 2002.
4. Ray Hulse, Keith Sherwin & Jack Cain, "Solid Mechanics", Palgrave ANE Books, 2004.
5. Singh D.K "Mechanics of Solids" Pearson Education 2002.
6. Timoshenko S.P, "Elements of Strength of Materials", Tata McGraw-Hill, New Delhi 1997

OEC-11	**FLUID MACHINERY**	3	0	0	3

COURSE OBJECTIVE:

1. The applications of the conservation laws to flow through pipes and hydraulic machines are studied.

2. To understand the importance of dimensional analysis.

3. To understand the importance of various types of flow in pumps and turbines.

UNIT I   INTRODUCTION: IMPULSE OF JET AND IMPULSE TURBINES   9

Classification of Fluid Machines & Devices, Application of momentum and moment of momentum equation to flow through hydraulic machinery, Euler's fundamental equation. Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat &curve), Classification of turbines, Impulse turbines, Constructional details, Velocitytriangles, Power and efficiency calculations, Governing of Pelton wheel

UNIT II   REACTION TURBINES   9

Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitation in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines.

UNIT III   CENTRIFUGAL PUMPS: 9

Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Cavitation & separation, Performance characteristics

UNIT IV   POSITIVE DISPLACEMENT AND OTHER PUMPS   9

Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels, Comparison of centrifugal and reciprocating pumps, Performance characteristics.

UNIT IV   ACCUMULATOR: 9

Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift, hydraulic Ram,hydraulic coupling, hydraulic torque converter, air lift pump, jet pump.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand and apply the basic concepts of Fluid Mechanics to carry out professional engineering activities in the field of fluids and to apply scientific method strategies to fluid mechanics: analyzed qualitatively and quantitatively the problem situation, propose hypotheses and solutions.	K2
CO2	Use the appropriate means of knowledge, procedures, results, skills and aspects inherent to fluid mechanics and to understand the major and minor losses in flow through circular conduits	K3
CO3	Plan and carry out dimensional analysis, similitude and model analysis in accordance with the relevant specific technology	K3
CO4	To estimate the conservation laws to flow through pipes and hydraulic machines and the importance of various types of flow in pumps and turbines	K5
CO5	To apply and study the basic concepts of pumps, air vessels and its performance curves.	K3

TEXT BOOKS:

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1983.

2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.

REFERENCE BOOKS::

1. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, DhanpatRai&Sons,Delhi, 1988.

2. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.)Eurasia Publishing House (P) Ltd., New Delhi, 1995.

3. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi.

OEC-12	**AUTOMOBILE ENGINEERING**	3	0	0	3

COURSE OBJECTIVE:

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system.

UNIT I   VEHICLE STRUCTURE AND ENGINES   9

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, resistances to vehicle motion and need for a gearbox, components of engine-their forms, functions and materials

UNIT II   ENGINE AUXILIARY SYSTEMS   9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system, Turbo chargers, Engine emission control by three way catalytic converter system.

UNIT III   TRANSMISSION SYSYTEMS   9

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.

UNIT IV   STEERING, BRAKES AND SUSPENSION SYSTEMS   9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System and Traction Control

UNIT V   ALTERNATIVE ENERGY SOURCES   9

Use of Natural Gas, Liquefied Petroleum Gas. Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the various disciplines of Automobile Engineering with the emphasis on Design and Manufacturing.	K2
CO2	Examine the Ignition, Emission and Electrical system in the control of Engine.	K4
CO3	Determine the functions of Transmission system like clutch, gearboxes, axles and drives. Evaluate the various types of Steering, Suspension and braking systems.	K5
CO4	Evaluate the various types of Steering, Suspension and braking systems.	K5
CO5	Assess the Engine Performance with the help of alternative fuels (natural gas LPG, bio-fuels, hydrogen, and fuel cells).	K5

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering Vol 1 & 2 ", Standard Publishers, Seventh Edition, 1997, New Delhi

2. Jain,K.K., and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.

REFERENCE BOOKS::

1. Newton ,Steeds and Garet," Motor Vehicles ", Butterworth Publishers,1989
2. Joseph Heitner, "Automotive Mechanics,", Second Edition ,East-West Press ,1999
3. Martin W. Stockel and Martin T Stockle , " Automotive Mechanics Fundamentals," The Goodheart – Will Cox Company Inc, USA ,1978
4. Heinz Heisler , 'Advanced Engine Technology," SAE International Publications USA,1998
5. Ganesan V." Internal Combustion Engines" , Third Edition, Tata Mcgraw-Hill, 2007.

OEC-13	ELECTRICAL MATERIALS	3	0	0	3

COURSE OBJECTIVE:

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system.

UNIT I   ELEMENTARY MATERIALS SCIENCE CONCEPTS

9

Bonding and types of solids, Crystalline state and their defects, Classical theory of electrical and thermal conduction

in solids, temperature dependence of resistivity, skin effect, Hall effect.

UNIT II   DIELECTRIC PROPERTIES OF INSULATORS IN STATIC AND ALTERNATING FIELD   9

Dielectric constant of mono-atomic gases, poly-atomic molecules and solids, Internal field in solids and liquids, Properties of Ferro-Electric materials, Polarization, Piezoelectricity, Frequency dependence of Electronic and Ionic Polarizability, Complex dielectric constant of non-dipolar solids, dielectric losses

UNIT III   MAGNETIC PROPERTIES AND SUPERCONDUCTIVITY   9

Magnetization of matter, Magnetic Material Classification, Ferromagnetic Origin, Curie-Weiss Law, Soft and Hard Magnetic Materials, Superconductivity and its origin, Zero resistance and Meissner Effect, critical current density.

UNIT IV   CONDUCTIVITY OF METALS   9

Ohm's law and relaxation time of electrons, collision time and mean free path, electron scattering and resistivity of metals.

UNIT V   SEMICONDUCTOR MATERIALS   9

Classification of semiconductors, semiconductor conductivity, temperature dependence, Carrier density and energy gap, Trends in materials used in Electrical Equipment.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the use of bonding and crystallinity in the concept of electrical materials.	K2
CO2	Make use of the dielectric properties of insulators in static and alternating fields in the related system.	K3
CO3	Apply the magnetic properties and superconductivity in the electrical system.	K3
CO4	Explain the behavior of conductivity of metals.	K5
CO5	Understand the facts of semiconductor materials by means of carrier density and band gap.	K2

TEXT BOOKS:

1. Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.

2. Electrical Properties of Materials, 8th Edition by Solymar, L, Oxford University PressNew Delhi.

REFERENCE BOOKS::

1. Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi.

2. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi.

OEC-14	MODERN MANUFACTURING PROCESSES	3	0	0	3

COURSE OBJECTIVE:

      To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications.

UNIT I   INTRODUCTION

      9

Need for non-traditional machining methods-Classification of modern machining processes – Considerations in process selection, Materials, Applications. Ultrasonic machining – Elements of the process, mechanics of metal removal process parameters, economic considerations, Applications and limitations, recent development.

