JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
JALPAIGURI- 735102
(An Autonomous Government College)

COURSE STRUCTURE AND SYLLABUS
FOR
B.TECH. IN ELECTRICAL ENGINEERING
(Implemented from the Academic Year 2021-22 for the new batch only)

www.jgec.ac.in
Phone: 03561 – 255131 (Principal), Fax: 03561 – 256143
255465 (EPABX)- 105(EE)

CC	SC	Subject Name	Contact Hrs. /Week		CC	SC	Subject name	Contact Hrs. /Week	
			L –T-P-TO	Cr.				L –T-P-TO	Cr.
First Semester					***Second Semester***				
BSC	BS-PH101	Physics	3-1-0-4	4	BSC	BS-CH201	Chemistry	3-1-0-4	4
BSC	BS-M101B	Mathematics-1B	3-1-0-4	4	BSC	BS-M201B	Mathematics-IIB	3-1-0-4	4
ESC	ES-CS101	Programming for Problem Solving	3-0-0-3	3	ESC	ES-EE201	Basic Electrical Engineering	3-1-0-4	4
BSC	BS-PH191	Physics Laboratory	0-0-3-3	1.5	HUM	HM-HU201	English	2-0-0-2	2
ESC	ES-CS191	Programming for Problem Solving Laboratory	0-0-4-4	2	BSC	BS-CH291	Chemistry Laboratory	0-0-3-3	1.5
ESC	ES-ME191	Workshop/Manufacturing Practice	1-0-4-5	3	ESC	ES-EE291	Basic Electrical Engineering Laboratory	0-0-2-2	1
Mandatory Induction Program- 3 weeks duration. It is to be done before initiation of classes (theoretical, laboratory & sessional) as per syllabus following guidelines of AICTE and MAKAUT					ESC	ES-ME291	Engineering Graphics & Design	1-0-4-5	3
					HUM	HM-HU291	Language Laboratory	0-0-2-2	1
			10-2-11-23	17.5				12-3-11-26	20.5
Third Semester					***Fourth Semester***				
BSC	BS-M(EE) 301	Mathematics – III	3-1-0-4	4	HUM	HM-HU(EE) 401	Value & Ethics in Profession	2-0-0-2	2
BSC	BS-CH(EE) 301	Biology	2-0-0-2	2	ESC	ES-ME(EE) 401	Thermal Power Engineering	3-0-0-3	3
ESC	ES-ME(EE) 301	Engineering Mechanics	3-0-0-3	3	ESC	ES-PH(EE) 401	Electromagnetic Fields	3-0-0-3	3
PCC	PC-EE301	Analog Electronic Circuits	3-0-0-3	3	PCC	PC-EE401	Digital Electronic Circuits	3-0-0-3	3
PCC	PC-EE302	Electrical Machines-I	3-0-0-3	3	PCC	PC-EE402	Electrical Machines-II	3-1-0-4	4
PCC	PC-EE303	Electrical Circuit Analysis	3-0-0-3	3	PCC	PC-EE403	Power Electronics	3-0-0-3	3
PCC	PC-EE391	Electrical Engineering-I Laboratory (Laboratories on Analog Electronics, Electrical Machines, Electrical Circuits)	0-0-6-6	3	PCC	PC-EE491	Electrical Engineering-II Laboratory(Laboratories on Digital Electronics, Electrical Machines, Power Electronics)	0-0-6-6	3
MC	MC-HU(EE) 301	Environmental Science	3-0-0-3	0	MC	MC-HU(EE) 401	Essence of Traditional Knowledge	3-0-0-3	0
			20-1-6-27	21				20-1-6-27	21
Fifth Semester					Sixth Semester				
HUM	HM-HU(EE) 501	Principles of Management	2-0-0-2	2	PCC	PC-EE601	Electric Drives	3-0-0-3	3
PCC	PC-EE501	Signal & Systems	3-1-0-4	4	PCC	PC-EE602	Power System-II	3-0-0-3	3
PCC	PC-EE502	Power System-I	3-0-0-3	3	PCC	PC-EE603	Electrical & Electronic Measurements	3-0-0-3	3
PCC	PC-EE503	Control System	3-0-0-3	3	PEC	PE-EE601	**Professional Elective-II :** a. Electrical Energy Conservation & Auditing b. Industrial Electric System c. HVDC Transmission System d. Renewable & No-conventional Energy	3-0-0-3	3
PCC	PC-EE504	Microprocessors & Microcontrollers	3-0-0-3	3	PEC	PE-EE-602	**Professional Elective-III :** a. Control System Design b. Electrical Machine Design c. Digital Signal Processing d. Power Plant Engineering	3-0-0-3	3
PEC	PE-EE501	**Professional Elective-I:** a. Power Quality & FACTS b. High Voltage Engineering c. Illumination Engineering. d. Advanced Power Electronics	3-0-0-3	3	OEC	OE-CS (EE)601	**Open Elective-1 :** a. Computer Architecture b. Data Structure & Algorithm c. Computer Organization d. Computer Networks e. AI & Soft Computing. f. Data Base Management System g. Software Engineering	3-0-0-3	3
PCC	PC-EE591	Electrical Engineering-III Laboratory(Laboratories on Power System, Control System, Microprocessor)	0-0-6-6	3	PCC	PC-EE691	Electrical Engineering-IV Laboratory (Laboratories on Electric Drives, Power System, Measurement & Instrumentation)	0-0-6-6	1
MC	MC-HU(EE) 501	Constitution of India	3-0-0-3	0					

			20-1-6 -27	21					18-0-6 -24	21
CC	SC	Subject Name	Contact Hrs. /Week			SC	Subject name	Contact Hrs. /Week	CC	SC
			L –T-P-TO	Cr.						
Seventh Semester						Eight Semester				
HUM	HM-HU(EE) 701	Financial Management and Accounts	3-0-0-3	3		PEC	PE-EE801	**Professional Elective-VI**: a. Power System Dynamics & Control b. Process Control c. Power Generation & Economics . d. Utilization of Electric Power	3-0-0-3	3
PEC	**PE-EE701**	**Professional Elective-IV:** a. Wind & Solar Energy System b. Line-Commutated and Active PWM Rectifiers c. Electric & Hybrid Vehicles d. Electrical Engineering Materials e. FACTS & HVDC	3-0-0-3	3		OEC	OE-EC (EE)801	**Open Elective-IV :** a. VLSI & Microelectronics b. Biomedical Electronics c. Embedded System d. Wavelet Transform e. Satellite Communication and Remote Sensing	3-0-0-3	3
PEC	PE-EE702	**Professional Elective-V:** a. Power System Protection b. Digital Control System c. Advanced Electrical Drives d. Sensors & Transducers e. Power Plant Instrumentation & Control	3-0-0-3	3		OEC	OE-CS (EE)802	**Open Elective-V:** a. Internet to Things b. Big Data Analysis c. Data Warehousing & Data Mining d. Digital Image Processing e. Computer Graphics & Visualization f. Object Oriented Programming	3-0-0-3	3
OEC	OE-EC (EE)701	Open Elective-II a. Computational Electromagnetics b. Electronic Devices c. Electromagnetic Waves d. Analog & Digital Communication e. Digital System Design	3-0-0-3	3		Proj	PR-EE881	Project-II	0-0-12-12	6
OEC	OE-ME (EE)702	**Open Elective-III:** a. Automobile Engineering b. Strength of Materials c. Automation in Manufacturing d. Mechatronic Systems e. Manufacturing Processes f. Total Quality Management g. Fluid Mechanics & Fluid Machines. h. Thermal & Fluid Engineering i. Manufacturing Technology	3-0-0-3	3		Proj	PR-EE882	Viva-Voce	-----	2
PCC	PC-EE781	Electrical and Electronic Design Sessional.	0-0-4-4	2		Proj	PR-EE-883	Internship Evaluation	0-0-0-0	0
Proj	PR-EE782	Project-I	0-0-8-8	4						
			15-0-12 -27	21					9-0-12 -21	17

Total Credits: 160

Mandatory Induction Program: 3 weeks duration: Physical activity, Creative Arts, Universal Human Values, Literary, Proficiency Modules, Lectures by Eminent People, Visits to local Areas, Familiarization to Dept./Branch & Innovations

First Semester

BS-PH101:Physics: 3-1-0 -4: 4

Course Objectives:

1. The course aims at making students to understand the basic concepts of Principles of Physics in a broader sense with a view to lay foundation for the various engineering courses.
2. Students will be able to demonstrate competency and understanding of the concepts found in Mechanics, Harmonic Oscillations, Waves in one dimension, wave Optics, Lasers, Fiber Optics and a broad base of knowledge in physics.
3. The main purpose of this course is to equip engineering undergraduates with an understanding of the scientific method, so that they may use the training beneficially in their higher pursuits.
4. Today the need is to stress principles rather than specific procedures, to select areas of contemporary interest rather than of past interest, and to condition the student to the atmosphere of change he will encounter during his career.

1. Mechanics (7L):
Problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Potential energy function F = -grad V, equipotential surfaces and meaning of gradient. Conservative and non-conservative forces. Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonic oscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D.Angular velocity vector. Moment of inertia.

2. Optics (5L):
Distinction between interference and diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits (only the expressions for max;min, & intensity and qualitative discussion of fringes); diffraction grating(resolution formulae only), characteristics of diffraction grating and its applications. Polarisation : Introduction, polarisation by reflection, polarisation by double reflection, scattering of light, circular and elliptical polarisation, optical activity.
Lasers : Principles and working of laser : population inversion, pumping, various modes, threshold population inversion with examples .

3. Electromagnetism and Dielectric Magnetic Properties of Materials (8L):
permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossottiequation(expression only), applications of dielectrics.
Magnetisation , permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

4. Quantum Mechanics (16 L):
Introduction to quantum physics, black body radiation, explanation using the photon concept, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

5. Statistical Mechanics: (8L)
Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Diracand Bose-Einstein statistics.

Learning Resources:

1.Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley
3. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
4. Engineering Mechanics (In SI Units) (SIE), S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati , McGraw Hill
5. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education
6. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education

7. Engineering Mechanics, M.K. Harbola ,Cengage India
8. An Introduction to Mechanics (SIE), David Kleppner, Robert Kolenkow, McGraw Hill Education
9. Principles of mechanics, John L. Synge and Byron A. Griffith, New York, McGraw-Hill
10. Mechanics (Dover Books on Physics) , J. P. Den Hartog , Dover Publications Inc.
11. Engineering Mechanics: Dynamics, L.G. Kraige J.L. Meriam, Wiley
12. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley
13. Introduction to Quantum Mechanics, J. Griffiths David , Pearson Education
14. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press
15. Optics , Hecht, Pearson Education
16. Optics, Ghatak, McGraw Hill Education India Private Limited
17. Fundamentals of Statistical and Thermal Physics, Reif, Sarat Book Distributors
18. Statistical Mechanics ,Pathria , Elsevier
19. Statistical Physics, L.D.Landau , E.M. Lifshitz, Butterworth-Heinemanntics.

Course Outcomes:

1. The knowledge of Physics relevant to engineering is critical for converting ideas into technology.
2. An understanding of Physics also helps engineers understand the working and limitations of existing devices and techniques, which eventually leads to new innovations and improvements.
3. In the present course, the students can gain knowledge on the mechanism of physical bodies upon the action of forces on them, the generation, transmission and the detection of the waves, Optical Phenomena like Interference, diffraction, the principles of lasers and Fibre Optics.
4. Various chapters establish a strong foundation on the different kinds of characters of several materials and pave a way for them to use in at various technical and engineering applications.

BS-M101B: Mathematics-IB: 3-1-0-4:4

The objective of this course:

Familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims 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.

1. ***Calculus (Integration):*** Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.8
2. ***Calculus (Differentiation):*** Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.6
3. ***Sequence and Series:*** Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.11
4. ***Multivariate Calculus:*** Limit, continuity and partial derivatives, Directional derivatives, Total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, Curl and Divergence.9
5. ***Matrices:*** Inverse and rank of a matrix, Rank-nullity theorem; System of linear equations; Symmetric, Skew-symmetric and Orthogonal matrices; Determinants; Eigenvalues and Eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Learning Resources:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
2. Michael Greenberg, Advanced Engineering Mathematics, Pearson.

3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
4. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.

Course Outcomes:

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims 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.

The students will learn:

1. To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. The tool of power series and Fourier series for learning advanced Engineering Mathematics.
4. To deal with functions of several variables that are essential in most branches of engineering.
5. The essential tool of matrices and linear algebra in a comprehensive manner.

ES-CS101: Programming for Problem Solving: 3-0-0-3:3

Unit 1: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - (1 lecture).
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. (1 lecture)
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code- (2 lectures)
Unit 2: Arithmetic expressions and precedence (2 lectures)
Conditional Branching and Loops (6 lectures)
Writing and evaluation of conditionals and consequent branching (3 lectures)
Iteration and loops (3 lectures)
Unit 3: Arrays (6 lectures):
Arrays (1-D, 2-D), Character arrays and Strings
Unit 4: Basic Algorithms (6 lectures):
Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)
Unit 5: Function (5 lectures):
Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference
Unit 6: Recursion (4 -5 lectures)
Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.
Unit 7: Structure (4 lectures)
Structures, Defining structures and Array of Structures
Unit 8: Pointers (2 lectures)
Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)
Unit 9: File handling (only if time is available, otherwise should be done as part of the lab)
Suggested Text Books
(i) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
(ii) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Suggested Reference Books
(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, PrenticeHall of India

Course Outcomes:
The student will learn:

1. To formulate simple algorithms for arithmetic and logical problems.
2. To translate the algorithms to programs (in C language).
3. To test and execute the programs and correct syntax and logical errors.
4. To implement conditional branching, iteration and recursion.
5. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
6. To use arrays, pointers and structures to formulate algorithms and programs.
7. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
8. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

BS-PH191 Physics Laboratory.: 0-0-3-3:1.5

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

Experiments in Optics:
1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton's ring
3. Determination of wavelength of a monochromatic light by Fresnel's bi-prism
4. Determination of wavelength of the given laser source by diffraction method

Electricity & Magnetism experiments
1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.
5. To study current voltage characteristics, load response, areal characteristic and spectral response of a PV solar cell.
6. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
7. Determination of unknown resistance using Carey Foster's bridge
8. Study of Transient Response in LR, RC and LCR circuits using expeyes
9. Generating sound from electrical energy using expeyes

Experiments in Quantum Physics.
1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a PV solar cell.

Miscellaneous experiments.
1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure

2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5.To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseulle's capillary flow method

Course Outcomes: On Completion of this course, students are able to –
• Develop skills to impart practical knowledge in real time solution.
• Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
• Design new instruments with practical knowledge.
• Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.
• Understand measurement technology, usage of new instruments and real time applications in engineering studies.

ES-CS191: Programming for Problem Solving Laboratory: 0-0-4-4:2

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:
Lab 7: Simple functions
Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures
Tutorial 12: File handling:
Lab 12: File operations

Laboratory Outcomes:

1. To formulate the algorithms for simple problems
2. To translate given algorithms to a working and correct program
3. To be able to correct syntax errors as reported by the compilers
4. To be able to identify and correct logical errors encountered at run time
5. To be able to write iterative as well as recursive programs
6. To be able to represent data in arrays, strings and structures and manipulate them through a program
7. To be able to declare pointers of different types and use them in defining self referential structures.

To be able to create, read and write to and from simple text files.

ES-ME191: Workshop/ Manufacturing Practices 1-0-4-5:3 :

(i) Lectures & videos:

Detailed contents:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical &Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

Course Outcomes:

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

(ii) Workshop Practice:

Machine shop (8 hours) *Typical jobs that may be made in this practice module:*

- To make a pin from a mild steel rod in a lathe.
- To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

Fitting shop (8 hours)*Typical jobs that may be made in this practice module:*

- To make a Gauge from MS plate.

Carpentry (8 hours)*Typical jobs that may be made in this practice module:*

- To make wooden joints and/or a pattern or like.

Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs))*Typical jobs that may be made in this practice module:*

- ARC WELDING (4 hours): To join two thick (approx 6mm) MS plates by manual metal arc welding.
- GAS WELDING (4 hours): To join two thin mild steel plates or sheets by gas welding.

Casting (8 hours)*Typical jobs that may be made in this practice module:*

- One/ two green sand moulds to prepare, and a casting be demonstrated.

Smithy (4 hours): *Typical jobs that may be made in this practice module:*

- A simple job of making a square rod from a round bar or like

Plastic moulding& Glass cutting (4 hours) *Typical jobs that may be made in this practice module:*

- For plastic moulding, making at least one simple plastic component should be made.
- For glass cutting, three rectangular glass pieces may be cut to make a kaleidoscope using a black colour diamond cutter, or similar other components may be made.

Electrical & Electronics (8 hours)

Familiarization with LT switchgear elements, making its sketches and noting down its specification. Kitkat fuse, Glass cartridge fuse, Plastic fuse holders (optional), Iron clad isolators, MCB style isolators, Single phase MCB, Single-phase wire, wiring cable.

Demonstration of domestic wiring involving two MCB, two piano key switches, one incandescent lamp, one LED lamp and plug point. Simple wiring exercise to be executed to understand the basic electrical circuit.

Simple soldering exercises to be executed to understand the basic process of soldering.

Fabrication of a single-phase full wave rectifier with a step down transformer using four diodes and electrolytic capacitor and to find its volt-ampere characteristics to understand basic electronic circuit fabrication.

Learning Resources:

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 McGrawHill House, 2017.

Laboratory Outcomes:

1. Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
2. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
3. By assembling different components, they will be able to produce small devices of their interest

MAN: Induction Program: No Credit: 3 weeks entry program

A Guide:

1. Introduction

(Induction Program was discussed and approved for all colleges by AICTE in March 2017. It was discussed and accepted by the Council of IITs for all IITs in August 2016. It was originally proposed by a Committee of IIT Directors and accepted at the meeting of all IIT Directors in March 2016.1 This guide has been prepared based on the Report of the Committee of IIT Directors and the experience gained through its pilot implementation in July 2016 as accepted by the Council of IITs. Purpose of this document is to help institutions in understanding the spirit of the accepted Induction Program and implementing it.). Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his study. However, he must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he would understand and fulfill his responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed. There is a mad rush for engineering today, without the student determining for himself his interests and his goals. This is a major factor in the current state of demotivation towards studies that exists among UG students. The success of gaining admission into a desired institution but failure in getting the desired branch, with peer pressure generating its own problems, leads to a peer environment that is demotivating and corrosive. Start of hostel life without close parental supervision at the same time, further worsens it with also a poor daily routine. To come out of this situation, a multi-pronged approach is needed. One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them 1A Committee of IIT Directors was setup in the 152nd Meeting of IIT Directors on 6th September 2015 at IIT Patna, on how to motivate undergraduate students at IITs towards studies, and to develop verbal ability. The Committee submitted its report on 19th January 2016. It was considered at the 153rd Meeting of all IIT Directors at IIT Mandi on 26 March 2016, and the accepted report came out on 31 March 2016. The Induction Program was an important recommendation, and its pilot was implemented by three IITs, namely, IIT(BHU), IIT Mandi and IIT Patna in July 2016. At the 50th meeting of the Council of IITs on 23 August 2016, recommendation on the Induction Program and the report of its pilot implementation were discussed and the program was accepted for all IITs.
work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character.

2. Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days. We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between

faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature. The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it. The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

****Induction Program as described here borrows from three programs running earlier at different institutions:** (1) Foundation Program running at IIT Gandhinagar since July 2011, (2) Human Values course running at IIIT Hyderabad since July 2005, and (3) Counseling Service or mentorship running at several IITs for many decades. Contribution of each one is described next.

(1) IIT Gandhinagar was the first IIT to recognize and implement a special 5-week Foundation Program for the incoming 1st year UG students. It took a bold step that the normal classes would start only after the five week period. It involved activities such as games, art, etc., and also science and other creative workshops and lectures by resource persons from outside.

(2) IIIT Hyderabad was the first one to implement a compulsory course on Human Values. Under it, classes were held by faculty through discussions in small groups of students, rather than in lecture mode. Moreover, faculty from all departments got involved in conducting the group discussions under the course. The content is non-sectarian, and the mode is dialogical rather than sermonizing or lecturing. Faculty were trained beforehand, to conduct these discussions and to guide students on issues of life.

(3) Counseling at some of the IITs involves setting up mentor-mentee network under which 1st year students would be divided into small groups, each assigned a senior student as a student guide, and a faculty member as a mentor. Thus, a new student gets connected to a faculty member as well as a senior student, to whom he/she could go to in case of any difficulty whether psychological, financial, academic, or otherwise.

The Induction Program defined here amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building physical activity, creativity, bonding, and character. It develops sensitivity towards self and one's relationships, builds awareness about others and society beyond the individual, and also in bonding with their own batch-mates and a senior student besides a faculty member. Scaling up the above amalgamation to an intake batch of 1000 plus students was done at IIT(BHU), Varanasi starting from July 2016.

2.1 Physical Activity

This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop team work. Each student should pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity wherelabour yields fruits from nature.

2.2 Creative Arts

Every student would chose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, now into engineering design later.

2.3 Universal Human Values

It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting sta_ in the hostel and department, be sensitive to others, etc. Need for character building has been underlined earlier. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values. The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute. Experiments in this direction at IIT(BHU) are noteworthy and one can learn from them. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It is to open thinking towards the self. Universal Human Values discussions could even continue for rest of the semester as a normal course, and not stop with the induction program. Besides drawing the attention of the student to larger issues of life, it would build relationships between teachers and students which last for their entire 4-year stay and possibly beyond. The Universal Human Values Course is a result of a long series of experiments at educational institutes starting from IIT-

Delhi and IIT Kanpur in the 1980s and 1990s as an elective course, NIT Raipur in late 1990s as a compulsory one-week o_ campus program. The courses at IIT(BHU) which started from July 2014, are taken and developed from two compulsory courses at IIIT Hyderabad first introduced in July 2005.

2.4 Literary

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

2.5 Proficiency Modules

This period can be used to overcome some critical lacunas that students might have, for example, English, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. We hope that problems arising due to lack of English skills, wherein students start lagging behind or failing in several subjects, for no fault of theirs, would, hopefully, become a thing of the past.

2.6 Lectures by Eminent People

This period can be utilized for lectures by eminent people, say, once a week. It would give the students exposure to people who are socially active or in public life.

2.7 Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

2.8 Familiarization to Dept./Branch & Innovations

The students should be told about different method of study compared to coaching that is needed at IITs. They should be told about what getting into a branch or department
means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

3 Schedule

The activities during the Induction Program would have an Initial Phase, a Regular Phase and a Closing Phase. The Initial and Closing Phases would be two days each.

3.1 Initial Phase

Time Activity Day 0
Whole day Students arrive - Hostel allotment. (Preferably do pre-allotment)

Day 1
09:00 am - 03:00 pm Academic registration
04:30 pm - 06:00 pm Orientation

Day 2
09:00 am - 10:00 am Diagnostic test (for English etc.)
10:15 am - 12:25 pm Visit to respective depts.
12:30 pm - 01:55 pm Lunch
02:00 pm - 02:55 pm Director's address
03:00 pm - 05:00 pm Interaction with parents
03:30 pm - 05:00 pm Mentor-mentee groups - Introduction within group. (Same as Universal Human Values groups)

3.2 Regular Phase

After two days is the start of the Regular Phase of induction. With this phase there would be regular program to be followed every day.

3.2.1 Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We _rst show a typical daily timetable. Session. Time Activity Remarks

Day 3 onwards

06:00 am Wake up call
I 06:30 am - 07:10 am Physical activity (mild exercise/yoga), 07:15 am - 08:55 am Bath, Breakfast, etc.

II 09:00 am - 10:55 am Creative Arts / Universal Human Values, Half the groups do Creative Arts
III 11:00 am - 12:55 pm Universal Human Values / Creative Arts, Complementary alternate
01:00 pm - 02:25 pm Lunch
IV 02:30 pm - 03:55 pm Afternoon Session See below.
V 04:00 pm - 05:00 pm Afternoon Session See below.
05:00 pm - 05:25 pm Break / light tea
VI 05:30 pm - 06:45 pm Games / Special Lectures
06:50 pm - 08:25 pm Rest and Dinner
VII 08:30 pm - 09:25 pm Informal interactions (in hostels)
Sundays are off. Saturdays have the same schedule as above or have outings.

3.2.2 Afternoon Activities (Non-Daily)

The following five activities are scheduled at different times of the Induction Program, and are not held daily for everyone:

1. Familiarization to Dept./Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Here is the approximate activity schedule for the afternoons (may be changed to suit local needs):
Activity Session Remarks
Familiarization with Dept/Branch & Innovations
IV For 3 days (Day 3 to 5)
Visits to Local Area IV, V and VI
For 3 days - interspersed (e.g., 3 Saturdays)
Lectures by Eminent People
IV As scheduled - 3-5 lectures
Literary (Play / Book Reading / Lecture)
IV For 3-5 days
Proficiency Modules V Daily, but only for those who need it

3.3 Closing Phase

Time Activity
Last But One Day
08:30 am - 12 noon Discussions and finalization of presentation within each group
02:00 am - 05:00 pm Presentation by each group in front of 4 other groups besides their own (about 100 students)

Last Day

Whole day Examinations (if any).May be expanded to last 2 days, in case needed.

3.4 Follow Up after Closure

A question comes up as to what would be the follow up program after the formal 3-week Induction Program is over? The groups which are formed should function as mentor-mentee network. A student should feel free to approach his faculty mentor or the student
guide, when facing any kind of problem, whether academic or financial or psychological etc. (For every 10 undergraduate first year students, there would be a senior student as a student guide, and for every 20 students, there would be a faculty mentor.) Such a group
should remain for the entire 4-5 year duration of the stay of the student. Therefore, it would be good to have groups with the students as well as teachers from the same department/discipline. Here we list some important suggestions which have come up and which have been experimented with.

3.4.1 Follow Up after Closure { Same Semester It is suggested that the groups meet with their faculty mentors once a month, within the semester after the 3-week Induction Program is over. This should be a scheduled meeting shown in the timetable. (The groups are of course free to meet together on their own more often, for the student groups to be invited to their faculty mentor's home for dinner
or tea, nature walk, etc.)

3.4.2 Follow Up { Subsequent Semesters

It is extremely important that continuity be maintained in subsequent semesters. It is suggested that at the start of the subsequent semesters (upto fourth semester), three days be set aside for three full days of activities related to follow up to Induction Program. The students be shown inspiring films, do collective art work, and group discussions be conducted. Subsequently, the groups should meet at least once a month.

Summary

Engineering institutions were set up to generate well trained manpower in engineering with a feeling of responsibility towards oneself, one's family, and society. The incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents. As a result, most students fail to link up with the goals of their own institution. The graduating student must have values as a human being, and knowledge and meta skills related to his/her profession as an engineer and as a citizen. Most students who get demotivated to study engineering or their branch, also lose interest in learning. The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character. The Universal Human Values component, which acts as an anchor, develops awareness and sensitivity, feeling of equality, compassion and oneness, draw attention to society and We are aware that there are advantages in mixing the students from different depts. However, in mixing, it is our experience that the continuity of the group together with the faculty mentor breaks down soon after. Therefore, the groups be from the same dept. but hostel wings have the mixed students from different depts. For example, the hostel room allotment should be in alphabetical order irrespective of dept. nature, and character to follow through. It also makes them react on their relationship with their families and extended family in the college (with hostel sta_ and others). It also connects students with each other and with teachers so that they can share any difficulty they might be facing and seek help.

References:

Motivating UG Students Towards Studies, Rajeev Sangal, IITBHU Varanasi, Gautam Biswas, IIT Guwahati, Timothy Gonsalves, IIT Mandi, Pushpak Bhattacharya, IIT Patna, (Committee of IIT Directors), March 2016, IIT Directors' Secretariat, IIT Delhi.

Second Semester

BS-CH201 : Chemistry: 3-1-0 -4: 4

i) Atomic and molecular structure (10 lectures):

Schrodinger equation. Particle in a box solutions and their applications for simple sample. Molecular orbitals of diatomic molecules (e.g.H2). Energy level diagrams of diatomic. 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. Band structure of solids and the role of doping on band structures.

ii) Spectroscopic techniques and applications (8 lectures):

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

iii) Intermolecular *forces and potential energy surfaces (4 lectures):*

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena.

iv) Use of free energy in chemical equilibria (8 lectures):

First and second laws of thermodynamics and 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. Use of free energy considerations in metallurgy through Ellingham diagrams.

v) Periodic properties (4 Lectures):

Effective nuclear charge, penetration of orbitals, 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:

vi) Stereochemistry *(4 lectures):*

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

vii) Organic *reactions and synthesis of a drug molecule (4 lectures)*

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

Learning Resources:

1. University chemistry, by B. H. Mahan.
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
5. Physical Chemistry, by P. W. Atkins.
6. Spectroscopy of Organic Compounds, by P.S.Kalsi, New Age International Pvt Ltd Publishers.
7. Physical Chemistry, P. C. Rakshit, Sarat Book House.
8. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition. http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Outcomes:

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

1. Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
2. Rationalise bulk properties and processes using thermodynamic considerations.

3. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
4. Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
5. List major chemical reactions that are used in the synthesis of molecules.

BS-M201B: Mathematics-IIB: 3-1-0-4:4

1. ***Multivariate Calculus (Integration):***Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to Polar), Applications: Areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes. 11
2. ***First order ordinary differential equations:*** Exact, linear and Bernoulli's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. 5
3. ***Ordinary differential equations of higher orders:*** Second order linear differential equations with constant coefficients, Use of D operators, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties. 9
4. ***Complex Variable – Differentiation:*** Differentiation of complex functions, Cauchy-Riemann equations, Analytic functions, Harmonic functions, determination of harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithmic) and their properties; Conformal mappings, Mobius transformations and their properties. 6
5. ***Complex Variable – Integration:*** Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem(without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour. 9

Learning Resources:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.2. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
4. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications.
7. J. W. Brown and R. V. Churchill, Complex Variables and Applications, Mc-Graw Hill.

Course Outcomes:

1. The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims 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.
   The students will learn:
2. To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
3. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
4. The tool of power series and Fourier series for learning advanced Engineering Mathematics.
5. To deal with functions of several variables that are essential in most branches of engineering.
6. The essential tool of matrices and linear algebra in a comprehensive manner.

7. The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables.
8. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.
9. The mathematical tools needed in evaluating multiple integrals and their usage.
10. The effective mathematical tools for the solutions of differential equations that model physical processes.
11. The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems
12. The objective of this course is to familiarize the prospective engineers with techniques in basic calculus and linear algebra. It aims 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.
13. To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from various applications, they will have a basic understanding of Beta and Gamma functions.
14. The essential tools of matrices and linear algebra including linear transformations, eigenvalues, diagonalization and orthogonalization.

ES-EE201: Basic Electrical Engineering: 3-1-0-4:4

Course Objective:

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

Module 1: DC Circuits (8 hours): Electrical circuit elements (R, L and C), voltage and current sources, Source transformation, Kirchoff current and voltage laws, Mesh and Nodal analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems, Maximum power transfer theorem,Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours): 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. Concept of three phase supply and phase sequence, Three phase balanced circuits their phasor diagrams, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours): Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours): Principle of operation of DC machines, constructional details, induced emf expression, typesof generators, and the relation between induced emf and terminal voltage, Principle of operation of DC motors, back emf and torque equations, types of motors, characteristics (shunt andseries only), and applications.

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters (6 hours): DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module 6: Electrical Installations (6 hours): Components of LT Switchgear: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits, ELCB, MCCB, Types of Wires and Cables, Earthing, Electric

Shock, Earthing and its types, Safety Precautions to avoid shock ,Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Learning Recourses:

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.

Course Outcomes:

1. To understand and analyses AC & DC circuits.
2. To understand the working principle and applications of DC & AC machines.
3. To study the working principles of electrical machines and power converters.
4. To introduce the components of low voltage electrical installations

HM-HU201: English : 2-0-0-2:2

1. Vocabulary Building
1.1 The concept of Word Formation
1.2 Root words from foreign languages and their use in English
1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.4 Synonyms, antonyms, and standard abbreviations.
2. Basic Writing Skills
2.1 Sentence Structures
2.2 Use of phrases and clauses in sentences
2.3 Importance of proper punctuation
2.4 Creating coherence
2.5 Organizing principles of paragraphs in documents
2.6 Techniques for writing precisely
3. Identifying Common Errors in Writing
3.1 Subject-verb agreement
3.2 Noun-pronoun agreement
3.3 Misplaced modifiers
3.4 Articles
3.5 Prepositions
3.6 Redundancies
3.7 Clichés
4. Nature and Style of sensible Writing
4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction and conclusion
5. Writing Practices
5.1 Comprehension
5.2 Précis Writing
5.3 Essay Writing
6. Oral Communication
(This unit involves interactive practice sessions in Language Lab)

6.1 Listening Comprehension
6.2 Pronunciation, Intonation, Stress and Rhythm
6.3 Common Everyday Situations: Conversations and Dialogues
6.4 Communication at Workplace
6.5 Interviews
6.6 Formal Presentations

Suggested Readings:
(i) *Practical English Usage.* Michael Swan. OUP. 1995.
(ii) *Remedial English Grammar.* F.T. Wood. Macmillan.2007
(iii)*On Writing Well.*William Zinsser. Harper Resource Book. 2001
(iv) *Study Writing.* Liz Hamp-Lyons and Ben Heasly.Cambridge University Press. 2006.
(v) *Communication Skills*. Sanjay Kumar and PushpLata.Oxford University Press. 2011.
(vi) *Exercises in Spoken English.* Parts.I-III. CIEFL, Hyderabad. Oxford University Press

Course Outcomes: At the end of the semester the student will be able to

- Understand doing self introspection and self vigilance
- Achieve high quality of life, strength and sovereignty of a developed nation
- Understand the importance of writing skills and its techniques
- Envision the dangers of scientific and technological innovations
- Improve the exposure to universal happenings
- Communicate the necessity to exercise humour in the daily life

BS-CH291: Chemistry Laboratory:0-0-3-3:1.5

Choose 10 experiments from the following:

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
3. Determination of dissolved oxygen present in a given water sample.
4. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)
5. Determination of surface tension and viscosity
6. Thin layer chromatography
7. Ion exchange column for removal of hardness of water
8. Determination of the rate constant of a reaction
9. Determination of cell constant and conductance of solutions
10. Potentiometry - determination of redox potentials and emfs
11. Saponification/acid value of an oil
12. Chemical analysis of a salt
13. Determination of the partition coefficient of a substance between two immiscible liquids
14. Adsorption of acetic acid by charcoal
15. Use of the capillary viscos meters 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 .