UNIT II   MECHANICAL PROCESSES   9

Abrasive jet machining, Water jet machining and abrasive water jet machining Basic principles, equipments, process variables, mechanics of metal removal, MRR, application and limitations. Ultrasonic Machining, AJM, WJM and USM, Working Principles – equipment used – Process parameters – MRR-Variation in techniques used – Applications.

UNIT III ELECTRO – CHEMICAL PROCESSES   9

Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy economic aspects of ECM – Simple problems for estimation of metal removal rate. Fundamentals of chemical machining, advantages and applications.

UNIT IV   THERMAL METAL REMOVAL PROCESSES – I   9

General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

UNIT V   THERMAL METAL REMOVAL PROCESSES - II   9

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut. Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in

manufacturing industries. Chemical machining-principle maskants –etchants- applications. Magnetic abrasive finishing, Abrasive flow finishing.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the relevant process for the product manufacturing under certain condition	K2
CO2	Identify better mechanics of metal removal for various abrasive and water jet machining	K3
CO3	Identify the challenges and benefits in the electro chemical process.	K3
CO4	Analyze the development of metal removal process with help of electric discharge machining and Wire cut electric discharge machining.	K4
CO5	Classify the various types of thermal metal removal process.	K4

TEXT BOOKS:

1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2002

2. Benedict. G.F., "Nontraditional Manufacturing Processes" Marcel Dekker Inc., New York, 1987.

REFERENCE BOOKS::

1. Pandey P.C. and Shan H.S. "Modern Machining Processes", Tata McGraw-Hill, New Delhi. 1980

2. McGeough, "Advanced Methods of Machining", Chapman and Hall, London, 1998

OEC-15	INTERNET OF THINGS	3	0	0	3

COURSE OBJECTIVE:

1. To learn about the basics of IoT and its application sectors. To Understand M2M and IoT. To Understand and become proficient in IoT platforms.
2. To Understand and apply IoT protocols appropriately.
3. To Design and develop IoT based applications

UNIT I   INTRODUCTION AND CONCEPTS OF IOT

9

Introduction to IOT, definition and characteristics of IOT - Architecture of Internet of Things, Physical and logical design of IOT, IOT enabling technologies, IOT levels and deployment templates-Domain specific IOTs, home automation, cities, environment, Domain specific IOTs, Energy, retail, agriculture, industry, health and lifestyle

UNIT II   IOT AND M2M COMMUNICATION   9

M2M, difference between IOT and M2M, ETSI M2M Architecture, system architecture -ETSI M2M SCL resource structure, Security in ETSI M2M framework, SDN and NFV for IOT, IOT system management, need for IOT system management -SNMP, Network operator requirements, NETCONF-YANG, IOT system management with NETCONF-YANG, IoT Design methodology-case study on IOT system for Weather Monitoring

UNIT III   IoT PLATFORMS   9

Introduction to Hardware used for IoT: Microcontrollers, Microprocessors, SoC, Sensors -Introduction to Arduino, Pi, Spark, Intel Galileo

UNIT   IoT TECHNICAL STANDARDS AND PROTOCOLS   9
IV

RF Protocols: RFID, NFC;IEEE 802.15.4: ZigBee, Z-WAVE, THREAD; Bluetooth Low Energy (BLE), IPv6 for Low Power and Lossy Networks (6LoWPAN) and Routing Protocol for Low power and lossy networks (RPL) -CoAP ,XMPP, Web Socket, AMQP, MQTT, WebRTC, PuSH -Architectural Considerations in Smart Object Networking

UNIT V   DEVELOPING INTERNET OF THINGS   9

IoT platforms design methodology, IoT Physical devices and endpoints -IoT Systems: Logical design using Python, IoT physical servers and cloud offerings (Cloud computing for IoT)

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the necessities, development and Importance of IoT.	K2
CO2	Determine the Market perspective of IoT.	K5
CO3	Evaluate the relevant communication protocol in IoT	K5
CO4	Compare and make use of Devices, Gateways and Data Management in IoT	K4
CO5	Model state of the art architecture in IoT	K3

TEXT BOOKS:

1. Vijay Madisetti, "Internet of Things, A Hands -on Approach", 1st Edition 2015, University Press, ISBN: 978-81-7371- 954-7

2. Oliver Hersent, David Boswarthick, Omar Elloumy, "The Internet of Things",1st Edition ,2015,ISBN: 978-81-265-5686-1

REFERENCE BOOKS::

1. Michael Miller, "The Internet of Things, How Smart TVs, Smart Cars, Smart Homes, and Smart Cities are changing the World", First edition ,2015, Pearson , ISBN:978-93-325-524

OEC-16	**BIG DATA ANALYSIS**	3	0	0	3

COURSE OBJECTIVE:

The main goal of this course is to help students learn, understand, and practice big data analytics and machine learning approaches, which include the study of modern computing big data technologies and scaling up machine learning techniques focusing on industry applications.

UNIT I   INTRODUCTION TO BIG DATA

9

Introduction to Big Data Platform – Challenges of conventional systems - Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting - Modern data analytic tools, Statistical concepts: Sampling distributions, resampling, statistical inference, prediction error.

UNIT II   DATA ANALYSIS   9

Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics - Rule induction - Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods.

UNIT III   MINING DATA STREAMS   9

Introduction to Streams Concepts – Stream data model and architecture - Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window – Real time Analytics Platform(RTAP) applications - case studies - real time sentiment analysis, stock market predictions.

UNIT IV   FREQUENT ITEMSETS AND CLUSTERING   9

Mining Frequent item sets - Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent item sets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern based clustering methods – Clustering in non-euclidean space – Clustering for streams and Parallelism.

UNIT V   FRAMEWORKS AND VISUALIZATION   9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed file systems – Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications:

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the challenges and application of big data management.	K2
CO2	Identify the characteristics of datasets and compare the trivial data and big data for various applications	K3
CO3	Solve problems associated with batch learning and online learning, and the big data characteristics.	K3
CO4	Analyze the datasets and the utilization of the clustering.	K4
CO5	Analyze and control the big data analytics by the tools like MapReduce, Hadoop and NoSQL	K4

TEXT BOOKS:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasheets,Cambridge University Press, 2012.

REFERENCE BOOKS:

1. Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analytics, John Wiley & sons,2012.
2. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O" Reilly, 2011.
3. Jiawei Han, MichelineKamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.

OEC-17	**COMMUNICATION ENGINEERING**	3	0	0	3

COURSE OBJECTIVE:

1. To introduce different methods of analog communication and their significance. To introduce Digital Communication methods for high bit rate transmission.

2. To introduce the concepts of source and line coding techniques for enhancing rating of transmission of minimizing the errors in transmission.

3. To introduce MAC used in communication systems for enhancing the number of users. To introduce various media for digital communication.

UNIT I   FUNDAMENTALS OF ANALOG COMMUNICATION

9

Principles of amplitude modulation, AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM Voltage distribution, AM power distribution, Angle modulation - FM and PM waveforms, phase deviation and modulation index, frequency deviation and percent modulation, Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves.