Laboratory Outcomes:

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:

1. Estimate rate constants of reactions from concentration of reactants/products as a function of time

2. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
3. Synthesize a small drug molecule and analyse a salt sample

ES-EE291: Basic Electrical Engineering Lab.:0-0-2-2:1

Choose 10 experiments from the following:

1. First activity: Introduction to basic safety precautions and mentioning of the do's and Don'ts. Noting down list of experiments to be performed, and instruction for writing the laboratory reports by the students. Group formation. Students are to be informed about the modalities of evaluation. 2. Introduction and uses of following instruments : (a) Voltmeter (b) Ammeter (c) Multimeter (d) Oscilloscope
2. Demonstration of real life resistors, capacitors with color code , inductors and autotransformer.
3. Demonstration of cut-out sections of machines: DC machine, Induction machine, Synchronous machine and single phase induction machine.
4. Calibration of ammeter and Wattmeter.
5. Determination of steady state and transient response of R-L, R-C and R-L-C circuit to a step change in voltage.
6. Determination of steady state response of R-L and R-C and R-L-C circuit and calculation of impedance and power factor.
7. Determination of resonance frequency and quality factor of series and parallel R-L-C circuit.
8. (a) Open circuit and short circuit test of a single-phase transformer
(b) Load test of the transformer and determination of efficiency and regulation
9. Demonstration of three phase transformer connections. Voltage and current relationship, phase shifts between the primary and secondary side.
10. Measurement of power in a three phase unbalanced circuit by two wattmeter method.
11. Determination of Torque –Speed characteristics of separately excited DC motor.
12. Determination of Torque speed characteristics and observation of direction reversal by change of phase sequence of connection of Induction motor.
13. Determination of operating characteristics of Synchronous generator.
14. Demonstration of operation of (a) DC-DC converter (b) DC-AC converter (c) DC-AC converter for speed control of an Induction motor
15. Demonstration of components of LT switchgear.

Laboratory Outcomes:

1. Get an exposure to common electrical components and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the usage of common electrical measuring instruments.
4. Understand the basic characteristics of transformers and electrical machines.
5. Get an exposure to the working of power electronic converters.

ES-ME291:Engineering Graphics & Design:1-0-4-5:3

1. **INTRODUCTION TO ENGINEERING DRAWING:** Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes. 1T+4P
2. **LETTERING, DIMENSIONING, SCALES:** Plain scale, Diagonal scale and Vernier Scales. 1T+4P

3. **GEOMETRICAL CONSTRUCTION AND CURVES:** Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Arch-median Spiral. 1T+ 4P
4. **PROJECTION OF POINTS, LINES, SURFACES:** Principles of Orthographic Projections- conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes- Auxiliary Planes. 1T+ 4P
5. **PROJECTION OF REGULAR SOLIDS:** Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone). 1T+4P
6. **COMBINATION OF REGULAR SOLIDS, FLOOR PLANS:** Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. 1T+4P
7. **ISOMETRIC PROJECTIONS:** Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions; 1T+4P
8. **SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULARSOLIDS:** Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only) 1T+4P
9. **OVERVIEW OF COMPUTER GRAPHICS**, C**USTOMISATION&CAD DRAWING:** listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;
1T+4P
10. **ANNOTATIONS, LAYERING & OTHER FUNCTIONS:** applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling; 2T+8P
11. **DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT:** Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).

General Instructions:

1. In every topic some problems are to be done in the class and some are to be given to students as home assignment.
2. The problems for class work are to be prepared on drawing sheet of A1 size in the class/ using AutoCAD software.
3. The problems for home assignments are to be prepared on drawing copy/ using AutoCAD software.
4. Print out of every assignment is to be taken for CAD Drawings on Drawing sheets (A4 Sheets).

5. A title block must be prepared in each sheet/ assignment. Following is the list of drawing instruments that required for making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter/ Set-squares (45°–45° & 60°–90°), T-square
3. Protractor (180°, 360°)
4. Scales (Plain, Diagonal)
5. Compass (Small and Large)
6. Divider (Small and Large)
7. French Curves
8. Drawing paper (A1 Size)
9. Drawing pencil (H, HB, B)
10. Sharpener
11. Eraser
12. Drawing pins & clips
13. Duster or handkerchief etc.

Learning Resources:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
3. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
5. Corresponding set of CAD Software Theory and User Manuals

Course Outcomes:

All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

1. to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability to prepare you to communicate effectively
2. to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

The student will learn :

1. Introduction to engineering design and its place in society
2. Exposure to the visual aspects of engineering design
3. Exposure to engineering graphics standards
4. Exposure to solid modelling
5. Exposure to computer-aided geometric design
6. Exposure to creating working drawings
7. Exposure to engineering communication

HM-HU291:Language Laboratory. 0-0-2-2:1

1) Honing 'Listening Skill' and its sub skills through Language Lab Audio device; 3P
2) Honing 'Speaking Skill' and its sub skills 2P
3) Helping them master Linguistic/Paralinguistic features (Pronunciation/Phonetics/Voice modulation/ Stress/ Intonation/ Pitch &Accent) of connected speech 2P
4) Honing 'Conversation Skill' using Language Lab Audio –Visual input; Conversational Practice Sessions (Face to Face / via Telephone, Mobile phone &Role Play Mode) 2P

5) Introducing ‘Group Discussion’ through audio –Visual input and acquainting them with key strategies for success 2P
6) G D Practice Sessions for helping them internalize basic Principles(turn- taking, creative intervention, by using correct body language, courtesies &other soft skills) of GD 4P
7) Honing ‘Reading Skills’ and its sub skills using Visual / Graphics/Diagrams /Chart Display/Technical/Non TechnicalPassages Learning Global / Contextual / Inferential Comprehension; 2P
8) Honing ‘Writing Skill’ and its sub skills by using Language Lab Audio –Visual input; Practice Sessions 2P

Course Outcomes:

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

.

Third Semester

BS-M(EE)301: Mathematics-III 3-1-0-4:4

Objective:

1. To understand Probability theory required an Electrical Engineer to apply in profession.
2. To understand numerical methods to solve engineering problem
3. To understand basics of Z transform to solve engineering problems.

1. Probability :
   Basic Probability Theory: Classical definition and its limitations. Axiomatic definition. Some elementary deduction: i) $P(O)=0$, ii) $0 \leq P(A) \leq 1$, iii) $P(A')=1-P(A)$ etc. where the symbols have their usual meanings. Frequency interpretation of probability.

   Addition rule for 2 events (proof) & its extension to more than 2 events (statement only). Related problems. Conditional probability & Independent events. Extension to more than 2 events (pair wise & mutual independence). Multiplication Rule. Examples. Baye's theorem (statement only) and related problems.

   Random Variable & Probability Distributions. Expectation: Definition of random variable. Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties (without proof). Examples. Definitions of Expectation & Variance, properties & examples.

   Some important discrete distributions: Binomial & Poisson distributions and related problems. Some important continuous distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson & Uniform distributions only.

2. Numerical Methods:
   Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors.

   Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.

   Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.

   Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method.

   Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton-Raphson method.

   Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method.

3. Z transform:
   Sequence, Representation of sequence, Basic operations on sequences, Z-transforms, Properties of Z-transforms, Change of scale, Shifting property, Inverse Z-transform, Solution of difference equation , Region of convergence.

   Text books:
   1. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.
   2. C.Xavier: C Language and Numerical Methods.
   3. Dutta & Jana: Introductory Numerical Analysis.
   4. J.B.Scarborough: Numerical Mathematical Analysis.

5. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).
6. Hwei P Hsu, " Signal and system", (Schaum's Outline Series), Mc Graw Hill education.
Reference books
1. Balagurusamy: Numerical Methods, Scitech.
2. R.S. Salaria: Numerical Methods, Khanna Publishing House.
3. S.S. Sashtry: Numerical Methods, PHI
4. Baburam: Numerical Methods, Pearson Education.
5. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
6. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
7. Srimanta Pal: Numerical Methods, OUP.
Course Outcome: After completion of this course, the learners will be able to
1. explain basics of probability theories, rules, distribution and properties of Z transform
2. describe different methods of numerical analysis.
3. solve numerical problems based on probability theories , numerical analysis and Z transform
4. apply numerical methods to solve engineering problems.
5. solve engineering problems using z transform and probability theory.

Special Remarks:
The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

BS-CH(EE)301: Biology 2-0-0-2:2

Objectives:
1. To introduce modern biology with an emphasis on evolution of biology as a multidisciplinary field.
2. To make students aware of application of engineering principles in biology and engineering robust solution inspired by biological examples.

Module 1: Introduction (2 hours)
Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2: Classification (3 hours)
Purpose: To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification.
Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultra_structure _prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricotelic, ureotelic (e) Habitata- acquaticor terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Module 3: Genetics (4 hours)
Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences". Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of Gene cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4: Biomolecules (4 hours)

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine. Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Module 5: Enzymes (4 Hours)

Purpose: To convey that without catalysis life would not have existed on earth. Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6: Information Transfer (4 hours)

Purpose: The molecular basis of coding and decoding genetic information is universal. Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Module 7: Macromolecular analysis (5 hours)

Purpose: To analyse biological processes at the reductionistic level. Proteins- structure and function. Hierarchy in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8: Metabolism (4 hours)

Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.

Module 9. Microbiology (3 hours)

Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

Text / References:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “Biology: A global approach”, Pearson Edu. Ltd, 2014.
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, “Outlines of Biochemistry”, John Wiley and Sons, 2009.
3. D. L. Nelson and M. M. Cox, “Principles of Biochemistry”, W.H. Freeman and Company, 2012.
4. G. S. Stent and R. Calendar, “Molecular Genetics”, Freeman and company, 1978.
5. L. M. Prescott, J. P. Harley and C. A. Klein, “Microbiology”, McGraw Hill Higher Education, 2005.

Course Outcomes:

After studying the course, the student will be able to:

1. Describe how biological observations of 18th Century that lead to major discoveries.
2. Convey that classification *per se* is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
3. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
4. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
5. Classify enzymes and distinguish between different mechanisms of enzyme action.
6. Identify DNA as a genetic material in the molecular basis of information transfer.
7. Analyse biological processes at the reductionistic level
8. Apply thermodynamic principles to biological systems.
9. Identify and classify microorganisms.

ES-ME(EE)301: Engineering Mechanics 3-0-0-3:3

Objective:

1. To understand the basic mathematical tools to deal with the physical bodies.
2. To learn different mathematical techniques to analyze physical bodies.
3. To learn analysis techniques of rigid bodies.
4. To solve problem of general motion.

Module 1: Introduction to vectors and tensors and co-ordinate systems (5 hours)
Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.

Module 2: Three-dimensional Rotation (4 hours)
Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

Module 3: Kinematics of Rigid Body (6 hours)
Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

Module 4: Kinetics of Rigid Bodies (5 hours)
Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

Module 5: Free Body Diagram (1 hour)
Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.

Module 6: General Motion (9 hours)
Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.

Module 7: Bending Moment (5 hours)
Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.

Module 8: Torsional Motion (2 hours)
Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Module 9: Friction (3 hours)
Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

Text / References:

1. J. L. Meriam and L. G. Kraige, "Engineering Mechanics: Dynamics", Wiley, 2011.
2. M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media, 1986.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the concepts of co-ordinate systems.
2. Analyse the three-dimensional motion.
3. Understand the concepts of rigid bodies.
4. Analyse the free-body diagrams of different arrangements.
5. Analyse torsional motion and bending moment.

PC-EE301: Analog Electronic Circuits 3-0-0-3:3

Course Objectives:

- To introduce components such as diodes, BJTs and FETs their switching characteristics, applications
- Learn the concepts of high frequency analysis of transistors.
- To give understanding of various types of basic and feedback amplifier circuits such as small signal, cascaded, large signal and tuned amplifiers.
- To introduce the basic building blocks of linear integrated circuits.
- To introduce the concepts of waveform generation and introduce some special function ICs.

Course Outcomes: At the end of this course, students will demonstrate the ability to

- Know the characteristics, utilization of various components.
- Understand the biasing techniques
- Design and analyze various rectifiers, small signal amplifier circuits.
- Design sinusoidal and non-sinusoidal oscillators.
- A thorough understanding, functioning of OP-AMP, design OP-AMP based circuits with linear integrated circuits.

Diode circuits:
P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

BJT circuits:
Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

MOSFET circuits:
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, trans-conductance, high frequency equivalent circuit.

Feedback Amplifiers:
Concepts of feedback – Classification of feedback amplifiers – General characteristics of Negative feedback amplifiers – Effect of Feedback on Amplifier characteristics – Voltage series, Voltage shunt, Current series and Current shunt Feedback configurations – Simple problems.

Oscillators: Condition for Oscillations, RC type Oscillators-RC phase shift and Wien-bridge Oscillators,LC type Oscillators –Generalized analysis of LC Oscillators, Hartley and Colpitt Oscillators.

Differential, multi-stage and operational amplifiers:
Differential amplifier; power amplifiers(different classes, circuits, efficiency); direct coupled &RC 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)

Linear applications of op-amp:
Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion.

Nonlinear applications of op-amp:
Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators.Filters,Precision rectifier, peak detector. Monoshot.

Text/References:

1. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.

5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

Course Outcomes: After completion of this course, the learners will be able to

1. describe analog electronic components and analog electronics circuits
2. explain principle of operation of analog electronic components, filters, regulators and analog electronic circuits.
3. compute parameters and operating points of analog electronic circuits.
4. determine response of analog electronic circuits.
5. distinguish different types amplifier and different types oscillators based on application.
6. construct operational amplifier based circuits for different applications.
7. Understand the characteristics of transistors.
8. Design and analyse various rectifier and amplifier circuits.
9. Design sinusoidal and non-sinusoidal oscillators.
10. Understand the functioning of OP-AMP and design OP-AMP based circuits.

PC-EE302: Electrical Machines-I 3-0-0-3:3

Module 1: Magnetic fields and magnetic circuits (4 Hours)
Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

Module 2: Transformers (12 Hours)
Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Module 3: Fundamentals of machine windings (8 Hours)
Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor . DC Windings- Lap & wave winding.

Module 4: DC machines (8 Hours)
Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Module 5: DC machine - motoring and generation (8 Hours)
Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of

separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Text / References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of magnetic circuits.
2. Understand the operation of dc machines.
3. Analyse the differences in operation of different dc machine configurations.
4. Analyse single phase and three phase transformers circuits.

PC-EE303: Electrical Circuit Analysis 3-0-0-3:3

Course Objective:

- To provide a methodical approach to solve electrical circuit problem.
- To learn a number of powerful engineering circuit analysis techniques such as nodal analysis,
- mesh analysis, theorems, Laplace Transforms and several methods of simplifying networks.
- To understand the concept of graphical solution to electrical network
- To understand Fourier method for waveform analysis
- To develop a clear understanding of the important parameters of a magnetic circuit.
- To analyze various types of filters and attenuators.
- Different types of two-port network analysis using network parameters, with different types
- of connections.

Module 1: Introduction (4 Hours)

Continuous & Discrete, Fixed & Time varying, Linear and Nonlinear, Lumped and Distributed, Passive and Active networks and systems. Independent & Dependent sources, Step, Ramp, Impulse, Sinusoidal, Square, Saw tooth signals, Node and Mesh Analysis.Soultion of problems with DC & AC Sources.

Module 2: Network Theorems (7 Hours)

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

Module 3: Graph theory and Networks equations (4Hours)

Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials.

Module 4: Sinusoidal steady state analysis (5 Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer

Module 5: Fourier method of waveform analysis (4 Hours)

Fourier series and Fourier Transform (in continuous domain only). Application in circuit analysis, Solution of Problems

Module 6: Electrical Circuit Analysis Using Laplace Transforms and Applications (10 Hours)

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances, Solution of first and second order

differential equations for Series and parallel R-L, R-C, RL-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Module 7: Two Port Network and Network Functions (5 Hours)

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks, Driving point impedance & Admittance. Solution of Problems.

Module 8: Filter Circuits (4 Hours)

Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using passive elements and operational amplifier. Solution of Problems

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
6. C.L. Wadhwa,"Network Analysis and Synthesis," New Age International Publishers, 2013.

Course Outcomes: After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.
4. select suitable techniques of network analysis for efficient solution.
5. estimate parameters of two-port networks.
6. apply network theorems for the analysis of electrical circuits.
7. obtain the transient and steady-state response of electrical circuits.
8. analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
9. analyse two port circuit behavior.
10. design filter circuits.