UNIT II   DIGITAL COMMUNICATION   **9**

Introduction, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK bit rate and baud, FSK transmitter, BW consideration of FSK, FSK receiver, phase shift keying – binary phase shift keying – carrier recovery – squaring loop, Costas loop, DPSK.

UNIT III   SOURCE CODES, LINE CODES & ERROR CONTROL   **9**

Primary communication – entropy, properties, BSC, BEC, source coding: Shaum, Fao, Huffman coding: noiseless coding theorem, BW – SNR trade off codes: NRZ, RZ, AMI, HDBP, ABQ, MBnB codes: Efficiency of transmissions, error control codes and applications: convolutions & block codes.

UNIT IV   MULTIPLE ACCESS TECHNIQUES   **9**

SS&MA techniques: FDMA, TDMA, CDMA, SDMA application in wire and wireless communication: Advantages (merits).

UNIT V   SATELLITE, OPTICAL FIBER   **9**

Orbits: types of satellites: frequency used link establishment, MA techniques used in satellite communication, earth station; aperture actuators used in satellite – Intelsat and Insat: fibers – types: sources, detectors used, digital filters, optical link.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Ability to comprehend and interpret the significance and role of analog communication	K2,K3
CO2	Ability to comprehend and interpret the significance and role of digital communication	K2,K3
CO3	Analyze Source and Error control coding methods	K4
CO4	Categorize the various Multiple Access Techniques	K4
CO5	Understand and analyze about satellites. Also explain the use of fiber optic cables in communication system	K2,K4

TEXT BOOKS:

1. Wayne Tomasi, "Advanced Electronic Communication Systems", 5/e, Pearson Education, 2007.

2. Haykin, "Digital Communications", John Wiley, 2006.

REFERENCE BOOKS::

1. Kennedy and Davis "Electronic communication systems" Tata McGraw hill, 4th edition, 1993.Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O" Reilly, 2011.

2. Sklar "Digital communication fundamentals and applications" Pearson Education, 2001

3. Baryle, Memuschmidt, digital Communication, Kluwer Publication, 2004.

4. B.P.Lathi "Modern digital and analog communication systems" Oxford University Press, 1998.

5. Dennis Roddy "Satellite Communications" Tata McGraw hill, 4th edition, 2009.

OEC-18	PRINCIPLES OF MANAGEMENT & PROFESSIONAL ETHICS	3	0	0	3

COURSE OBJECTIVE:

To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.

UNIT I   OVERVIEW OF MANAGEMENT

9

Definition - Management - Role of managers - Evolution of Management thought – Organization and the environmental factors – Trends and Challenges of Management in Global Scenario.

UNIT II   PLANNING & ORGANIZING   9

Nature and purpose of planning and Organizing - Planning process - Types of plans – Managing by objective (MBO) Strategies - Types of strategies - Policies - Decision Making - Types of decision - Decision Making Process - Rational Decision Making Process - Decision Making under different conditions. - Organization structure - Formal and informal groups I organization - Line and Staff authority - Departmentation - Span of control - Centralization and Decentralization - Delegation of authority - Staffing - Selection and Recruitment - Orientation - Career Development - Career stages – Training - Performance Appraisal.

UNIT III   DIRECTING & CONTROLLING   9

Creativity and Innovation - Motivation and Satisfaction - Motivation Theories - Leadership Styles - Leadership theories - Communication - Barriers to effective communication – Organization Culture - Elements and types of culture - Managing cultural diversity. Process of controlling - Types of control - Budgetary and non-budgetary control techniques - Managing Productivity - Cost Control - Purchase Control - Maintenance Control - Quality Control - Planning operations.

UNIT IV   ENGINEERING ETHICS & HUMAN VALUES   9

Definition - Societies for engineers – Code of Ethics – Ethical Issues involved in cross border research - Ethical and Unethical practices – case studies – situational decision making - Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination – Global issues - Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand and explain the management roles and skills and evolution of the management.	K2
CO2	Analyze the planning and organizing system of the management.	K4
CO3	Understand the directing and controlling system of the management	K2
CO4	Develop engineering ethics in society and improve human values	K3
CO5	Understand the safety responsibilities, apply ethics in society and discuss the ethical issues related to engineering	K2,K3

TEXT BOOKS:

1. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition.
2. Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS::

1. Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.
2. Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management - A global & Entrepreneurial Perspective', Tata Mcgraw Hill, 12th edition, 2007.
3. Andrew J. Dubrin, 'Essentials of Management', Thomson Southwestern, 7th edition, 2007.
4. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
5. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003

OEC-19	**TOTAL QUALITY MANAGEMENT**	3	0	0	3

COURSE OBJECTIVE:

To facilitate the understanding of Quality Management principles and process

UNIT I   INTRODUCTION

9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT II   TQM PRINCIPLES   **9**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal 106 - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III   TQM TOOLS AND TECHNIQUES I   **9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT III   TQM TOOLS AND TECHNIQUES II   **9**

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V   QUALITY SYSTEMS   **9**

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Compare the contributions made by Deming, Juran and Crosby to implement TQM concept	K4
CO2	Conclude the role of the management and leadership in an organization.	K5
CO3	Classify various quality improvement tools and techniques to improve the quality of a product.	K4
CO4	Value the importance of six sigma concepts and TPM concepts for the growth of an organization.	K5
CO5	Explain the need for ISO 9--1-2--8 and ISO 14--- Quality System in an organization	K5

TEXT BOOKS:

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint,2006.

REFERENCE BOOKS::

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First IndianEdition, Cengage Learning, 2012.

2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd.,2006.Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004

OEC-20	**DIGITAL SIGNAL PROCESSING**	3	0	0	3

COURSE OBJECTIVE:

1. To impart knowledge on the discrete time systems and their mathematical representation. To study about the discrete time systems and to learn about FFT algorithms.

2. To study the design techniques for FIR and IIR digital filters. To study the finite word length effects in signal processing.

UNIT I   DISCRETE-TIME SIGNALS AND SYSTEMS   9

Discrete time signals and systems- Sequences-Representation of signals -Representation of discrete systems using difference equations- Sampling and reconstruction of signals –aliasing- Sampling theorem and Nyquist rate- z transform-Region of Convergence- Analysis of Linear Time Invariant systems using z transform- Properties of z transform for causal signals- Inverse z transforms.

UNIT II   DISCRETE FOURIER TRANSFORM   9

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, FFT computations using Decimation in time and Decimation in frequency algorithms, Parseval's Identity, Overlap-add and save methods.

UNIT III   INFINITE IMPULSE RESPONSE DIGITAL FILTERS   9

Review of design of analogue Butterworth and Chebyshev Filters-Frequency transformation in analogue domain -Design of IIR digital filters using impulse invariance technique - Design of digital filters using bilinear transform – pre warping – Approximations of derivatives –Low pass, Band pass, Band stop and High pass filters.

UNIT IV   FINITE IMPULSE RESPONSE DIGITAL FILTERS   9

Linear phase FIR filters -Design of FIR Digital filters: Window method, Frequency Sampling method. Effect of finite register length in filter design - Fixed point and floating point number representations – Comparison – Truncation and Rounding errors - Quantization noise- Overflow error- Round off noise power.

UNIT V   APPLICATIONS OF DIGITAL SIGNAL PROCESSING   9

Introduction to multirate signal processing- Upsampling, downsampling - Correlation Functions and Power Spectra, Stationary Processes- Optimal fil   tering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Identify the various discrete-time signals. Classify the different types of discrete time signals and systems	K3
CO2	Evaluate Z-transform for various discrete-time signals. Estimate the linear and circular convolutions for discrete-time sequences.	K5
CO3	Solve DFT and FFT problems. Compare DFT and FFT techniques to compute Discrete Fourier Transform	K3
CO4	Compare the IIR filter design using impulse invariant technique and bilinear transformation technique for a given signal	K4
CO5	Explain the finite word-length effects in DSP systems and also Compare the FIR filter design using window techniques	K2

TEXT BOOKS:

1. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson, Fourth Edition, 2007.
2. Salivahanan, S., A. Vallavaraj, C. Gnanapriya, Digital Signal Processing, TMH/McGraw Hill International, 2007.

REFERENCE BOOKS:

1. Oppenheim, Alan V., Schafer, Ronald W. "Discrete-Time Signal Processing" Prentice-Hall, 1989.
2. Ifeachor,E.C.and B.W. Jervis, " Digital signal processing – A practical approach", Second edition, Pearson,

   2002.

3. Mitra,S.K.,"Digital Signal Processing, A Computer Based approach, Tata McGraw Hill, 1998.
4. Johny R. Johnson,"Introduction to Digital Signal Processing", PHI, 2006

OEC-21	**FUNDAMENTALS OF NANOSCIENCE**	3	0	0	3

COURSE OBJECTIVE:

To learn about basis of nanomaterial science, preparation method, types and application.

UNIT I   INTRODUCTION

9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II   SENSORS AND ACTUATORS-I   9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT III   SENSORS AND ACTUATORS-II   9

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT III   MICROMACHINING

9

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process. 97

UNIT V   POLYMER AND OPTICAL MEMS   9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the synthesis of nano materials, their application and the impact of nano materials on environment	K2
CO2	Create analytical design and development solutions for sensors and actuators	K4,K6
CO3	Understanding of thermocouples, piezoelectric and pyro-electric transducers and their applications	K2
CO4	Analyze the different micro machining processes such as EDM, ECM, LBM, etc.	K4
CO5	Substitute metals with conducting polymers and determine cheaper biodegradable polymers to reduce environmental pollution.	K5

TEXT BOOKS:

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.

2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.

3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.

REFERENCE BOOKS::

1. NadimMaluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.

2. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2001.

3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.

4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005. 5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.

OEC-22	MICRO ELECTRO MECHANICAL SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

1. To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices, To educate on the rudiments of Micro fabrication techniques.

2. To introduce various sensors and actuators ,To introduce different materials used for MEMS& To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT I   INTRODUCTION

9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II   SENSORS AND ACTUATORS-I   **9**

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT III   NANOMATERIALS   **9**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides- ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclaysfunctionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV   CHARACTERIZATION TECHNIQUES   **9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V   APPLICATIONS   **9**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems

(NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Understand the concept of micro fabrication and the process involved in it.	K2
CO2	Understand the working of mechanical actuators.	K2
CO3	Understand about the piezo electric sensors and actuators.	K2
CO4	Analyze the process of etching.	K4
CO5	Understand the different types of polymers.	K2

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.

2. N John Dinardo, "NanoscaleCharecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCE BOOKS::

1. G Timp, "Nanotechnology", AIP press/Springer, 1999.

2. AkhleshLakhtakia,"The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

OEC-23	ADVANCEDDIGITAL SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVE:

1. To bring out the concepts related to stationary and non-stationary random signals. To emphasize the importance of true estimation of power spectral density.
2. To introduce the design of linear and adaptive systems for filtering and linear prediction.
3. To introduce the concept of wavelet transforms in the context of image processing.

UNIT I   DISCRETE-TIME RANDOM SIGNALS

9

Discrete random process – Ensemble averages, Stationary and ergodic processes, Autocorrelation and Autocovariance properties and matrices, White noise, Power Spectral Density, Spectral Factorization, Innovations Representation and Process, Filtering random processes, ARMA, AR and MA processes.

UNIT II   SPECTRUM ESTIMATION   9

Bias and Consistency, Periodogram, Modified periodogram, Blackman-Tukey method, Welch method, Parametric methods of spectral estimation, Levinson-Durbin recursion.

UNIT III   LINEAR ESTIMATION AND PREDICTION   9

Forward and Backward linear prediction, Filtering - FIR Wiener filter- Filtering and linear prediction, non-causal and causal IIR Wiener filters, Discrete Kalman filter.

UNIT III   ADAPTIVE FILTERS   9

Principles of adaptive filter – FIR adaptive filter – Newton's Steepest descent algorithm – LMS algorithm – Adaptive noise cancellation, Adaptive equalizer, Adaptive echo cancellers.

UNIT V   WAVELET TRANSFORM   9

Multiresolution analysis, Continuous and discrete wavelet transform, Short Time Fourier Transform, Application of wavelet transform, Cepstrum and Homomorphic filtering.

TOTAL: 45 h

COURSE OUTCOMES:

At the end of this course the students will be able to

CO1	Describe discrete random process and its properties	K2
CO2	Describe the statistical properties of the conventional spectral estimators	K2
CO3	Select linear filtering techniques to engineering problems and develop the filter	K3
CO4	Describe adoptive filter algorithm and LMS algorithm	K2
CO5	Describe the continuous and discrete wavelet transform and apply the wavelet transform to various applications	K2

TEXT BOOKS:

1. Monson H, Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, Indian Reprint, 2007.

2. John G.Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson, Fourth, 2007.

3. Dwight F. Mix, "Random Signal Processing", Prentice Hall, 1995.

REFERENCE BOOKS::

1. Sophocles J. Orfanidis, "Optimum Signal Processing, An Introduction", McGraw Hill, 1990.

OEC-24	ROBOTICS AND AUTOMATION	3	0	0	3

COURSE OBJECTIVES:

1. To study the various parts of robots and fields of robotics, To study the various kinematics and inverse kinematics of robots.

2. To study the Euler, Lagrangian formulation of Robot dynamics.

3. To study the trajectory planning for robot & To study the control of robots for some specific applications.

UNIT I   BASIC CONCEPTS   9

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots.

UNIT II   POWER SOURCES AND SENSORS   9

Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.

UNIT III   MANIPULATORS, ACTUATORS AND GRIPPERS   9

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

UNIT IV   KINEMATICS AND PATH PLANNING   9

Solution of inverse kinematics problem – multiple solution jacobian work envelop – hill climbing techniques – robot programming languages

UNIT V   CASE STUDIES   9

Mutiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Explain the fundamentals of robotics and its components	K5
CO2	Illustrate the Kinematics and Dynamics of robotics	K2
CO3	Elaborate the need and implementation of related Instrumentation & control in robotics	K6
CO4	Illustrate the movement of robotic joints with computers/microcontrollers.	K2
CO5	Explain sensors and instrumentation in robotics	K5

TEXT BOOKS

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 1996.