PC-EE391: Electrical Engineering-I Laboratory: 0-0-6-6:3

Laboratory experiments will be performed on the subjects allotted in this syllabus. Name of the experiments will be enlisted by the department covering all the subjects. (**Electric Circuit, Analog Electronics , Electric Machines-I**)

MC-HU(EE)301:Environmental Science: 3-0-0-3:0 No Credit:

Objectives:

1. To understand the environment and its relationships with human activities, human health
2. To frame environmental laws and regulations
3. To develop guidelines and procedures
4. To acquire the skill to solve problem related to environment and pollution

Basic ideas of environment, basic concepts, man, society & environment, their inter relationship. Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development.
Materials balance: Steady state conservation system, steady state system with non conservative pollutants, step function.
Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering.
Ecology: Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function. Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundarban); Food chain ,Food web. Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.
Air pollution and control : Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause.
Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.
Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget.
Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion).
Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model. Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. Smog, Photochemical smog and London smog.
Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification.
Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference).
Water Pollution and Control :Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. River/Lake/ground water pollution: River: DO, 5 day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [de-oxygenation, re-aeration], COD, Oil, Greases, pH. Lake: Eutrophication. Ground water: Aquifers, hydraulic gradient, ground water flow.
Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] ,Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic.
Land Pollution: Lithosphere; Internal structure of earth, rock and soil Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes; Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling. Solid waste management and control (hazardous and biomedical waste). Noise Pollution :Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise], Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, Noise pollution control. L
Environmental Management: Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol. 2L

References/Books.

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.
2. De, A. K., "Environmental Chemistry", New Age International.

Course Outcome:

After completion of this course, the learners will be able to

1. To understand the environment and its relationships with human activities, human health
2. To frame environmental laws and regulations
3. To develop guidelines and procedures
4. To acquire the skill to solve problem related to environment and pollution

Fourth Semester

HM-HU(EE)401 : VALUES & ETHICS IN PROFESSION 2-0-0-2:2:

Objectives:

1. To inculcate Human values to grow as a responsible human beings with a proper personality.
2. To instill Professional Ethics to maintain ethical conduct and discharge professional duties.

Science, Technology and Engineering as knowledge and as Social and Professional Activities.
Effects of Technological Growth: Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development
Energy Crisis: Renewable Energy Resources, Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics,
Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.
Ethics of Profession: Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.
Profession and Human Values: Values Crisis in contemporary society
Nature of values: Value Spectrum of a good life
Psychological values: Integrated personality; mental health
Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.
Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity
Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.
Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2^{nd}Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Course Outcome:

After completion of this course, the learners will be able to
1. illustrate different aspects of human values, ethics, engineers' responsibility and duties
2. explain different principles, different theories and laws of engineering ethics and social experimentation
3. identify different factors in the light of Engineers' responsibility towards safety and risk
4. correlate ethics of different work environment.
5. explain the need for intellectual property rights.

ES-ME(EE)401 : Thermal Power Engineering. 3-0-0-3:3

Objectives:

1. To learn the principle of operation of different types of boilers and Turbines
2. To learn the principle of operation of IC engines and Gas turbines
3. To acquire problem solving skills to solve problems of boilers, turbines, IC engines and Gas turbines

1. Boilers: Water Tube & Fire Tube boilers, Circulating Principles, Forced Circulation, Critical pressure, Superheaters, Reheaters, attemperators, induced draught, forced draught and secondary air Fans, Boiler performance analysis and heat balance. Combustion Systems, Environmental Protection – ESP, Cyclone Separator, Dust Collector etc. 12
2. Turbines: Rotary Thermodynamic devices – Steam turbines &their classifications – Impulse & Reaction type Turbines, Thermodynamics of compressible fluid-flow, equation and continuity – Isentropic flow through nozzles, velocity diagram,

Blade efficiency, optimum velocity ratio, multi-staging, velocity & pressure compounding, losses in turbines, erosion of turbine blades, turbine governing, performance analysis of turbine, Condensing system. 12
3. IC Engines: IC Engines – classification, Analysis of a standard cycle, fuel characteristic of SI & CI Engine, Combustion, Engine performance, Automotive Engine exhaust emission and their control 6
4 Gas Turbines: Gas turbine Analysis – Regeneration - Reheating, Isentropic efficiency Combustion efficiency 10

Text books:
1. Engineering Thermodynamics, P.K. Nag, 6th Edition , Mc Graw Hill Education Pvt. Ltd
2. Power Plant Engineering, P K Nag, 4th Edition, Mc Graw Hill Education Pvt. Ltd
3. Thermal Engineering , P.S. Ballaney, 25th Edition, , Khanna publishers
4. Power Plant Engineering, Domkundwar, Arora, Dhanpat Rai & Co.

Reference books:
1. Thermodynamics ,Cengel , 6th Edition, Tata Mc Graw- Hill Education.
2. Power Plant Technology ,MMEi-Wakil 1st Edition, Tata McGraw Hill
3. Heat and Thermodynamics, M W Zemansky&R.H.Dittman , 8th Edition, McGraw Hill

Course Outcomes:
After completion of this course, the learners will be able to
1. describe the function of different components of boilers. Engines and turbines
2. explain the principle of operation of different types of boilers, turbines, IC engines and Gas turbines.
3. solve numerical problems of boilers, turbines, IC engines and Gas turbines.
4. analyze the performance of boilers, engines and turbines.
5. determine efficiency of boilers, engines and turbines. 6. explain methods to control boiler, engines and turbines parameters.

ES-PH(EE)401: Electromagnetic Fields 3-0-0-3:3

Objectives:
1. To understand the basic mathematical tools to deal with Electromagnetic field Problem.
2. To understand properties and application of Electric and magnetic field.
3. To analyze electromagnetic wave propagation
4. To solve problem related to Electromagnetic field.

Module 1: **Review of Vector Calculus (6 hours)**
Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications ,triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

Module 2: Static Electric Field (6 Hours)
Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Module 3: Conductors, Dielectrics and Capacitance (6 Hours)
Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module 4: Static Magnetic Fields (6 Hours)
Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Module 5: Magnetic Forces, Materials and Inductance (6 Hours)

Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

Module 6: Time Varying Fields and Maxwell's Equations (6 Hours)

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.

Module 7: Electromagnetic Waves (6 Hours)

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Text / References:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
7. E. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966.
8. B. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Edu. Publishers, International Ed. 1971.
9. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.

Course Outcomes:

At the end of the course, students will demonstrate the ability

1. To understand the basic laws of electromagnetism.
2. To obtain the electric and magnetic fields for simple configurations under static conditions.
3. To analyse time varying electric and magnetic fields.
4. To understand Maxwell's equation in different forms and different media.
5. To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

PC-EE401: Digital Electronic Circuits: 3-0-0-3:3

Objectives:

1. To learn the fundamentals of Digital systems and principle of operation of Logic families.
2. To learn the principle of operation of Combinational digital circuits.
3. To learn the principle of operation of sequential circuit and systems.
4. To learn the principle of operation of A/D and D/A converter
5. To learn the principle of operation of semiconductor memories and Programmable logic devices.
6. To acquire problem solving skills to solve problems of Digital circuits

Fundamentals of Digital Systems and logic families:

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

Combinational Digital Circuits:
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 generator, encoders, decoders/drivers for display devices, Q-M method of function realization.

Sequential circuits and systems:
A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flip-flops, Applications of flipflops, shift registers, applications of shift registers, 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.

A/D and D/A Converters:
Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, 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

Semiconductor memories and Programmable logic devices:
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).

Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

Course Outcomes:
At the end of this course, students will demonstrate the ability to

1. Understand working of logic families and logic gates.
2. Design and implement Combinational and Sequential logic circuits.
3. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
4. Be able to use PLDs to implement the given logical problem.

PC-EE402: Electrical Machines – II : 3-1-0-4:4

Objective:

1. To understand the arrangement of windings of AC machines.
2. To understand the principle of production of pulsating and revolving magnetic fields.
3. To understand the principle of operation and characteristics of three phase Induction machines
4. To understand the principle of operation and characteristics of single phase Induction machines .
5. To understand the principle of operation and characteristics of synchronous machine
6. To understand the principle of operation and characteristics of special electromechanical devices. .
7. To solve problems of Induction machines, synchronous machines and special eletro-mechanical devices

Module 1: Electromagnetic force and torque (6 Hours)
B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency.

Module 2: Pulsating and revolving magnetic fields (4 Hours)
Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Module 3: Induction Machines (10 Hours)
Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Module 4: Single-phase induction motors (6 Hours)
Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Module 5: Synchronous machines (14 Hours)
Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the concepts of rotating magnetic fields.
2. Understand the operation of ac machines.
3. Analyse performance characteristics of ac machines.

PC-EE403: Power Electronics :3-0-0-3:3

Course Objectives:
1. To understand the functioning and characteristics of power switching devices.
2. To understand the principle of operation of converters.
3. To understand different triggering circuits and techniques of commutation of SCR
4. To find external performance parameter of converters.
5. To analyze methods of voltage control, improvement of power factor and reduction of harmonics of the converter
6. To solve numerical problems of converters
7. To Design/develop suitable power converter for efficient control or conversion of power in drive applications
8. To Design / develop suitable power converter for different applications.

Power switching devices:

Concept of power electronics, scope and applications, types of power converters; Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; ratings of thyristor, Firing circuit for thyristor; methods of commutations of a thyristor; Gate drive circuits for MOSFET and IGBT.

Uncontrolled & Controlled rectifiers:

Single phase and three phase uncontrolled rectifiers with different types of load, Single-phase full-bridge thyristorized rectifier with R-load, R-L load, RLE load and highly inductive load; Three-phase full-bridge thyristorised rectifier with R-load, R-L load, RLE load and highly inductive load; Semi-converters; Input current wave shape, performance indices of rectifier and controlled converters. Effect of source inductance, Idea of gating circuit, dual converters.

DC-DC Converters (Chopper/SMPS): Introduction, elementary chopper with an active switch and diode, concepts of duty ratio, average inductor voltage, average capacitor current. Buck converter - Power circuit, analysis and waveforms at steady state, duty ratio control of output voltage. Boost converter - Power circuit, analysis and waveforms at steady state, relation between duty ratio and average output voltage. Buck-Boost converter - Power circuit, analysis and waveforms at steady state, relation between duty ratio and average output voltage. Isolated choppers (flyback, forward etc.)

DC-AC converters (Inverters): Introduction, principle of operation, performance parameters, single phase bridge VSI with R, RL loads, Voltage control of single phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation. concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage. Harmonic control of inverter.Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation3-phase bridge inverters - 120- and 180-degrees mode of operation. CSI

AC-AC Converters: Phase Controller (AC Voltage Regulator)-Introduction, principle of operation of single-phase voltage controllers for R, R-L loads and its applications. Cyclo-converter-Principle of operation of single phase to single phase, threephase to single phase&three phase to three phasecyclo-converters, relevant waveforms, circulating current mode of operation, Advantages and disadvantages.

Application of Power electronic circuits: Static Circuit Breaker, UPS, SMPS, Heatings, Motor control etc.

Text/References:

1. M. H. Rashid, "*Power electronics: circuits, devices, and applications*", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the differences between signal level and power level devices.
2. Analyse controlled rectifier circuits.
3. Analyse the operation of DC-DC choppers.
4. Analyse the operation of voltage source inverters.

PC-EE491: Electrical Engineering-II Laboratory: 0-0-6-6:3

Laboratory experiments will be performed on the subjects allotted in this syllabus. Name of the experiments will be enlisted by the department covering all the subjects. (**Power Electronics, Digital Electronics , Electric Machines-II**)

MC-HU(EE)401: Essence of Traditional Knowledge : 3-0-0-3-0

Objectives:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day to day life

UNIT-I:
Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge
UNIT-2:
Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.
UNIT-3:
Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.
UNIT-4:
Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge
UNIT-5:
Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

Text Books:
1. Traditional Knowledge System in India, by Amit Jha, 2009.
Reference Books:
1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
Web Links:
1.https://www.youtube.com/watch?v=LZP1StpYEPM
2.http://nptel.ac.in/courses/121106003/

Course Outcomes :
At the end of the Course, Student will be able to:
1: Identify the concept of Traditional knowledge and its importance.
2: Explain the need and importance of protecting traditional knowledge.
3: Illustrate the various enactments related to the protection of traditional knowledge.
4: Interpret the concepts of Intellectual property to protect the traditional knowledge.
5: Explain the importance of Traditional knowledge in Agriculture and Medicine.

Fifth Semester

HM-HU(EE)501: PRINCIPLE OF MANAGEMENT :2-0-0-2:2

OBJECTIVES:
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

Basic concepts of management: Definition – Essence, Functions, Roles, Level.
Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organization Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness.
Management and Society– Concept, External Environment, CSR, Corporate Governance, Ethical Standards.
People Management– Overview, Job design, Recruitment & Selection, Training & Development, Stress Management.
Managerial Competencies– Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship
Leadership: Concept, Nature, Styles.
Decision making: Concept, Nature, Process, Tools & techniques.
Economic, Financial & Quantitative Analysis– Production, Markets, National Income, Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.
Customer Management– Market Planning & Research, Marketing Mix, Advertising & Brand Management.
Operations & Technology Management– Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.

Text Books:
1. Management: Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz, Revised edition, Tata McGraw Hill (TMH)
3. Management – Stoner, James A. F. (Pearson)
4. Management - Ghuman, Tata McGraw Hill(TMH)

Outcomes:
Upon completion of the course , students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling and have some basic knowledge on international aspect of management.

PC-EE501: Signal and Systems : 3-1-0-4:4

Module 1: Introduction to Signals and Systems (3 hours):
Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.
Module 2: Behavior of continuous and discrete-time LTI systems (8 hours)
Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.
Module 3: Fourier, Laplace and z- Transforms (10 hours)

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 4: Sampling and Reconstruction (4 hours)

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson,
3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2009.
6. M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.
7. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of continuous time and discrete time systems.
2. Analyse systems in complex frequency domain.
3. Understand sampling theorem and its implications

PC-EE502: Power Systems-I 3-0-0-3:3

Module 1: Basic Concepts: (6 hours)

Evolution of Power System and present-day Scenario, Structure of
power system: Bulk power grid and Micro Grid.

Generation of Electric Power:

General layout of a typical coal fired power station, Hydro-electricpower station, nuclear power station, their components and working principles, comparison of different methods of power generation.

Introduction to Solar & Wind energy system.

Transmission and Distribution Systems: Line diagrams, transmission and distributionvoltage levels and topologies (meshed and radial systems).

Synchronous Grids and Asynchronous (DC) interconnections.

Concept of active and reactive power in single phase and 3 phase circuit.

Review of Three phase system-balanced source and load, star connected, delta connected, unbalanced source and loads-star connected, delta connected

Per-unit System and per-unit calculations- necessities and advantages

Module 2: Power System Components (15hours)

Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators.

Transformers: Three-phase connections and Phase-shifts. Three-winding transformers, autotransformers, Neutral Grounding transformers. Tap-Changing in transformers. Transformer Parameters. Single phase equivalent of three-phase transformers.

Loads: Types, Voltage and Frequency Dependence of Loads.

Overhead Transmission Lines and Cables:
Choice of frequency, Choice of voltage, Types of conductors,
Inductance and Capacitance of a single phase and three phasesymmetrical and unsymmetrical configurations, Bundle conductors, Transposition, Concept of GMD and GMR,
Influence of earth on conductor capacitance
Cables:
Types of cables, cable components, capacitance of single core & 3core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.

Module 3: (6 hours)
Overhead line construction:
Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers, Erection condition
Corona:
Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.
Insulators: Types, Voltage distribution across a suspension
Insulator string, String efficiency, Arching shield & rings, Methods
of improving voltage distribution across Insulator strings, Electrical tests on line Insulators.

Module 4: Performance of lines: (8 hours)
Short, medium (nominal, T) and long lines and their representation.A, B, C & D constants, Voltage regulation & efficiency, Ferranti effect, Power equations and load compensation and line compensation, Power Circle diagrams.
Tariff: Guiding principle of Tariff, different types of tariff.

Module 5: (7 hours)
Distribution substation and Grounding:
Types of substations, location ofsubstations, substation equipments and accessories, feeder and distributors, radial and loopsystems, Grounding-neutral grounding and equipment grounding-necessity, different types of neutral grounding, soil resistivity, earthing transformer
Tariff: Characteristics, twopart tariff, three part tariff, power factor tariff
Power factor correction – necessities, for star connected, delta connected load, cost of reactive power and saving in tariff.

Text/References:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
4. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.
5. Ashfaq Hussain,“Electrical Power System”, CBS Publishers & Distributors,2015

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the basic concepts of power systems.
2. Understand the various power system components.
3. Evaluate the performance of transmission lines and cables
4. Understand the mechanical design aspects of overhead lines
5. Understand the different aspects of tariff
6. Understand the voltage distribution across different insulator of overhead line
7. Understand basicsof corona

PC-EE503: Control System 3-0-0-3:3

Module 1: Introduction to control problem (4 hours)
Industrial Control examples. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Mathematical models of physical systems. Block diagram algebra.

Module 2: Time Response Analysis (10 hours)
Standard test signals. Time response of first and second order systems for standard test inputs (impulse, step & ramp). Design specifications for second-order systems based on the time-response. Error Analysis. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Module 3: Frequency-response analysis (6 hours)
Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module 4: Introduction to Controller Design (10 hours)
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: Bode plot method of controller design. Application of Proportional, Integral and Derivative Controllers. Analog and Digital implementation of controllers. Lead and Lag compensation in designs.

Module 5: State variable Analysis (6 hours)
Concepts of state variables. State space model. State Transition Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

Module 6: Introduction to Optimal Control and Nonlinear Control(5 hours)
Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.