2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

REFERENCE BOOKS::

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 1992.

2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.

3. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – – An integrated approach, Prentice Hall of India, New Delhi, 1994.

4. McKerrow P.J. Introduction to Robotics, Addison Wesley, USA, 1991. 5. Issac Asimov I Robot, Ballantine Books, New York, 1986

OEC-25	DIGITAL SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVE:

To Design and evaluate the control and data structures for digital systems and to study basic building blocks of both combinational and sequential circuits .

UNIT I   INTRODUCTION TO VHDL   9

Introduction to VHDL, design units, data objects, signal drivers, inertial and transport delays, delta delay, VHDL data types, concurrent and sequential statements.

UNIT II   SUBPROGRAMS   9

Subprograms – Functions, Procedures, attributes, generio, generate, package, IEEE standard logic library, file I/O, test bench, component declaration, instantiation, configuration.

UNIT III   DESIGN OF COMBINATIONAL LOGIC CIRCUIT   9

Combinational logic circuit design and VHDL implementation of following circuits – first adder, Subtractor, decoder, encoder, multiplexer, ALU, barrel shifter, 4X4 key board encoder, multiplier, divider, Hamming code encoder and correction circuits.

UNIT IV   SYNCHRONOUS   SEQUENTIAL CIRCUITS DESIGN   9

Synchronous sequential circuits design – finite state machines, Mealy and Moore, state assignments, design and VHDL implementation of FSMs, Linear feedback shift register (Pseudorandom and CRC)

UNIT V   ASYNCHRONOUS SEQUENTIAL CIRCUITS DESIGN   9

Asynchronous sequential circuit design – primitive flow table, concept of race, critical race and hazards, design issues like metastability, synchronizers, clock skew and timing considerations

TOTAL: 45h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Classify the Discrete time signals and systems	K4
CO2	Apply Z transforms to discrete systems and analyze their stability	K3
CO3	Determine DFT using both DIT and DIF-FFT algorithm	K5
CO4	Design Linear digital filters both FIR and IIR using different techniques and their associated structures	K6
CO5	Understand and explain the architecture details and instruction sets of fixed and floating point DSP	K2

TEXT BOOKS

1. Morris Mano, M. 'Digital Design', Pearson Education, 2006.
2. John M.Yarbrough, 'Digital Logic, Application & Design', Thomson, 2002.

REFERENCE BOOKS::

1. JohnF.Wakerly, 'Digital Design Principles and Practice', 3rd edition, Pearson Education, 2002.
2. Tocci, "Digital Systems : Principles and aopplications, 8th Edition" Pearson Education.

OEC-26	APPLIED SOFT COMPUTING	3	0	0	3

COURSE OBJECTIVES:

1. To expose the students to the concepts of feed forward neural networks.,To provide adequate knowledge about feedback neural networks ,To provide adequate knowledge about fuzzy and neuro-fuuzy systems.

2. To provide comprehensive knowledge of fuzzy logic control to real time systems&To provide adequate knowledge of genetic algorithms and its application to economic dispatch and unit commitment problems.

UNIT I   ARCHITECTURES – ANN   9

Introduction – Biological neuron – Artificial neuron – Neuron model – Supervised and unsupervised learning- Single layer – Multi layer feed forward network – Learning algorithm- Back propagation network.

UNIT II   NEURAL NETWORKS FOR CONTROL   9

Feedback networks – Discrete time Hopfield networks – Transient response of continuous time system – Applications of artificial neural network - Process identification – Neuro controller for inverted pendulum.

UNIT III   FUZZY SYSTEMS   9

Classical sets – Fuzzy sets – Fuzzy relations – Fuzzification – Defuzzification – Fuzzy rules - Membership function – Knowledge base – Decision-making logic – Introduction to neuro fuzzy system- Adaptive fuzzy system.

UNIT IV   APPLICATION OF FUZZY LOGIC SYSTEMS   9

Fuzzy logic control: Home heating system - liquid level control - aircraft landing- inverted pendulum – fuzzy PID control, Fuzzy based motor control.

UNIT V   GENETIC ALGORITHMS   9

Introduction-Gradient Search – Non-gradient search – Genetic Algorithms: binary and real representation schemes, selection methods, crossover and mutation operators for binary and real coding - constraint handling methods – applications to economic dispatch and unit commitment problems.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand and study the overview of artificial neural network and training algorithms.	K2
CO2	Analyze problems to formulate models and develop control schemes using Neuro controller	K4
CO3	Design fuzzy controller for non-linear systems	K6
CO4	Apply soft computing techniques for electrical engineering problems	K3
CO5	Formulate the process and steps in developing a genetic algorithm	K6

TEXT BOOKS:

1. LauranceFausett, Englewood cliffs, N.J., 'Fundamentals of Neural Networks',Pearson Education, 1992.

2. Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 1997.

3. S.N.Sivanandam and S.N.Deepa, Principles of Soft computing, Wiley India Edition, 2nd Edition, 2013.

REFERENCE BOOKS::

1. Simon Haykin, 'Neural Networks', Pearson Education, 2003.

2. John Yen & Reza Langari, 'Fuzzy Logic – Intelligence Control & Information', Pearson Education, New Delhi, 2003.

3. M.Gen and R,Cheng, Genetic algorithms and Optimization, Wiley Series in Engineering Design and Automation, 2000.

4. Hagan, Demuth, Beale, " Neural Network Design", Cengage Learning, 2012.

5. N.P.Padhy, " Artificial Intelligence and Intelligent Systems", Oxford, 2013.

6. William S.Levine, "Control System Advanced Methods," The Control Handbook CRC Press, 2011.

OEC-27	MICROCONTROLLER BASED SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES:

1. To introduce the architecture of PIC microcontroller , To educate on use of interrupts and timers , To educate on the peripheral devices for data communication and transfer.

2. To introduce the functional blocks of ARM processor & To educate on the architecture of ARM processors

UNIT I   INTRODUCTION TO PIC MICROCONTROLLER   9

Introduction to PIC Microcontroller–PIC 16C6x and PIC16C7x Architecture–PIC16cxx–- Pipelining - Program Memory considerations – Register File Structure - Instruction Set - Addressing modes – Simple Operations.

UNIT II   INTERRUPTS AND TIMER   9

PIC micro controller Interrupts- External Interrupts-Interrupt Programming–Loop time subroutine - Timers-Timer Programming– Front panel I/O-Soft Keys– State machines and key switches– Display of Constant and Variable strings.

UNIT III   PERIPHERALS AND INTERFACING   9

I2C Bus for Peripherals Chip Access– Bus operation-Bus subroutines– Serial EEPROM—Analog to 98 Digital Converter–UART-Baud rate selection–Data handling circuit–Initialization - LCD and keyboard Interfacing -ADC, DAC, and Sensor Interfacing.

UNIT IV   INTRODUCTION TO ARM PROCESSOR   9

ARM Architecture –ARM programmer's model –ARM Development tools- Memory Hierarchy –ARM Assembly Language Programming–Simple Examples–Architectural Support for Operating systems.

UNIT V   ARM ORGANIZATION   9

3-Stage Pipeline ARM Organization– 5-Stage Pipeline ARM Organization–ARM Instruction Execution-ARM Implementation– ARM Instruction Set– ARM coprocessor interface– Architectural support for High Level Languages – Embedded ARM Applications.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Able to Understand the concepts of architecture PIC Microcontroller	K2
CO2	Able to analyze Interrupts and Timers.	K4
CO3	Able to examine the concepts of Peripherals and Interfacing for communicating the data	K4
CO4	Able to understand the concepts of ARM Processor	K2
CO5	Able to apply the knowledge of ARM processors in ARM organization and ARM applications.	K3

TEXT BOOKS:

1. Peatman,J.B., "Design with PIC Micro Controllers"PearsonEducation,3rdEdition, 2004.
2. Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000.

REFERENCE BOOKS::

1. Mazidi, M.A.,"PIC Microcontroller" Rollin Mckinlay, Danny causey Printice Hall of India, 2007.

OEC-28	NEURAL NETWORKS AND FUZZY SYSTEMS	3	0	0	3

COURSE OBJECTIVE:

To cater the knowledge of Neural Networks and Fuzzy Logic Control and use these for controlling real time systems.

UNIT I   ARTIFICIAL NEURAL NETWORKS   9

Introduction to Artificial Neural Networks-Fundamental concepts, weights, biases and thresholds-Artificial models-Linear capability-Common activation functions-Learning rules and Learning methods of ANN-Single Layer, Multilayer Feed forward networkRecurrent network.

UNIT II   NEURAL NETWORK ARCHITECTURES AND ALGORITHMS   9

Mcculloh Pitts neuron-Hebbnet-Perceptron-Adaline-Hopfield net-Maxnet-Mexican HatHamming net-Kohonen self-organizing map-Adaptive resonance theory-Back propagation neural net.

UNIT III   NEURAL COMPUTING   9

Terminology-Adaptive co-efficient connection-Learning law-processing elementscheduling function-Transfer function-Transformations-Weights-Application of neural computing for pattern classification and recognition.

UNIT IV   FUZZY THEORY   9

Fuzzy set theory- Fuzzy relations-Linguistic variables-Membership functions-fuzzy to crisp conversions-fuzzy rule base-choice of variables-derivation of rules-Defuzzification methods-Fuzzy logc control-Structure of FLC-Mamdani and sugeno Fuzzy systems.

UNIT V   NEURO FUZZY CONTROL   9

Cognitron and Neocognitron Architecture-Training Algorithm and application-Fuzzy associative memories-fuzzy and neural function estimators-FAM system Architecture-Comparison of Fuzzy and Neural systems-Adaptive neuro, Adaptive Fuzzy, Adaptive Neuro-Fuzzy interface systems-Neuro Controller, Fuzzy logic Controller for a temperature process and aircraft landing problem.

TOTAL: 45 h

COURSE OUTCOME:

At the end of this course the students will be able to

CO1	Understand Fuzzy Logic, Various fuzzy systems and their functions	K2
CO2	Know the various optimization techniques understanding of architechtures and algorithms	K3
CO3	Evaluate the Application of neural computing	K5
CO4	Able to understand and apply fuzzy systems	K2
CO5	Evaluate the fuzzy and neuro controllers	K5

TEXT BOOKS

1. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.
2. George J.Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall, First Edition, 1995.

REFERENCE BOOKS::

1. LawreneFausset, "Fundamentals of neural networks", Prentice Hall, 1994.
2. D.Drainkov, H.Hellendoorn arrow, M.Reinfrank, "An Introduction to Fuzzy control", Narosa publishing Co., New Delhi, 1996.
3. Timothy J.Ross, "Fuzzy logic with Engineering Applications", McGraw Hill, Newyork, 1996.
4. S.N. Sivanandam, S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., New Delhi, 2007.

OEC-29	PLC AND DISTRIBUTED CONTROL SYSTEM	3	0	0	3

COURSE OBJECTIVES:

1. To give an introductory knowledge about PLC and the programming languages. To give adequate knowledge about of application of PLC.
2. To give basic knowledge in the architecture and local control unit of distributed control system.
3. To give adequate information in the interfaces used in DCS.To give basic knowledge about Computer Controlled Systems

UNIT I   PLC **9**

Evolution of PLCs — Sequential and programmable controllers — Architecture GE Fanuc- ABB- Siemens Higher end — Programming of PLC — relay logic — Ladder logic — Functionalblocks programming.

UNIT II   COMMUNICATION IN PLCS **9**

Requirement of communication networks for PLC — connecting PLC to computer — Use ofEmbedded PC as PLC — comparative study of Industrial PLCs - PLC application in IndustrialAutomation.

UNIT III   DISTRIBUTED CONTROL SYSTEMS **9**

Evolution — Different architectures — Local control unit — Operator interface — Display's —Engineering interface. Case study - DCS - Study of two popular DCS available in market —Factors to be considered in selecting DCS.

UNIT IV   HART AND FIELD BUS **9**

Introduction — Evolution of signal standard — HART Communication protocol — Communication modes — HART networks — HART commands — HART field controller implementation — HART and OSI model — Field bus — Introduction profibus, Mod bus – Foundation field bus — General field bus architecture — basic requirements of field bus standard — Field bus topology — Interoperability CAN & LIN bus .

UNIT V   AS – INTERFACE (AS-i), DEVICENET AND INDUSTRIAL ETHERNET **9**

AS interface- Introduction, Physical layer, Data link layer and Operating characteristics. Devicenet:- Introduction, Physical layer, Data link layer and Application layer. Industrial Ethernet:- Introduction, 10Mbps Ethernet and 100Mbps Ethernet - Introduction to OLE for process control (OPC).

TOTAL: 45 h

COURSE OUTCOME:

CO1	Understand the architecture and the ladder logic diagram of PLC	K2
CO2	Develop PLC programme for industrial application.	K3
CO3	Choose the Distributed control system according to the application requirement	K3
CO4	Analyse the protocols and architecture of HART and field bus.	K4
CO5	Design various interfaces to digital control system.	K6

TEXT BOOKS

1. John.W. Webb, Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 2003.
2. B.G. Liptak, "Instrument Engineers Hand, Process control and Optimization", CRC press- Radnor, Pennsylvania,2006.
3. M.Chidambaram, "Computer Control of Process," Narosa Publishing, New Delhi, 2003

REFERENCE BOOKS:

1. A.S.Tanenbaum, Computer Networks, Third Edition, Prentice Hall of India, 1996.
2. Michael P.Lucas, Distributed Control System, Van Nastrand Reinhold Company, New York,1986.
3. Romilly Bowden, HART application Guide, HART Communication Foundation, 1999.
4. G.K.Mc-Millan, Process/Industrial Instrument and controls and handbook, McGraw Hill, New York, 1999.
5. Petrezeulla, Programmable Controllers, Mc-Graw Hill, 1989.
6. Hughes T, Programmable Logic Controllers, ISA Press, 1989.
7. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004.
8. Berge, J., "Field Buses for Process Control: Engineering, Operation, and Maintenance" , ISA Press, 2004.