Text/References:

1. B. S Manke, "Linear Control Systems with MATLAB Applications", Khanna Publishers, 11th edition
2. S. Hasan Saeed, "Automatic Control Systems", Kataria, S. K., & Sons, 2009
3. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
4. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
5. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
6. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

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

1. Deduce the transfer function and state-space representations of physical ststem.
2. Design simple feedback controllers.
3. Apply the concept of mathematical modelling in physical system.
4. Analysize time response of different systems.
5. Estimate static and dynamic errors of any system
6. Understand the concept of stability and its assessment for linear-time invariant systems.
7. Evaluate stability margins both graphically and analytically.
8. Select controllers in accoradance to system response
9. Apply required phase comsentation in a system.
10. Understand nonlinear system parameters and performances.

PC-EE504: Microprocessors & Microcontrollers: 3-0-0-3:3

Course Objective:
To have an in-depth knowledge of the architecture and programming of 8-bit and 16-bit Microprocessors, Microcontrollers and to study how to interface various peripheral devices with them.

Module 1: Fundamentals of Microprocessors: (5 Hours)
Fundamentals of Microprocessor Architecture. 8-bit Microprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.

Module 2: Architecture, Instruction Set & Programmingof typical Microprocessor/s: (17 Hours)
Architecture of a typical Microprocessor, Bus configuration, The CPU module, Instruction set of typical microprocessor (e.g. 8085), Subroutine & stack, Timing diagram, Memory Interfacing, Interfacing input output port, Interrupt & interrupt handling, Serial & parallel data transfer scheme, Programmed & interrupt driven data transfer, Direct memory access.

16 bit Microprocessor (e.g. 8086): Architecture, Min-max mode. Addressing Modes, Instruction Sets
Assembly language programme of a typical Microprocessors (8085 and 8086): Use of compilers, assembler, linker & debugger.

Programmable peripheral devices, Programmable interval timer, Analog input-output using AD & DA converter.
M**odule 3 : Architecture and Instruction Set & Programming of 8051 Microcontroller Architecture (10 Hours)**
Overview of the 8051 family.Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices.
Addressing modes & Assembly language programs.

Module 4: External Communication Interface (4 Hours)
Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.
Module6: Applications- (04 Hours)
LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

Text / References:

1. R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing.
2. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education.
3. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education, 2007.
4. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.
5. R. Kamal, “Embedded System”, McGraw Hill Education,2009.
6. D. A. Patterson and J. H. Hennessy, "Computer Organization and Design: TheHardware/Software interface”, Morgan Kaufman Publishers, 2013.

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Do assembly language programming.
2. Do interfacing design of peripherals like I/O, A/D, D/A, timer etc.
3. Develop systems using different microcontrollers.

PE-EE501(a) Power Quality and FACTS 3-0-0-3:3

Module 1: Transmission Lines and Series/Shunt Reactive Power Compensation (4 hours)
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.
Module 2: Thyristor-based Flexible AC Transmission Controllers (FACTS) (6 hours)
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.
Module 3: Voltage Source Converter based (FACTS) controllers (8 hours)

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.

Module 4: Application of FACTS (4 hours)

Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Module 5: Power Quality Problems in Distribution Systems (4 hours)

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.

Module 6: DSTATCOM (8 hours)

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.

Module 6: Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours)

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.

Text/References

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.
3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 1983.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. Understand the working principles of FACTS devices and their operating characteristics.
3. Understand the basic concepts of power quality.
4. Understand the working principles of devices to improve power quality.

PE-EE501(b) High Voltage Engineering 3-0-0-3:3

Module 1: Breakdown in Gases (8 Hours)

Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge

Module 2: Breakdown in liquid and solid Insulating materials (7 Hours)

Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Module 3: Generation of High Voltages (7 Hours)

Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, tripping and control of impulse generators.

Module 4: Measurements of High Voltages (7 Hours)

Peak voltage, impulse voltage and high direct-current voltage measurement method, cathode ray oscillographs for impulse voltage measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Module 5: Lightning and Switching Over-voltages (7 Hours)
Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching overvoltages, Protection against over-voltages, Surge diverters, Surge modifiers.
Module 6: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories (7 Hours)
Various standards for HV Testing of electrical apparatus, IS, IEC standards, testingof 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.

Text/Reference 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.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
5. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing

Course outcomes:
At the end of the course, the student will demonstrate

1. Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
2. Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
3. Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
4. Knowledge of how over-voltages arise in a power system, and protection against these over-voltages.

PE-EE501(c) : Illumination Engineering: 3-0-0-3:3

Course Objectives :

- To provide an introduction to the fundamentals of illumination engineering and architectural lighting design.
- To impart lighting fundamentals, measurement, and technology and their application in the analysis and design of architectural lighting systems

Light, sight & color: Sources of light: Day light, artificial light sources, energy radiation, visible spectrum of radiation, black body radiation and full radiator. Incandescence, dependence of light o/p ontemperature. Theory of gas discharge and production of light. Perception of light and color, optical system of human eye, eye as visual processor. Reflection, refraction and other behavior of light.
Measurement of light: Measurement of light - radiometric and photometric quantities, units of measurement, standardization. Measurement of light distribution, direct and diffused reflection, fundamental concepts of colourimentry and measurement of colour.
Lamp, accessories & luminaries: Light production by gas discharge, fluorescence, incandescence, daylight principle of operation, light efficacy, color, electrical characteristics, typical applications, dimming condition of GLS filament, tungsten halogen lamps, fluorescent tubes, compact fluorescent lamp (CFL), low- and high-pressure sodium lamps, high pressure mercury lamp, metal halide lamp. Functions of luminaries, classification, Materials Used in luminaries manufacturing, reflection, refraction, diffusion, polarization and optical design, photometric measurements, application data and its use.LED.
Interior lighting: Objectives, quantity and quality of light, selection of lamps, luminaries' section, placement. Design considerations for lighting of offices, conference rooms, hospitals, teaching places, house etc., design calculations.
Lighting control:Types of lighting controls, strategy for selection, benefits of lighting control. Electric distribution system for lighting, maintenance strategies, group replacement schedule. Techniques of achieving energy efficient lighting design, role of computers in lighting design, advantages and limitations of computer aided lighting design.

Text Books:

1. Utilization of Electric Power, C.L. Wadha, New Age International Ltd.
2. Generation, Distribution and Utilization of electrical energy, C.L. Wadha, New Age International Ltd.
3. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.
4. Standard Hand Book for Electrical Engineers, Fink & Beaty, McGraw Hill International

Course outcomes. The students will be able to:

1. Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space
2. Perform calculations on photometric performance of light sources and luminaires for lighting design
3. Evaluate different types of lighting designs and applications

PE-EE501(d): Advanced Power Electronics: 3-0-0-3-:3

Course Objective:

1. To review basic concepts of power electronics in the field of power control and drives
2. To address the underlying concepts and methods behind Advanced Power Electronics
3. To impart knowledge of power semiconductor technologies and their advancement in the field of power conversion.

Resonant AC power supplies, bidirectional AC power supplies. Multistage conversions, Control Circuits: Voltage Mode Control, Current Mode Control

DC-DC converters: Analysis and detailed design of buck, boost, buck-boost, Cuk and SEPIC converters, Analysis and detailed design of isolated dc-dc converters including forward, flyback, push-pull, full bridge and dual-active bridge topologies, Continuous and discontinuous current modes of operation, Linearized, small-signal average models of dc-dc converters, Voltage mode and current mode control design methods, Design of magnetics for dc-dc converters Power management, Switching regulators for modern processors – multi-phase voltage regulators, design for high dynamic performance, switched capacitor converters, features of power management integrated circuits

Digital control of power electronic converters: Review of digital control systems, Digital control techniques for power converters; modeling and simulation.

Design examples of multi-phase VR, and PWM dc-ac converter, AC-DC PWM rectifiers.

Power quality issues: Boost and flyback converter based power factor correction circuits (PFC), Models, design and control of PFC, Full bridge bi-directional PWM rectifiers, applications in front end of motor drives, DC-AC PWM inverters, Voltage source inverters - topology and PWM techniques, Models of single phase and three phase inverters and control methods, Applications in low frequency AC synthesis.

Three-phase PWM techniques Grid interface of renewable energy resources Power converters and control for interfacing solar and wind energy to grid Distributed generation and impact on power distribution systems, Microgrids and smart grid technologies using power electronic converters.

Soft switching and resonant converters : Concept of ZVS and ZCS, Zero voltage transition converters, Resonant converters and applications in lighting Practical issues in power electronic converters Selection criteria for diodes, MOSFETs and IGBTs; gate drive circuits , Thermal management, EMI and layout issues

Books:

1. N. Mohan, T.M. Undeland, W.P. Robbins, “Power Electronics: Converters, Applications and Design,” John Wiley and sons, 3rd ed.
2. R.W. Erickson, D. Maksimovic, “Fundamentals of Power Electronics” Kluwer Academic Publishers, second edition.
3. NPTEL http://nptel.iitm.ac.in
4. Power quality enhancement using custom power devices, A. Ghosh and G. Ledwich, Kluwer Academic Publication, 2. Power quality, C. Shankran, CRC Press, 2001.
5. Handbook of power quality, editor: Angelo Baggini, John Wiley & Sons, 2008.
6. Electrical power systems quality Roger C. Dugan et al., Tata McGrawHill, 2002.

7. Instantaneous power theory and application to power conditioning, H. Akagi et al., IEEE Press, 2007.

Students Learning Outcomes:

The student

1. Can identify different areas power conversion and related topology.
2. Can find the applications of power electronics in day to day life.

PC-EE591: Electrical Engineering-III Laboratory: 0-0-6-6:3

Laboratory experiments will be performed on the subjects allotted in this syllabus. Name of the experiments will be enlisted by the department covering all the subjects. (**Power System, Control System, Microprocessors**)

MC-HM(EE)501: Constitution of India :3-0-0-3:0

Objective:

1. To have basic knowledge about Indian Constitution.
2. To understand the structure and functioning of union, state and local self-government.
3. To understand the structure, jurisdiction and function of Indian judiciary.

Syllabus:

1. **History of Making of the Indian Constitution:** History Drafting Committee, (Composition& Working)
2. **Philosophy of the Indian Constitution:** Preamble Salient Features
3. **Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights Right to Constitutional Remedies, Directive Principles of State Policy Fundamental Duties.
4. **Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions Executive President, Governor Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications
   Powers and Functions
5. **Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy
6. **Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. tate Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes: After completion of this course, the learners will be able to

1. describe
   - different features of Indian constitution..
   - power and functioning of Union, state and local self-government.
   - structure, jurisdiction and function of Indian Judiciary.
   - basics of PIL and guideline for admission of PIL.
   - Functioning of local administration starting from block to Municipal Corporation.
2. identify authority to redress a problem in the profession and in the society.

Sixth Semester

PC-EE601: Electrical Drives 3-0-0-3:3

Module 1: DC motor characteristics (5 hours)
Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.

Module 2: Chopper fed DC drive (5 hours)
Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.

Module 3: Multi-quadrant DC drive (6 hours)
Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.

Module 4: Closed-loop control of DC Drive (6 hours)
Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.

Module 5: Induction motor characteristics (6 hours)
Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.

Module 6: Scalar control or constant V/f control of induction motor (6 hours)
Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.

Module 7: Control of slip ring induction motor (6 hours)
Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.

Text / References:

1. G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2001.
3. G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

Course Outcomes:
At the end of this course, students will demonstrate the ability to

1. Understand the characteristics of dc motors and induction motors.
2. Understand the principles of speed-control of dc motors and induction motors.
3. Understand the power electronic converters used for dc motor and induction motor speed control.

PC-EE602: Power Systems – II 3-0-0-3:3

Module 1: Fault Analysis and Protection Systems (10 hours)

Necessities of fault studies, Balanced fault,shortcircuit of a synchronous machine under no load & loaded condition,Transient on a transmission line, simplifying assumptions, Thevenin's equivalent, fault limiting reactors, short circuit MVA of a bus,

Unbalanced Faults-Method of Symmetrical Components (positive, negative and zero sequences). Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents, bus voltages and line currents during fault

Switchgear: Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Module 2: Power Flow Analysis (10hours)

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a bus. Classification of buses-load bus, PV bus and slack bus, Application of numerical methods for solution of nonlinear algebraic equations and power flow equations

Gauss Seidel method- acceleration factor, convergence criteria, algorithm, flow chart, solution for small system

Newton-Raphson method- sensitivities and Jacobean Matrix, mismatches in power, corrections of angles and magnitudes of voltages, solution for small system

Computational Issues in Large-scale Power Systems

Module 2: Stability Constraints in synchronous grids (8 hours)

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. D escription of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Measures to improve stability, Effect of generation rescheduling and series compensation of transmission lines on stability.

Module 3: **Control of Frequency and Voltage (7 hours)**

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers.

Module 4: Economic Load Dispatch: (7 hours)

Generation cost function, Incremental Fuel Cost(IFC), Economic Load Dispatch -neglecting loss and MW limit, considering MW limit, considering transmission loss, incremental transmission loss, penalty factor, loss coefficients

Text/References:

1. HadiSaadat, "Power System Analysis" PSA Publishing, 3rd Edition,2010.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
4. B. R Gupta, "Power System", S. Chand Publishing, 2008.

Course Outcomes:

At the end of this course, students will demonstrate his/her ability to

1. Calculate fault current, bus voltages and line currents during fault for symmetrical and unsymmetrical faults.
2. Use numerical methods to analyse a power system in steady state.
3. Understand stability constraints in a synchronous grid.
4. Understand methods to control the voltage, frequency and power flow.
5. Understand the basics of economic way to serve load.

PC-EE603: Electrical and Electronic Measurements 3-0-0-3:3

Objectives:

1. To learn methods of measurement, errors in measurement and its classification.
2. To learn the principle of operation of analog and digital meters.
3. To learn the basic principle of operation of instrument transformers.

4. To learn the principle of operation of cathode ray oscilloscope and different sensors and transducers.
5. To learn the principle of measurement of power, energy and different electrical parameters
6. To acquire problem solving skills to solve problems on the topics studied.

Syllabus:

Measurements: Method of measurement, Measurement system, Classification of instruments, accuracy, True value, Precision, Drift, Hysteresis, Resolution, Speed of response, Dead-band, sensitivity, Error in measurement, Classification of errors, Basic statistical analysis applied to measurements: Mean, Standard Deviation etc.Dynamic response and the calibration of few instruments loading effect due to shunt and series connected instruments.Various measurement devices, their characteristics, their operation and their limitations.
Analog meters: General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments • Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Clamp-on meters, True RMS meter, Extension of instrument ranges and multipliers, Megger.
Measurements of R, L and C: Classification of resistance. Measurement of medium resistances – ammeter and voltmeter method, substitution method, Wheatstone bridge method.Measurement of low resistances – Potentiometer method and Kelvin's double bridge method. Measurement of high resistance: Price's Guard-wire method. Measurement of earth resistance..Generalized treatment of four-arm AC bridges.Sources and detectors. Maxwell's bridge, Hay's bridge and Anderson bridge for self-inductance measurement. Heaviside's bridge for mutual inductance measurement.De Sauty Bridge for capacitance measurement.Wien's bridge for capacitance and frequency measurements.Sources of error in bridge measurements and precautions.Screening of bridge components.Wagner earthing device.
Measurement of Voltage, Current, Power & Energy: Shunts, Potential Dividers, Wattmeter, Energy meters, Potentiometer (AC & DC), Hall sensor, Instrument Transformers, Clamp-on meters.
Cathode ray oscilloscope (CRO): Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO, Digital Storage Oscilloscope.
Electronic Instruments: Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multi-meter, Digital frequency meter, Signal generator.
Sensors & Transducers: Introduction to sensors & Transducers, Strain gauge, LVDT, transducers for Temperature, pressure, torque, flow, Speed and Position. Understand statistical data analysis. Understand computerized data acquisition

Text Books:
1. A course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, DhanpatRai& sons.
2. Electrical Measurement & Measuring Instruments, E.W. Golding & F.C. Wides, Wheeler Publishing.
3. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.
4. Electrical and Electronics Measurements and Instrumentation, P. Purkait, B. Biswas, Santanu Das, C. Koley, McGraw Hill Education
Reference Books:
1. Sensors & Transducers, D. Patranabis, PHI, 2nd edition.
2. Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments, A.D. Helfric& W.C. Copper, Wheeler Publication.
4. Instrument transducers, H.K.P. Neubert, Oxford University press.

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Design and validate DC and AC bridges.
2. Analyze the dynamic response and the calibration of few instruments.
3. Learn about various measurement devices, their characteristics, their operation and their limitations.
4. Understand statistical data analysis.
5. Understand computerized data acquisition.

PE-EE601(a) : Electrical Energy Conservation and Auditing 3-0-0-3:3

Module 1: Energy Scenario (6 Hours)

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module 2: Basics of Energy and its various forms (7 Hours)

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.

Module 3: Energy Management & Audit (6 Hours)

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.

Module 4: Energy Efficiency in Electrical Systems (7 Hours)

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.

Module 5: Energy Efficiency in Industrial Systems (8 Hours)

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.

Module 6: Energy Efficient Technologies in Electrical Systems (8Hours)

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.

Text/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. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of different energy efficient devices.

PE-EE601(b) :Industrial Electric Systems 3-0-0-3:3

Module 1: Electrical System Components (8 Hours)

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

Module 2: Residential and Commercial Electrical Systems (8 Hours)

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.

Module 3: Illumination Systems (6 Hours)

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.

Module 4: Industrial Electrical Systems I (8 Hours)

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.

Module 5: Industrial Electrical Systems II (6 Hours)

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Module 6: Industrial Electrical System Automation (6 Hours)

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.

Text/Reference Books

2. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
3. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
4. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
5. Web site for IS Standards.
6. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. Understand various components of industrial electrical systems.
3. Analyze and select the proper size of various electrical system components.

PE-EE601(c): HVDC Transmission Systems 3-0-0-3:3

Module 1:dc Transmission Technology (4 hours)

Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVdc Systems. Components of a HVdc system. Line Commutated Converter and Voltage Source Converter based systems.

Module 2: Analysis of Line Commutated and Voltage Source Converters (10 hours)

Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links.

Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.

Module 3:Control of HVDC Converters: (10 hours)
Principles of Link Control in a LCC HVDC system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control / AC v oltage regulation.

Module 3: Components of HVDC systems: (8 hours)
Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. Dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.

Module 4:Stability Enhancement using HVDC Control (4 hours)
Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.

Module 5:MTdc Links (4 hours)
Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MT dc systems using VSCs. Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.

Text/References:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVDC transmission system.
4. Understand the improvement of power system stability using an HVDC system.

PE-EE-601(d): RENEWABLE & NON CONVENTIONAL ENERGY:3-0-0-3:3

Course Objectives: To explore renewable energy resources and effective technologies.

Introduction to Energy sources: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.
Solar Energy: Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems.
Wind Energy: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations
Energy from Biomass: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.
Geothermal Energy: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry-rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Energy from Ocean: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages ,limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.
Magneto Hydrodynamic power generation: Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.
Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.
Fuel cell: Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells

Text Books:
1. Non conventional Energy sources, G.D. Rai, Khanna Publishers.
2. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.
3. Non conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.
Reference Books:
4. Renewable energy resources and emerging technologies, D.P. Kothari, Prentice Hall of India Pvt. Ltd.

Course Outcomes (COs): At the end of this course students will be able to …
1. Identify energy demand and relate with available energy resources
2. Analyze harnessing of solar energy.
3. Analyze harnessing of wind energy
4. Analyze harnessing of Biomass energy
5. Analyze harnessing of Geothermal and Ocean energies.
6. Analyze Magneto hydrodynamics and Fuel cell technology.

PE-EE602(a): Control System Design 3-0-0-3:3

Module 1: Design Specifications (6 hours)
Introduction to design problem and philosophy. 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.
Module 2: Design of Classical Control System in the time domain (8 hours)
Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.
Module 3: Design of Classical Control System in frequency domain (8 hours)
Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.
Module 4: Design of PID controllers (6 hours)
Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.
Module 5: Control System Design in state space (8 hours)
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. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.
Module 6: Nonlinearities and its effect on system performance (3 hours)
Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

Text and Reference 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.
5. B. C. Kuo, “Automatic Control system”, Prentice Hall, 1995.
6. J. J. D’Azzo and C. H. Houpis, “Linear control system analysis and design (conve. and modern)”, McGraw Hill, 1995.
7. R. T. Stefani and G. H. Hostetter, “Design of feedback Control Systems”, Saunders College Pub, 1994.

Course Outcomes: At the end of this course, students will beable to

1. Understand various design specifications.
2. Demonstrate different compensator designs.
3. Apply concept of performance parameters in time response problems.
4. Analyze compensator and controller specifications.
5. Estimate optimum controller tunning.
6. Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID).
7. Design controllers using the state-space approach.

PE-**EE602(b) : Electrical Machine Design 3-0-0-3:3**

Module 1: Introduction
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.

Module 2: Transformers
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.

Module 3: Induction Motors
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.

Module 4: Synchronous Machines
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.

Module 5: **Computer aided Design (CAD):**
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 **c**omplex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text / References:

1. A. 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.
4. K. L. Narang, “A Text Book of Electrical Engineering Drawings”, SatyaPrakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International, 1979.
6. 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.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the construction and performance characteristics of electrical machines.
2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. Understand the principles of electrical machine design and carry out a basic design of an ac machine.
4. Use software tools to do design calculations

PE-EE602(c) : Digital Signal Processing 3-0-0-3:3

Module 1: Discrete-time signals and systems (8 hours)

Discrete time signals and systems: Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate. Block diagram of DSP systems. Types of signals and systems;Linear Convolution; Representation of discrete systems using difference equations.

Module 2: Z-transform (6 hours)

Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using Z transform, Properties of Z-transform for causal signals, Interpretation of stability in z-domain, Inverse Z-transforms.

Module 3: Discrete Fourier Transform (10 hours)

Frequency Domain Analysis: Concept of Discrete Fourier Series (DFS) and Discrete Time Fourier Transform (DTFT). Discrete Fourier Transform (DFT): Properties of DFT, CircularConnvolution of signals. Fast Fourier Transform algorithm (Radix-2), Parseval's Identity, Implementation of Discrete Time Systems.

Module 4: Designof Digital filters (10 hours)

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band stop and High-pass filters (qualitative discussions). Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Module 5: Applications of Digital Signal Processing (6 hours)

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:

1. P. Ramesh Babu, "Digital Signal Processing 6/e", Scitech, 2015.
2. S. Salivahanan, A. Vallavaraj, "Digital Signal Processing", Tata McGraw-Hill Education, 2001
3. A. Nagoor Kani, "Digital Signal Processing 2/e", Tata McGraw-Hill Education, 2012
4. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
5. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", PHI, 1997.
6. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.

Course Outcomes:

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

1. Explain concept of signals and systems.
2. Estimate proper sampling rate for signal processing.
3. Undrstand need of signal processing in realtime signals
4. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
5. Analyse discrete-time systems using z-transform.
6. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
7. Design digital filters for various applications.
8. Apply digital signal processing for the analysis of real-life signals.
9. Analyze different signal processing models.

10. Estimare errors and approximations in signal modelling.

PE-EE602(d):Power Plant Engineering :3-0-0-3:3

Course Objectives:
• To introduce students to different aspects of power plant engineering.
• To familiarize the students to the working of power plants based on different fuels.
• To expose the students to the principles of safety and environmental issues.

Introduction: Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant.
Power plant economics and selection: Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.
Steam power plant: General layout of steam power plant, Power plant boilers including critical and supercritical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.
Diesel power plant: General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.
Gas turbine power plant: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant .
Nuclear power plant: Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems.Non Conventional Power Plants Introduction to non-conventional power plants (Solar, wind, geothermal, tidal)etc.
Electrical system: Generators and their cooling, transformers and their cooling. Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms. Pollution due to power generation.

Text Books:
1. Power Plant Engineering, P.K. Nag, Tata McGraw Hill.
2. Power Plant Engineering, F.T. Morse, Affiliated East-West Press Pvt. Ltd, NewDelhi/Madras
3. Power Plant Technology El-Vakil, McGraw Hill.
Reference Books:
4. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House

Course Outcomes: At the end of the course, a student will be able to:
1. Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.
2. Analyze the working and layout of steam power plants and the different systems comprising the plant and discuss about its economic and safety impacts
3. Combine concepts of previously learnt courses to define the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.

4. Describe the working principle and basic components of the nuclear power plant and the economic and safety principles involved with it.
5. Discuss the working principle and basic components of the hydro electric plants and the economic principles and safety precautions involved with it.
6. Discuss and analyze the mathematical and working principles of different electrical equipments involved in the generation of power.

OE-CS(EE)601(a): Computer Architecture 3-0-0-3:3

Module 1: Introduction to computer organization (6 hours)
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.
Module 2: Memory organization (6 hours)
System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.
Module 3: Input – output Organization (8 hours)
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.
Module 4: 16 and 32 microprocessors (8 hours)
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
Module 5: Pipelining(8 hours)
Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.
Module 6: Different Architectures (8 hours)
VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text/Refence 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.
6. N. Mathivanan, **"**Microprocessors, PC Hardware and Interfacing**"**, Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, **"**Microcomputer Systems: The 8086/8088 Family**"**, Prentice Hall India, 1986.
8. J. Uffenbeck, **"**The 8086/8088 Design, Programming, Interfacing**"**, Prentice Hall, 1987.
9. B. Govindarajalu, **"**IBM PC and Clones**"**, Tata McGraw Hill, 1991.
10. P. Able, **"**8086 Assembly Language Programming**"**, Prentice Hall India.

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the concepts of microprocessors, their principles and practices.
2. Write efficient programs in assembly language of the 8086 family of microprocessors.
3. Organize a modern computer system and be able to relate it to real examples.
4. Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.
5. Implement embedded applications using ATOM processor.

OE-CS(EE)601(b): Data Structure &Algorithm 3-0-0-3:3

Objectives of the course:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures

Detailed contents:

Module 1:

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. **Searching:** Linear Search and Binary Search Techniques
and their complexity analysis.

Module 2:

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Module 3:

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and
algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

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 their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree:
definitions, algorithms and analysis.

Module 4:

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 and complexity analysis.

Suggested books:

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

Suggested 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.

Course outcomes:

1. For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
2. For a given Search problem (Linear Search and Binary Search) student will able to implement it.
3. For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.
4. Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.
5. Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

OE-CS(EE)601(c): Computer Organization : 3-0-0-3:3

Objectives:

This course is intended to teach the basics involved in data representation and digital logic circuits used in the computer system. This includes the general concepts in digital logic design, including logic elements, and their use in combinational

and sequential logic circuit design. This course will also expose students to the basic architecture of processing, memory and i/o organization in a computer system.

Basic organization of the stored program in computer and operation sequence for execution of a program. Role of operating systems and compiler / assembler. Fetch, decode and execute cycle. Concept of operator, operand, registers and storage. Instruction format. Instruction sets and addressing modes. Commonly used number systems. Fixed and floating point representation of numbers.
Overflow and underflow. Design of address- ripple carry and carry look ahead principles. Design of ALU ,Fixed point multiplication-Booth's algorithm , Fixed point division-Restoring and non restoring algorithms. Floating point-IEEE 754 standard.
Memory unit design with special emphasis on implementation of CPU-memory interfacing. Memory organization. Static and dynamic memory, memory hierarchy, associative memory. Cache memory. Virtual memory. Data path design for read/write access.
Design of control unit-hardwired and micro programmed control. Introduction to instruction pipelining.
Introduction to RISC architecture, RISC vs. CISC architecture. I/O operations-Concepts of handshaking. Polled I/O, Interrupt and DMA.

Text Books:
1. Computer System architecture, M.M. Mano, PHI
2. Computer Architecture, P. Behrooz, Oxford University Press.

Reference Books:
1. Computer Architecture & Organization, J.P. Hayes, Mc Graw Hill.
2. Computer Organization, Hamacher, Mc Graw Hill.
3. Computer Organization & design, P. Pal Chaudhuri, PHI
4. Computer Organization & Architecture, P. N. Basu, Vikas Pub.

Learning Outcomes: The student will be able to:
• Identify, understand and apply different number systems and codes.
• Understand the digital representation of data in a computer system.
• Understand the general concepts in digital logic design, including logic elements, and their use in combinational and sequential logic circuit design.
• Understand computer arithmetic formulate and solve problems, understand the performance requirements of systems

OE-CS(EE)601(d): Computer Networks 3-0-0-3:3

Objectives of the course:
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
4. To provide a WLAN measurement ideas.

Detailed contents
Module 1:
Data communication Components: Representation of data and its flow Networks , Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth
utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.
Module 2:
Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - 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

Module 3:

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP– Delivery, Forwarding and Unicast Routing protocols.

Module 4:

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

Module 5:

Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography

Suggested books

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.

Suggested 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.

Course Outcomes:

1. Explain the functions of the different layer of the OSI Protocol.
2. Draw the functional block diagram of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) describe the function of each block.
3. For a given requirement (small scale) of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) design it based on the market available component
4. For a given problem related TCP/IP protocol developed the network programming.
5. Configure DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

OE-CS(EE)601(e): AI and Soft Computing: 3-0-0-3:3

Course Objectives:

1. To provide a strong foundation of fundamental concepts in Artificial Intelligence
2. To provide a basic exposition to the goals and methods of Artificial Intelligence
3. To enable the student to apply these techniques in applications which involve perception, reasoning and learning

Introduction: Intelligent Agents – Agents and environments - Good behavior – The nature of environments – structure of agents - Problem Solving - problem solving agents – example problems – searching for solutions – uniformed search strategies - avoiding repeated states –searching with partial information.

Searching techniques: Informed search and exploration – Informed search strategies – heuristic function – local search algorithms and optimistic problems – local search in continuous spaces – online search agents and unknown environments - Constraint satisfaction problems (CSP) –Backtracking search and Local search for CSP – Structure of problems - Adversarial Search –Games – Optimal decisions in games – Alpha – Beta Pruning – imperfect real-time decision– games that include an element of chance.

Knowledge representation: First order logic – representation revisited – Syntax and semantics for first order logic – Using first order logic – Knowledge engineering in first order logic - Inference in First order logic –prepositional versus first order logic – unification and lifting – forward chaining – backward chaining - Resolution - Knowledge representation - Ontological Engineering - Categories and objects – Actions - Simulation and events - Mental events and mental objects.

Learning: Learning from observations - forms of learning - Inductive learning - Learning decision trees- Ensemble learning - Knowledge in learning – Logical formulation of learning – Explanation based learning – Learning using relevant information – Inductive logic programming -Statistical learning methods - Learning with complete data - Learning with hidden variable -EM algorithm - Instance based learning - Neural networks - Reinforcement learning –Passive reinforcement learning - Active reinforcement learning - Generalization in reinforcement learning.
Applications: Communication – Communication as action – Formal grammar for a fragment of English –Syntactic analysis – Augmented grammars – Semantic interpretation – Ambiguity and disambiguation – Discourse understanding – Grammar induction - Probabilistic language processing - Probabilistic language models – Information retrieval – Information Extraction– Machine translation.

Text Books:
Artificial Intelligence – A Modern Approach", Stuart Russell, Peter Norvig, 2nd Ed. Pearson Education /PHI, 2004.
Reference Books:
1. Artificial Intelligence: A new Synthesis, Nilsson. J. Nils , Harcourt Asia Pvt. Ltd., 2000.
2. Artificial Intelligence, Rich Elaine & Knight Kevin, 2nd Edition, Tata McGraw-Hill, 2003.
3. Artificial Intelligence-Structures and Strategies for Complex Problem Solving, Geogre
4. F. Luger, Pearson Education / PHI, 2002.

Course Outcomes: On completion of the course students will be able to
1. Understand the various searching techniques, constraint satisfaction problem and example problems- game playing techniques. 2. Apply these techniques in applications which involve perception, reasoning and learning.
3. Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
4. Acquire the knowledge of real world Knowledge representation.
5. Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
6. Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

OE-CS(EE)602(f): Database Management System 3-0-0-3:3

Objectives of the course:
1. To understand the different issues involved in the design and implementation of a database system.
2. To study the physical and logical database designs, database modeling, relational, hierarchical, and network models
3. To understand and use data manipulation language to query, update, and manage a database
4. To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server , (Database Server), Data Warehousing.
5. To design and build a simple database system and demonstrate competence with
6. the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Module 1
Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). **Data models:** Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.
Module 2:
Relational query languages: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQL server.
Relational database design: Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design.
Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.
Module 3:

Storage strategies: Indices, B-trees, hashing.

Module 4:

Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.

Module 5:

Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

Module 6:

Advanced topics: Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.

Suggested books:

1. "Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill.

Suggested reference books

1 "Principles of Database and Knowledge – Base Systems", Vol 1 by J. D. Ullman, Computer Science Press.
2 "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe, Pearson Education
3 "Foundations of Databases", Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley

Course Outcomes:

1. For a given query write relational algebra expressions for that query and optimize the developed expressions
2. For a given specification of the requirement design the databases using E_R method and normalization.
3. For a given specification construct the SQL queries for Open source and Commercial DBMS -MYSQL, ORACLE, and DB2.
4. For a given query optimize its execution using Query optimization algorithms
5. For a given transaction-processing system, determine the transaction atomicity, consistency, isolation, and durability.
6. Implement the isolation property, including locking, time stamping based on concurrency control and Serializability of scheduling.

OE-CS(EE)601(g): Software Engineering: 3-0-0-3:3

Overview of system analysis & design: Business system concept, System development life cycle, waterfall model, Spiral Model, Feasibility Analysis, Technical feasibility, Cost-benefit Analysis, COCOMO model.
System design: Context diagram and DFD, Problem partitioning, Top down and bottom up design, decision tree, decision table and structured English, Functional Vs object oriented approach.
Testing: Levels of testing, Integration testing, Test case specification, Reliability assessment, Validation & Verification metrics, Monitoring & control.
System project management: Project scheduling, Staffing, software configuration management, Quality assurance, Project monitoring.
Fundamentals of Object oriented design in UML: Static and dynamic models, necessity of modeling, UML diagrams, Class diagrams, Interaction diagrams, Collaboration diagram, Sequence diagram, State chart diagram, Activity diagram, Implementation diagram.