OEC-30	OBJECT ORIENTED PROGRAMMING	3	0	0	3

COURSE OBJECTIVES:

1. To introduce the concepts related to Object Oriented Programming.
2. To have a deep knowledge in understanding the concepts of Classes and Objects.
3. To have few case studies related to the concepts of Object Oriented Programming

UNIT I   INTRODUCTION   **9**

Procedure- Oriented Programming System - Object-Oriented Programming System - Comparison of C++ with C - Object-Oriented Terms and Concepts - Object-Oriented Languages - Differences between Procedural and Object-Oriented Programming - Merits and Demerits of Object-Oriented Methodology. Structure of a C++ Program– Data Types - Operators in C++ - Control Structures - Functions in C++.

UNIT II   CLASSES AND OBJECTS   **9**

Introduction to Classes and objects - Member Functions and Member Data - Objects and Functions - Objects and Arrays - Name Spaces - Nested Classes - Dynamic Memory Allocation and Deallocation - Constructors and Destructors.

UNIT III   INHERITANCE AND POLYMORPHISM   **9**

Introduction - Base Class and Derived Class Pointers - Function Overriding - Base Class Initialization - Protected Access Specifier - Deriving by Different Accessing specifiers - Different Kinds of Inheritance - Order of Invocation of Constructors and Destructors - Virtual Functions - Mechanism of Virtual Functions - Pure Virtual Functions - Virtual Destructors and Constructors

UNIT IV   OPERATOR OVERLOADING AND TEMPLATES   **9**

Operator Overloading - Overloading of various Operators - Type Conversion - New Style Casts and the typed Operator - Function Templates - Class Templates - The Standard Template Library (STL).

UNIT V   EXCEPTION HANDLING AND CASE STUDIES   **9**

Introduction - C-Style Handling of Error-generating Code - C++-Style Solution - the try/ throw/ catch Construct - Limitations of Exception Handling. Case Studies: String Manipulations - Building classes for matrix operations

TOTAL: 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	List and use Object Oriented Programming concepts for problem solving.	K3
CO2	Examine the classes and objects and describe the dynamic memory allocation functions.	K4
CO3	Analyze the concepts of access specifier and the behavior of inheritance.	K4
CO4	Design of overloading operators and templates	K6
CO5	Construct programs for complex problems with error handling	K3

TEXT BOOKS:

1. Balagurusamy E. ,"Object Oriented Programming with C++",3rd Edition, Tata McGraw Hill, 2007

2. Paul Deitel and Harvey Deitel, "C++ How to Program", 9th Edition, Pearson Education Limited, 2014.

3. SouravSahay, "Object Oriented Programming with C++", Oxford University Press, 2006.

REFERENCES:

1. Joyce Farrell, "Object Oriented Programming using C++", Cengage Learning, 2001.

OEC-31	ELECTRIC VEHICLE MECHANICS AND CONTROL	3	0	0	3

COURSE OBJECTIVES:

1. To provide knowledge of the operation and dynamics of electrical vehicles
2. To impart knowledge on vehicle control for standard drive cycles of electrical vehicles (EVs)
3. To estimate the energy requirement of EVs and Hybrid Electric Vehicles (HEVs)
4. To provide knowledge about different energy sources and energy management in HEVs
5. To provide knowledge of supervisory control of EVs

UNIT I   ELECTRIC VEHICLE ARCHITECTURE   9

History of evolution of Electric Vehicles - Series parallel architecture of Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes

UNIT II   MECHANICS OF ELECTRIC VEHICLES   9

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of EV's - motor torque and power rating and battery capacity.

UNIT III   CONTROL OF DC AND AC MOTOR DRIVES   9

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives.

UNIT IV   ENERGY STORAGE SYSTEMS   9

Battery: Principle of operation, types, models, SOC of battery, Traction Batteries and their capacity for standard drive cycles. **Alternate sources:** Fuel cells, Ultra capacitors, Fly wheels.

UNIT V   HYBRID VEHICLE CONTROL STRATEGY   9

HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode.

TOTAL: 45 h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Understand the architecture and dynamics of EVs and HEVs	K2
CO2	Acquire the knowledge of EV for standard drive cycle	K3
CO3	Understand the electrical motors' characteristics and its application for vehicle dynamics	K2
CO4	Estimate the energy requirements and energy sources for EV application	K5
CO5	Acquire the knowledgeof operation and control Strategy for Hybrid Vehicle	K3

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Electric Vehicles", CRC Press, 2011.

2. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017.

REFERENCES
1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Second Edition 2012.

2. Christopher D Rahn, Chao-Yang Wang, "Battery Systems Engineering", Wiley, 2013.

Syllabus

MANDATORY COURSES

MC-01	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3

COURSE OBJECTIVE

1. To inculcate the importance of environmental pollution, preservation of nature and environmental management for human welfare.

2. To understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non – governmental organization in environmental managements.

UNIT I   ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY   9

Definition – Scope and importance – Need for public awareness – Concepts of an Ecosystem – Structure and Function of an Ecosystem –Producers, Consumers and Decomposers – Energy Flow in the Ecosystem – Ecological Succession – Food Chains, Food Webs and Ecological Pyramids – Introduction, Types, Characteristic Features, Structure and Function of the (A) Forest Ecosystem (B) Grassland Ecosystem (C) Desert Ecosystem (D) Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers, Oceans, Estuaries) – Introduction to Biodiversity – Definition: Genetic, Species and Ecosystem Diversity – Biogeographical Classification of India – Value of Biodiversity: Consumptive Use, Productive Use, Social, Ethical, Aesthetic and Option Values – Biodiversity at Global, National and Local Levels – India as a Mega-Diversity Nation – Hot-Spots of Biodiversity – Threats to Biodiversity: Habitat Loss, Poaching of Wildlife, Man-Wildlife Conflicts – endangered and Endemic Species of India – Conservation of Biodiversity: In-Situ and Ex-Situ conservation of Biodiversity. Field Study of Common Plants, Insects and Birds. Field study of simple ecosystems - pond, river, hill slopes, etc.