Text Books:

1. Software Engineering, R.G. Pressman,TMH
2. Software Engineering Fundamental, Behforooz, OUP
3. Software Engineering, Ghezzi, PHI

Reference Books:

1. An integrated approach to Software Engineering, Pankaj Jalote, Narosa
2. Software quality, Benmenachen, Vikas
3. IEEE standard on Software Engineering.
4. Software defect Prevention, Kane, SPD.
5. Essentials of Software Engineering, Uma, Jaico

Course Outcomes:

Graduates of the program are expected to demonstrate:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

PC-EE691: Electrical Engineering-IV Laboratory: 0-0-6-6:3

Laboratory experiments will be performed on the subjects allotted in this syllabus. Name of the experiments will be enlisted by the department covering all the subjects. (**Power System-II, Electric Drives, Measurement & Instrumentation**)

Seventh Semester

HM-HU(EE)701: Financial Management & Accounts 3-0-0-3:3

Introduction: Financial Management, Financial Planning and Capitalization- definitions, objectives, changing roles and functions, Financial Decision.
Capital Budgeting: Nature of Investment decision, Importance of Capital Budgeting, The Capital. Budgeting Process - Investment Criterion, Pay-back period, Accounting, ROR (Rate of Return) Method, Discounting Cash flow method, Net - present value method, IRR (Internal Rate of Return) method, The benefit-Cost Ratio method.
Management of Working Capital: Various concepts, Elements, Classification, Financing and importance of working capital, Investment analysis, Cash flow determination, cost of capital, capital budgeting methods.
Budgeting Control Technique: Concepts of Budget, budgeting and budgetary control, Objectives, Functions, Uses, Advantages, Limitations; Master Budget and Report.
Cost - Volume - Profit Analysis: Classification of costs, Allocation, apportionment and absorption, Cost centers, different costing systems, Cost analysis for managerial decisions, Meaning of Linear CVP analysis, Objectives, Assumptions, Break-Even analysis, determining the Break-Even point profit, Volume graph profit, Volume ratios margin of Safety.
Introduction to Accounting: Basic accounting concepts, important definitions, uses, limitations, advantages; types of Accounting, Financial statements, introduction to Journal Accounting; different types of Vouchers, double entry bookkeeping, different types of transactions related to Financial Accounting.
Financial Control: Posting of Ledgers and preparation of Trial Balance; preparation of Balance Sheet and Profit and Loss Accounts; Controlling other departments by Financial Accounting (A practical Approach).

Books:
1. Financial Management and Accounting - P. K. Jain, S. Chand & Co.
2. Management & Accounting: Principles and Practice- R. K. Sharma & Shashi Kumar Gupta, Kalyani Publishers.
3. Advanced Management Accounting - Kaplan & Atkinson, PHI.
4. Fundamentals of Financial Management - Van Home,PE.
5. Financial Mgmt Accounting, Gupta,Pearson
6. Financial Mgmt, I.M. Pandey, Vikas
7. Financial Mgmt., Khan & Jain, TMH
8. Financial Mgmt ,Mcmenamin, OUP
9. Financial Mgmt& Policy, Van Horne, PHI
10. Financial Mgmt, Kulkarni&Satyaprasad, Himalaya

COURSE OUTCOMES:
After completion of this course, the student will be able to:
1. To understand the accounting process in business.
2. To gain a knowledge on application of concepts and principles in preparing
3. To evaluate the tactical decisions of middle level managers relating to cost and management accounting
4. To analyze the financial statements and evaluate the decisions for better investment.

PE-EE701(a) : Wind and Solar Energy System 3-0-0-3:3

Module 1: Physics of Wind Power: (5 Hours)
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.
Module 2: Wind generator topologies: (12 Hours)
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.
Module 3: The Solar Resource: (3 Hours)

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Module 4: Solar photovoltaic: (8 Hours)

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.

Module 5: Network Integration Issues: (8 Hours)

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.

Module 6: Solar thermal power generation: (3 Hours)

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text / References:

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

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

PE-EE701(b) : Line-Commutated and Active PWM Rectifiers 3-0-0-3:3

Module 1: Diode rectifiers with passive filtering (6 Hours)

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.

Module 2: Thyristor rectifiers with passive filtering (6 Hours)

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.

Module 3: Multi-Pulse converter (6 Lectures)

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.

Module 4: Single-phase ac-dc single-switch boost converter (6 Hours)

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.

Module 5: Ac-dc bidirectional boost converter (6 Hours)

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.

Module 6: Isolated single-phase ac-dc flyback converter (10 Hours)

Dc-dc flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure.

Text / References:

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

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Analyse controlled rectifier circuits.
2. Understand the operation of line-commutated rectifiers – 6 pulse and multi-pulse configurations.
3. Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

PE-EE701(c) : Electrical and Hybrid Vehicles 3-0-0-3:3

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

Module 1: Introduction (10 hours)

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

Introduction to Hybrid Electric Vehicles: 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.

Module 3: Electric Trains (10 hours)

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.

Module 4: Energy Storage (10 hours)

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

Module 5: Energy Management Strategies (9 hours)

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).

Text / References:

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.
3. 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.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

Course Outcomes:
At the end of this course, students will demonstrate the ability to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

PE-EE701(d):ELECTRICAL ENGINEERING MATERIALS :3-0-0-3:3

Course Objectives:
To understand the importance of various materials used in electrical engineering and obtain a qualitative analysis of their behaviour and applications.

Dielectric Materials: Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.
Magnetic Materials: Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and hysteresis
Semiconductor Materials: Crystal growth, zone refining, Degenerate and no degenerate semiconductors, Direct and indirect band gap semiconductors. Electronic properties of silicon, Germanium, Compound Semiconductor, Gallium Arsenide, gallium phosphide & Silicon carbide.Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI)
Conductive & Superconductive Materials: Electrical properties of conductive and resistive materials. Important characteristics and electronic applications of specific conductor & resistance materials. Superconductor phenomenon, Type I and Type II superconductors and their applications.

Text Books:

- "R K Rajput", " A course in Electrical Engineering Materials", Laxmi Publications, 2009
- "T K Basak", " A course in Electrical Engineering Materials", New Age Science Publications 2009

Reference Books:

- TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
- "AdrianusJ.Dekker", Electrical Engineering Materials, PHI Publication, 2006.
- S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", DhanpatRai& Sons, 2011.

Course Outcomes: After completion of this course, the student will be able to

- Understand various types of dielectric materials, their properties in various conditions.
- Evaluate magnetic materials and their behavior.
- Evaluate semiconductor materials and technologies.
- Acquire Knowledge on Materials used in electrical engineering and applications

PE-EE701(e): FACTS & HVDC :3-0-0-3:3

Objectives: The course starts with a review of static and dynamic issues in power systems. Then FACTS and HVDC are presented and it is shown how these components may be a technical solution to the described issues. It will be discussed in the

course how FACTS and HVDC are designed and also what functions they have. Basic mathematical models and control strategies are presented and used to analyze the impact of these components on power system stability.

Module-1: FACTS Concept and General System Considerations (8 hours)

Transmission Interconnections, Flow of Power in an AC System, What Limits the Loading Capability? Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.

Module-2: Static Shunt Compensators (8 hours)

Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability. Methods of Controllable Var Generation –Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC).Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches. Static VAR Compensators: SVC and STATCOM, the Regulation Slope. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time.

Module-3: Static Series Compensators (8 hours)

Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator, Transmitted Power Versus Transmission AngleCharacteristic.

Module-4: Development of HVDC Technology (8 hours)

Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects.
Power Conversion: 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.

Module-5: Control of HVDC Converter and System (8 hours)

Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.

Text Books:

1. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems Narain G Hingorani, Laszlo Gyugyi Wiley 1st Edition, 2000
2. HVDC Transmission, S. Kamakshaiah& V. Kamaraju, Tata McGraw hill education.
3. HVDC Power transmission system, K.R.Padiyar, Wiley Eastern Limited.
4. HVDC Transmission: Power Conversion Applicationsin Power Systems Chan-Ki Kim et al Wiley 1st Edition, 2009

Reference Books:

1. Thyristor Based FACTS Controllers for Electrical Transmission Systems R. Mohan Mathur, Rajiv K. Varma Wiley 1 st Edition, 2002
2. The Performance, Operation and Control of EHV Power Transmission Systems,A. Chakraborty, D.P. Kothary, A.K. Mukhopadhyay, Wheeler Pub.
3. High Voltage Direct Current Transmission, J. Arrillaga, Peter Pregrinu.Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, NewAge International (P) Ltd.
4. High Voltage Direct Current Power Transmission, Colin Adamson and N.G.Hingorani,Garraway Limited, London

Course outcomes:

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

- Discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- Describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- Explain advantages of HVDC power transmission, overview and organization of HVDC system.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions

PE-EE702(a) : Power System Protection 3-0-0-3:3

Module 1: **Introduction, Components of a Protection and Protection Principles (10 hours)**

Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers

Over-Current Protection:

Introduction, Fuse, Thermal Relays, Over-current Relay- Instantaneous, Definite Time Over-current(DTOC) Relay, Inverse Time Over-current Relay Implementation of Over-current Relay Using Induction Disk

Differential Protection:

Introduction, Dot Markings, Simple Differential Protection -behaviour during load, during external fault, during internal fault, Simple Differential Protection, Double-end-fed: Behaviour During Internal Fault, Zone of Protection of the Differential Relay, Actual Behaviour of a Simple Differential Scheme and drawback, Percentage biased Differential Relay, Earth Leakage Protection

Distance Protection: Drawbacks of Over-current Protection, Introduction to Distance Protection, Simple ImpedanceRelay, Reactance relay, Mho Relay

Module 2: Protection of power system components(22 Hours)

Generator Protection

Introduction, Various Faults and Abnormal Operating Conditions, Stator Faults, Stator Phase and Ground Faults, Transverse Differential Protection, Rotor Faults, Unbalanced Loading, Over-speeding, Loss of Excitation- Protection Against Loss of Excitation Using Offset Mho Relay, Loss of Prime Mover,

Transformer Protection

Types of Faults in Transformers, Over-current Protection, Percentage biased Differential Protection, Development of Connections, Phase c-to-Ground External Fault, Phase c-to-Ground Internal Fault, Inrush Phenomenon, Percentage biased Differential Relay with Harmonic Restraint, High Resistance Ground Faults in Transformers, Inter-turn Faults in Transformers, Buchholz Relay, Protection Against Over-fluxing, Numerical Problem

Busbar Protection

Introduction, Differential Protection of Busbars,Selection of CT Ratios in Case of BusbarProtection-Wrong Method, Correct Method, External and Internal Fault, Actual Behaviour of a Protective CT, Protection of Three-phase Busbars,

Induction Motor Protection:

Introduction, Various Faults and Abnormal Operating Conditions, Starting Current, Fault on Motor Terminals, Faults Inside Motor-Phase fault, Ground Faults, Inter-turn Faults, Abnormal Operating Conditions from Supply Side, Unbalanced Supply Voltage, Single Phasing, Reduction in Supply Voltage, Reversal of Phases, Abnormal Operating Conditions from Mechanical Side- Failure of Bearing and Rotor Jam, Overload

Protection of Transmission line:

Over Current Protection: Application of DTOC Relays and IDMT Relay for Protection of a Distribution Feeder, Choice Between IDMT and DTOC Relays, Protection of a Three-phase Feeder, Directional Over-current Relay- application area, Drawbacks of Over-current Relays

Distance Protection:-Trip Law, Implementation, Performance of During Normal load Flow, Effect of Arc Resistance on Relay Reach, Directional Property Exhibited by Relay,Comparison Between Distance RelaysDistance Protection of a Three-phase Line -Phase Faults and Ground FaultsComplete Protection of a Three-phase Line, Three-stepped Distance Protection, Impedance Seen from Relay Side

Carrier-current Protection: Need for Carrier-aided Protection, Various Options for a Carrier, Coupling and Trapping the Carrier into the Desired Line Section, Single Line-to-ground Coupling, Line-to-line Coupling, Unit Type Carrier-aided Directional Comparison RelayingCarrier-aided Distance Schemes for Acceleration of Zone

System Protection

Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.

Module 3: Static Relays and Digital Relays(6 hours)

Static Comparators as Relays:

Amplitude Comparator, Phase comparator, Cosine-type and Sine-type Phase Comparator, The Phase Comparator, Duality Between Amplitude and Phase Comparators, Synthesis of Various Distance Relays Using Static Comparators Synthesis of Mho Relay Using Static Phase Comparator, Electronic Circuit for Implementing a Cosine-type Phase Comparator, Sine-type Phase Comparator

Digital Protection:

Introduction, Computer-aided protection-Block Diagram, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues, of Numerical Relay,

Module 4: **Modelling and Simulation of Protection Schemes (4 hours)**

CT/PT modelling and standards, Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.

Text/References

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker, New York, 1987.
2. Y. G.Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008.
5. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis, 2006.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the different components of a protection system.
2. Understand the protection schemes for different power system components.
3. Understand the basic principles of digital protection.
4. Understand system protection schemes, and the use of wide-area measurements.

PE-EE702(b): Digital Control Systems 3-0-0-3:3

Module 1: Discrete Representation of Continuous Systems (6 hours)

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

Module 2: Discrete System Analysis (6 hours)

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.

Module 3: Stability of Discrete Time System (4 hours)

Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

Module 4: State Space Approach for discrete time systems (10 hours)

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.

Module 5: Design of Digital Control System(8 hours)

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.

Module 6: Discrete output feedback control (8 hours)

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

Text Books :

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Obtain discrete representation of LTI systems.
2. Analyse stability of open loop and closed loop discrete-time systems.
3. Design and analyse digital controllers.
4. Design state feedback and output feedback controllers.

PE-EE702(c): Advanced Electric Drives 3-0-0-3:3

Module 1: Power Converters for AC drives (10 hours)

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.

Module 2: Induction motor drives (10 hours)

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).

Module 3: Synchronous motor drives (6 hours)

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

Module 4: Permanent magnet motor drives (6 hours)

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

Module 5: Switched reluctance motor drives (6 hours)

Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.

Module 6: DSP based motion control (6 hours)

Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

Text / References:

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,
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.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the operation of power electronic converters and their control strategies.
2. Understand the vector control strategies for ac motor drives
3. Understand the implementation of the control strategies using digital signal processors.

PE-EE702(d): Sensors and Transducers: 3-0-0-3:3

COURSE OBJECTIVES:

1. To impart a basic knowledge about analytical instruments, its concepts, and its technique.
2. To give a vast knowledge about different types of spectroscopic analysis.
3. To study about different types of chromatographic analysis.

Introduction: Definition, principle of sensing & transduction, transducer classification, transducer characteristics.
Resistive transducers: Potentiometric type: Forms, material, resolution, accuracy, sensitivity, Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.
Inductive transducers: common types- Reluctance change type, Mutual inductance change type, transformer action type, brief discussion with respect to material, construction and input output variable, LVDT: Construction, material, output input relationship, I/O curve, discussion.
Capacitive transducers: Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth typeand cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics.
Piezoelectric transducers: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force& stress sensing, ultrasonic sensors.
Thermal sensors: Material expansion type: solid, liquid, gas & vapor, Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister material, shape, ranges and accuracy specification. Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type.
Radiation sensors: types, characteristics and comparison. Pyroelectric type, Geiger counters, Scintillation detectors.
Magnetic transducers:Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics, Magnetostrictive type,Ferromagnetic plunger type, Proximity sensor.
Optical sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response.
Introduction to smart sensors: Construction, characteristics and applications, standards for smart-sensor interface
Recent trends in sensor technologies: Film sensors

Text Books:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI
2. Instrument transducers, H.K.P. Neubert, Oxford University press.
3. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill.

Course Outcomes:

1. Graduate will be able to identify, understand and define the fundamentals of Analytical instruments: can you illustrate the elements of Absorption Spectroscopy

2. Graduate will able to sketch various types of photometry
3. Graduates will be able to learn the fundamentals and applications of fluorescence spectrometers
4. Graduate will be able to compare and evaluate the performance of Mass, NMR, ESR, X-ray Spectrometers 4,5 5 Graduate will be able to describe and articulate various aspects of Gas and Liquid Chromatography
5. Graduate will be able to deduce the relevance with deeper understanding of Gas analyzers, pH meters, conductivity meters, Dissolved Oxygen Meters :They will be able to choose the appropriate method

PE-EE702(e) : Power Plant Instrumentation & Control : 3-0-0-3:3

COURSE OBJECTIVES:
1 To introduce the basics of Power generation
2 To enable the design of power plant control using various methods

Module 1: Concepts of Power plants of different types (10 hours)
Setups, energy conversions and measurement requirements, examples of Thermal, Hydel, and Nuclear plants. Thermal power plant and system instrumentation.
Module 2: Instrumentation (12 hours)
Instrumentation for :(i) Turbines (ii) Condensers (iii) Generators (iv) Coal handling (v) Water treatment (vi) Feed water, combustion air and flue gases
Module 3: Control (12 hours)
Boiler Control - Steam pressure control, combustion control, Furnace Draft control, Steam temperature control, Feed water control, Data logger and computer control, supervisory control and monitoring system. Instrumentation for safety interlocks - protective gears, emergency measures, Alarm systems and Analysis etc. Pollution measurement, monitoring and control.