UNIT II   ENVIRONMENTAL POLLUTION   9

Definition – Causes, Effects and Control Measures of (A) Air Pollution (B) Water Pollution (C) Soil Pollution (D) Marine Pollution (E) Noise Pollution (F) Thermal Pollution (G) Nuclear Hazards – Solid Waste Management:- Causes, Effects and Control Measures of municipal solid Wastes – Role of an Individual in Prevention of Pollution – Pollution Case Studies – disaster Management - Floods, Earthquake, Cyclone and Landslides.Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III   NATURAL RESOURCES   9

Forest resources -Use and over – Exploitation – Deforestation – Case studies – Timber extraction – Mining – Dams and their ground water – Floods – Drought – Conflicts over water –Dams – Benefits and Problems – Mineral Resources- Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies – Food Resources: World Food Problems, Changes caused by

Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer- Pesticide Problems, Water Logging, salinity, Case Studies – Energy Resources:- Growing Energy Needs, Renewable and Non Renewable Energy Sources, Use of Alternate Energy Sources, Case Studies – Land Resources - Land as a Resource, Land Degradation, Man Induced Landslides, Soil Erosion and Desertification – Role of an Individual in Conservation of Natural Resources – Equitable use of Resources for Sustainable Lifestyles.Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV   SOCIAL ISSUES AND THE ENVIRONMENT   9

From Unsustainable To Sustainable Development – Urban Problems Related to energy – Water conservation, Rain Water Harvesting, Watershed Management – Resettlement and Rehabilitation of People, its Problems and Concerns, Case Studies Role of non – governmental organization - Environmental Ethics- Issues and Possible Solutions – Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies –Wasteland Reclamation – Consumerism and Waste Products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and Control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act –enforcement machinery involved in environmental Legislation – Central and state pollution control boards - Public Awareness.

UNIT V   HUMAN POPULATION AND THE ENVIRONMENT   9

Population Growth, Variation among Nations – Population Explosion Family Welfare Programme – environment and Human Health – Human Rights –Value   Education – HIV /AIDS – Women and Child Welfare – Role of Information Technology in Environment and Human Health – Case Studies.

 Total: 45 hrs

COURSE OUTCOME:

At the end of this course the students will be able to,

CO1	Understand the concept of ecosystem, biodiversity, constitutes the environment and the precious resources available and how to conserve natural resources and the relationship between living and non living things and ethics	K2
CO2	Analyze the different types of pollution and their causes, effect and control measures and the role of a human being in maintaining a clean environment exposure.	K4
CO3	Analyze the uses of available natural resources and the effect of over exploitation and deforestation, equitable use of resources for sustainable development and role of individual for conservation of resources.	K4
CO4	Create awareness; understand the role of non-governmental organization for sustainable development and their importance, effects and the different laws for environmental protection.	K6
CO5	Create awareness about human population in worldwide and their causes effect and role of information technology on control measures for sustainable	K6

Text Books

1. De AK, Environmental Chemistry, Wiley Eastern Ltd. Bharucha Erach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, India.
2. Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480pgs.
3. Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).

Reference Books

1. Agarwal KC, 2001. Environmental Biology, Nidi Publishers Ltd. Bikaner.
2. Gleick HP, 1993. Water in Crisis, Pacific Institute for Studies in Development, Environment and Security. Stockholm Environmental Institute, Oxford University Press, 473pgs.
3. Heywood VH, and Watson RT, 1995. global Biodiversity Assessment. Cambridge University Press 1140pgs.
4. Jadhav H and Bhosale VM, 1995. Environmental Protection and Laws. Himalaya Publishing House, Delhi 284pgs.
5. Mckinney ML and Schoch RM, 1996. Environmental Science Systems and Solutions. Web enhanced edition, 639pgs.
6. Miller TG, Jr. Environmental Science, Wadsworth Publishing CO.

MC-02	National Service Scheme	2 0 0 2

COURSE OBJECTIVE:

1. To understand the community in which they work.
2. To understand themselves in relation to their community.
3. To identify the needs and problems of the community and involve them in problem solving process.

Unit I   Introduction and Basic Concepts of NSS   3

History, Philosophy, aims & objectives of NSS,Emblem, flag, motto, song, badge etc.Organizational structure, roles and responsibilities of various NSS functionaries

Unit II   NSS Programmes and Activities   9

Concept of regular activities, special camping, Day Camps. Basis of adoption of village/slums, Methodology of conducting survey, Financial pattern of the scheme, Other youth prog./schemes of GOI,Coordination with

different agencies. Maintenance of the Diary

Unit III   Understanding Youth   4

Definition, profile of youth, categories of youth,Issues, challenges and opportunities for youth.Youth as an agent of social change

Unit IV   Community Mobilisation   8

Mapping of community stakeholders. Designing the message in the context of the problem and the culture of the community, Identifying methods of mobilization, Youth-adult partnership   .

Unit V   Volunteerism and Shramdan   6

Indian Tradition of volunteerism,Needs and importance of Volunteerism,Motivation and Constraints of Volunteerism Shramdan as a part of volunteerism

TOTAL :30h

COURSE OUTCOME:

At the end of the course the students will be able to

CO1	Understand and learn the objectives of NSS	K2
CO2	Propose NSS programmes and activities	K6
CO3	Develop civic & social responsibility as youth	K5
CO4	Identify the needs and problem of the community an involve them in problem solving	K3
CO5	Develop the attitude of volunteering and know the importance of volunteerism in social activities	K6

SI	SUMMER INTERNSHIP	0	0	2	1

Minimum of two weeks in an Industry in the area of Electrical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report

Course Outcome:

At the end of the course the students will be able to

CO1	Understand the social, cultural, global and environmental responsibility as an engineer.	K2
CO2	Capability to acquire and apply fundamental principles of engineering.	K3
CO3	Ability to identify, formulate and model problems and find engineering solution based on a systems approach.	K3,K6
CO4	Adapt with all the latest changes in technological world.	K6
CO5	Ability to develop communication efficiently.	K3

PROJ 01	PROJECT PHASE I	0	0	10	5

The object of Project Work I is to enable the student to take up investigative study in the broad field of Electri cal &Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;

2. Working out a preliminary Approach to the Problem relating to the assigned topic;

3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;

4. Preparing a Written Report on the Study conducted for presentation to the Department;

5. Final Seminar, as oral Presentation before a departmental committee.

Course Outcome:

At the end of the course the students will be able to

CO1	Identify a topic in advanced field of Electrical and Electronics Engineering.	K3
CO2	Understand and Study the problems in selected field through literature survey and reviews.	K2
CO3	Able to analyze the existing methodology and identify ways to develop solution for proposed methodology	K3,K4
CO4	Able to design engineering solution for the problem identified in proposed methodology	K6
CO5	Able to demonstrate the prototype, communicate effectively and present the work as team to achieve the goal.	K2,K5

PROJ 02	PROJECT PHASE II	0	0	16	8

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under Project phase I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under phase 1;

2. Review and finalization of the Approach to the Problem relating to the assigned topic;

3. Preparing an Action Plan for conducting the investigation, including team work;

4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;

5. Final development of product/process, testing, results, conclusions and future directions;

6. Preparing a paper for Conference presentation/Publication in Journals, if possible;

7. Preparing a Dissertation in the standard format for being evaluated by the Department.

8. Final Seminar Presentation before a Departmental Committee.

Course Outcome:

At the end of the course the students will be able to

CO1	Identify a topic in advanced field of Electrical and Electronics Engineering.	K3
CO2	Understand and Study the problems in selected field through literature survey and reviews.	K2
CO3	Able to analyze the existing methodology and identify ways to develop solution for proposed methodology	K3,K4
CO4	Able to design engineering solution for the problem identified in proposed methodology	K6
CO5	Able to demonstrate the prototype, communicate effectively and present the work as team to achieve the goal.	K2,K5