Module 4: Data handling (10 hours)
Processing, logging, acquisition, accounting, display and storage. Instrumentation for Generator and Busbar coupling. Introduction to power plant modeling/simulation

Text Books:
1. Principles of Industrial Instrumentation, D. Patranabis, TMH New Delhi
2. Power Plant Engineering, **K.K. Ramalingam,** Published by Scitech Publications (India) Pvt. Ltd.
Reference Books:
3. Electric Power Engineering Handbook – Edited by L. L. Grigsby.
4. Instrument Engineers Handbook, B. G. Liptak, Chilton Book Co., Philadelphia

Course Outcomes: After completion of this course, students will be able to
1. Describe different power generation station and compare its functionality Knowledge & Understand
2. Prepare P&I diagram of a boiler Application
3. Select proper measuring equipment for the measurements of boilers and turbines. Apply
4. Choose a method for the measurement of parameters in power plant. Application
5. Deduce different control scheme for the control of boiler operation. Application & Analyze
6. Sketch P&I diagrams for Nuclear power plant & reactors.

OE-EC(EE)701(a): Computational Electromagnetics 3-0-0-3:3

Module 1: Introduction (6 hours)

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.

Module 2: Analytical Methods (6 hours)

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

Module 3: Finite Difference Method (FDM) (7 hours)

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

Module 4: Finite Element Method (FEM) (7 hours)

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.

Module 5: Special Topics(7 hours)

{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.

Module 6: Applications (7 hours)

Low frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, actuators. CAD packages.

Text/Reference Books

1. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press, 1996.
2. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press, 2001.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the basic concepts of electromagnetics.
2. Understand computational techniques for computing fields.
3. Apply the techniques to simple real-life problems.

OE-EC(EE)701(b): Electronic Devices 3-0-0-3:3

Introduction to Semiconductor Physics: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon;

Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors Generation and recombination of carriers; Poisson and continuity equation P-N junction characteristics, I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode, Bipolar Junction Transistor, I-V characteristics, Ebers-Moll Model, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor, LED,

photodiode and solar cell;

Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

Text /Reference Books:

1. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson,2014.
2. D. Neamen , D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, "Physics of Semiconductor Devices," 3rd edition, John Wiley &Sons, 2006.
4. C.T. Sah, "Fundamentals of solid state electronics," World Scientific Publishing Co. Inc, 1991.
5. Y. Tsividis and M. Colin, "Operation and Modeling of the MOS Transistor," Oxford Univ.Press, 2011.

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand the principles of semiconductor Physics
2. Understand and utilize the mathematical models of semiconductor junctions and MOS transistors for circuits and systems.

OE-EC(EE)701(c): Electromagnetic Waves 3-0-0-3:3

Transmission Lines- Equations of Voltage and Current on TX line, Propagation constant and characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TX line, Smith Chart, Admittance Smith Chart,
Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements. Maxwell's Equations- Basics of Vectors, Vector calculus, Basic laws of Electromagnetics, Maxwell's Equations, Boundary conditions at Media Interface. Uniform Plane Wave- Uniform plane wave, Propagation of wave, Wave polarization, Poincare's Sphere, Wave propagation in conducting medium, phase and group velocity, Power flow and Poynting vector, Surface current and power loss in a conductor Plane Waves at a Media Interface- Plane wave in arbitrary direction, Reflection and refraction at dielectric interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary. Wave propagation in parallel planewaveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.
Radiation: Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz dipole, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna,

Text/Reference Books:
1. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005
2. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
3. Narayana Rao, N: Engineering Electromagnetics, 3rd ed., Prentice Hall, 1997.
4. David Cheng, Electromagnetics, Prentice Hall

Course Outcomes:
At the end of this course students will demonstrate the ability to
1. Understand characteristics and wave propagation on high frequency transmission lines
2. Carryout impedance transformation on TL
3. Use sections of transmission line sections for realizing circuit elements
4. Characterize uniform plane wave
5. Calculate reflection and transmission of waves at media interface
6. Analyze wave propagation on metallic waveguides in modal form
7. Understand principle of radiation and radiation characteristics of an antenna

OE-EC(EE)701(d) : Analog and Digital Communication 3-0-0-3:3

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.
Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation. 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. Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Base and Pulse Transmission- Inter symbol. Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying. Digital Modulation trade offs. Optimum demodulation of digital signals over

band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Text/Reference Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.
6. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. 1. Analyze and compare different analog modulation schemes for their efficiency and
2. bandwidth
3. 2. Analyze the behavior of a communication system in presence of noise
4. 3. Investigate pulsed modulation system and analyze their system performance
5. 4. Analyze different digital modulation schemes and can compute the bit error performance

OE-EC(EE)701(e):Digital System Design 3-0-0-3:3

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnough maps up to 6 variables, Binary codes, Code Conversion. MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU

Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation

VHDL constructs and codes for combinational and sequential circuits.

Text/Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition ,2006.
4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition 2012.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Design and analyze combinational logic circuits
2. Design &analyze modular combinational circuits with MUX/DEMUX, Decoder, Encoder
3. Design &analyze synchronous sequential logic circuits
4. Use HDL & appropriate EDA tools for digital logic design and simulation

OE-ME(EE)701(a): Automobile Engineering 3-0-0-3:3

Objectives:
To understand the construction and working principle of various parts of an automobile

Contents:
Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT). Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).
Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.
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 (ABS), electronic brake force distribution (EBD) and traction control.
Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells

Course Outcomes:
Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

Text books:
1. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.
3. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
4. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

OE-ME(EE)701(b): Strength of Materials 3-0-0-3:3

Objectives:
1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
2. To calculate the elastic deformation occurring in various simple geometries for different types of loading

Contents :
Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle. **(8)**
Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. **(8)**
Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.**(8)**
Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs. (**8)**
Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure **(8)**

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata M H Pub. Co. Ltd., New Delhi 2005.

Course Outcomes:

1. After completing this course, the students should be able to recognise various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
2. The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading

OE-ME(EE)701(c): Automation in manufacturing 3-0-0-3:3

Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC
3. To understand the basics of product design and the role of manufacturing automation

Course Contents:

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and MachiningCenters, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing. Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control
Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies
Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

Text Books:

(i)Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall
(ii) SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition, Pearson
(iii) YoramKoren, Computer control of manufacturing system, 1st edition
(iv) Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

Course Outcomes:

Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations

OE-ME(EE)701(d): Mechatronic Systems 3-0-0-3:3

Course Contents:

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface;
Sensors and transducers: classification, Development in Transducer technology, Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.;

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servomotor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;
Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.;
Micro-mechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies
Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

Text Books:
1) Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
2) Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3) A Textbook of Mechatronics ,R.K.Rajput, S. Chand & Company Private Limited
4) Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering,William Bolton, Prentice Hall

Outcomes:
(i) Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.
(ii) To understand the structure of microprocessors and their applications in mechanical devices
(iii) To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
(iv) To understand the use of micro-sensors and their applications in various fields

OE-ME(EE)701(e): Manufacturing Processes 3-0-0-3:3

Objectives:
To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods

Contents:
Conventional Manufacturing processes:
Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. **(5)**
Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.**(4)**
Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.**(8)**
Additive manufacturing: Rapid prototyping and rapid tooling**(3)**
Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding. **(4)**
Unconventional Machining Processes:
Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters **(5)**
Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish. **(8)**
Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining **(3)**

Course Outcomes:
Upon completion of this course, students will be able to understand the different conventional and unconventional manufacturing methods employed for making different products

Text Books:
1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

OE-ME(EE)701(f): Total Quality Management 3-0-0-3:3

Objectives:
To facilitate the understanding of total quality management principles and processes

Contents:
Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.
TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.
The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.
TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.
Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation,; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits;
TQM implementation in manufacturing and service sectors.

Text Books:
1. Besterfield D.H. et al., Total qualityManagement, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Course Outcomes:
Upon completion of this course, the students will be able to use the tools and techniques of TQM in manufacturing and service sectors.

OE-ME(EE)701(g): Fluid Mechanics And Fluid Machines 3-0-0-3:3

Objectives:
1. To learn about the application of mass and momentum conservation laws for fluid flows
2. To understand the importance of dimensional analysis
3. To obtain the velocity and pressure variations in various types of simple flows
4. To analyze the flow in water pumps and turbines.

Contents :

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.**(9)**

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram. **(9)**

Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis. **(6)**

Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps-

Reciprocating pump – working principle. **(8)**

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines. **(8)**

Course Outcomes:

1. Upon completion of this course, students will be able to mathematically analyse simple flow situations
2. They will be able to evaluate the performance of pumps and turbines.

OE-ME(EE)701(h): Thermal and Fluid Engineering 3-0-0-3:3

Course Outlines:

Design and analysis of thermal systems. Case studies based on real-world thermal systems will be used throughout the class to illustrate the connection between these interdisciplinary subjects. The lecture materials cover: Fundamentals of Thermodynamics, First and Second Laws of Thermodynamics, various power and refrigeration cycles, heat transfer modes including steady and unsteady conduction, convection and radiation, flow statics and buoyancy, mass, momentum and energy conservation, Bernoulli equations, internal and external flows.

1. Review Steady, 1-D heat conduction (resistance concepts), Extended-surface/fin problems, **Case study**
2. Steady 2-D heat conduction (Lapalce equation), Shape Factors, Numerical method (finite difference and finite element schemes),
3. Unsteady conduction (lumped capacitace method), Spatial effects and finite difference methods, **Case study**
4. Introduction to Convection, Review of conservation principles of mass, momentum and energy (differential form),
5. Fundamental Concepts of fluid mechanics, Basic equations in integral form, **Case study**
4. Laminar and turbulent boundary layer analysis, The velocity and thermal boundary layers, Governing equations for both momentum and energy transfers,
5. Dimensional analysis and similitude, Momentum and heat transfer (Reynolds) analog .
6. Internal flows, Laminar flow between plates, Flows in pipes and ducts, friction factor and head loss, Thermal boundary layer development, Newton's law of cooling, Energy balance: constant heat flux and constant surface temperature, **Case study**.
7. External flows: Pressure gradient and boundary layer flow, flow separation, Friction and pressure drags, lift, Empirical method, flow over flat plate, cylinder in cross-flow, banks of tubes, **Case study: Turbine blade film cooling. i**ncompressible, inviscid flow, Euler and Bernoulli equations revisit. Irrotational flow.
8. Free Convection, Empirical correlations: vertical, inclined, horizontal plates, cylinders and spheres,
9. Thermal radiation basic concepts, **Case study,** Blackbody radiation, emission, absorption and transmission, view factor

Textbooks:

1. Introduction to Thermodynamics and Heat Transfer (ITHT), by Yunus A. Cengel

2. Introduction to Fluid Mechanics (FM), by Fox & McDonald

The following objectives will be accomplished after the completion of these classes:

- To learn the fundamentals of engineering Thermodynamics, heat transfer and fluid mechanics.
- To learn techniques for formulating and solving thermal and fluid problems with emphasis on using an integrated and just-in-time teaching strategy.
- To prepare students for advanced courses in thermal and fluid sciences.
- To prepare students for competence in the workplace through cooperative group works and extensive computer-based teaching and learning.

OE-ME(EE)701(i): Manufacturing Technology 3-0-0-3:3

Objectives:

(i)To provide knowledge on machines and related tools for manufacturing various components.
(ii) To understand the relationship between process and system in manufacturing domain.
(iii) To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Course Contents:

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design. **(12)**
Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and work piece quality. **(16)**
Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices. **(6)**
Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks: CPM and PERT, critical path scheduling; Production planning& control: Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models.**(16)**
.

Text Books:

(i) Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
(ii) Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.
(iii) Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

Course Outcomes:

Upon completion of this course, students will be able to the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components and the application of optimization methods in manufacturing

PC-EE781: Electrical and Electronic Design Sessional.: 0-0-4-4-2
Understand the practical issues related to practical implementation of applications usingelectronic circuits.
Choosing appropriate components, software and hardware platforms.
Design a Printed Circuit Board, getit made and populate/solder itwith components.
Work as a team withotherstudents to implement an application.

Basic concepts on measurements; Noise in electronic systems; Sensors and signalconditioning circuits;
Introduction to electronic instrumentation and PC based dataacquisition;
Electronic system design, Analog system design, Interfacing of analog anddigital systems, Embedded systems,
Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations. Groupprojects involving electronic hardware (Analog, Digital, mixed signal) leading toimplementation of an application.
Designing a heating element with specified wattage, voltage and ambient temperature.
Designing an aircore grounding reactor with specified operating voltage, nominal current and fault current.
Designing the power distribution system for a small township.
Designing a double circuit transmission line for a given voltage level and power (MVA) transfer.
Wiring and installation design of a multistoried residential building (G+4),not less than 16 dwelling flats with a lift and common pump)
Wiring and installation design of an office building with lift, AC, pump etc.
Wiring and installation design of a multistoried hospital building with lift, common pump, AC etc.
Electronic circuit design and component selection.
Power Amplifier Design,
OPAMP circuits design,
Digital design.
Design the control circuit of a Lift mechanism
Design a controller for speed control of DC machine
Design a controller for speed control of AC machine.
Compensation design in control system.

Department / concerned teacher may develop experiments based on the theory taught in addition to experiments mentioned.
Course outcome: After completion of this course, the learners will be able to

1. explain basic concept of measurement, noise in electronic system, sensor and signal conditioning circuits
2. implement PC based data acquisition systems
3. construct circuits with appropriate instruments and safety precautions
4. design heating elements, air core grounding reactor, power distribution system for small township, double circuit transmission line and Electric machines
5. do wiring and installation design of a multistoried residential building with lift and pump
6. design electronic hardware for controller of lift, speed of AC/DC motor, and for an application with analog, digital, mixed signal, microcontroller and PCB

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

PR-EE782: Project-I: 0-0-8-8:4

Project Work –I

The object of Project Work I is to enable the student to take up investigative study in the broad field of Electronics & Communication 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 preliminaryAnalysis/Modeling/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.

Eight Semester

PE-EE801(a) : Power System Dynamics and Control 3-0-0-3:3

Module 1: Introduction to Power System Operations (3 hours)
Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and c ontrol.

Module 2: Analysis of Linear Dynamical System and Numerical Methods (5 hours)
Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modelling: Slow and Fast Transients, Stiff System.

Module 3: Modelling of Synchronous Machines and Associated Controllers (12 hours)
Modelling 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. Modelling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

Module 4: Modelling of other Power System Components (10 hours)
Modelling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modelling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, WindEnergy Systems.

Module 5: Stability Analysis (11 hours)
Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multimachine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre ofInertia Motion. Load Sharing: Governordroop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools:Transient Stability Programs, Small Signal Analysis Programs.

Module 6: Enhancing System Stability (4 hours)
Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.

Text/Reference 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.
3. P. Sauer and M. A. Pai, “Power System Dynamics and Stability”, Prentice Hall, 1997.

Course Outcomes:
At the end of this course, students will demonstrate the ability to

1. Understand the problem of power system stability and its impact on the system.
2. Analyse linear dynamical systems and use of numerical integration methods.
3. Model different power system components for the study of stability.
4. Understand the methods to improve stability.

Course Outcomes:
At the end of this course, students will demonstrate the ability to

5. Understand the problem of power system stability and its impact on the system.
6. Analyse linear dynamical systems and use of numerical integration methods.
7. Model different power system components for the study of stability.
8. Understand the methods to improve stability.

PE-EE-801(b): PROCESS CONTROL 3-0-0-3-3:

Course Objective: This course aims to provide in-depth understanding of designing and implementing practical control strategies in process industries.

Module 1: General review of process, Process control & automation, Servo and regulatory control, Basic process control loop block diagram. Characteristic parameters of a process, Self regulation.Process modeling, Process equations-their limitations-general approach,. Typical processes and derivation of their functions. Characteristics and functions of different modes of control actions, Schemes and analysis of On-Off, Multistep, Floating, Time proportional, PID control**(12 hours)**

Module 2: Module Process reaction curves, Controllability. Tuning of controllers; Electronic PID controller design, Pneumatic controllers-brief analysis.Brief discussion aboutdifferent control strategies-schemes. **(10 hours)**

Module 3: Final control element: actuators (Pneumatic actuators, Electrical actuators) and control valves (Globe, Ball. Butterfly, Gate, Pinch), different parts, Fail Position, Valve Characteristics, Cv, single & Double seated valves, Valve sizing, Valve selection, Cavitation, Flashing, Noise. Control valve accessories- Air filter regulator, I/P converter, Pneumatic positioner, Electro Pneumatic positioner, limit switches, Motion transmitter. Brief study of safety valves and Solenoid valves.**(12 hours)**

Module 4: Introduction to Programmable Logic controllers- Basic Architecture and function, Input output modules and interfacing, CPU and memory, Relays, Timers, Counters and their uses, PLC programming and applications, Introduction to DCS**(10 hours)**

Books:

1. Principle of Process control, D. Patranabis, TMH
2. Automatic Process Control, D.P. Eckman, John Wiley.
3. Process control, P. Harriott, Mc Graw Hill
4. Chemical process control, G. Stephanpoulos, PHI
5. Process control instrumentation technology, C.D. Johnson, PHI
6. Process Control-Principles and application, S. Bhanot, Oxford University press.

Course Learning Outcomes: At the completion of this course, students will be able to:

1. Understand the basic principles & importance of process control in industrial process plants;
2. Specify the required instrumentation and final elements to ensure that well-tuned control is achieved;
3. Understand the use of block diagrams & the mathematical basis for the design of control systems;
4. Design and tune process (PID) controllers;
5. Apply appropriate software tools for the modelling of plant dynamics and the design of well tuned control loops;
6. Analyze the importance and application of good instrumentation for the efficient design of processcontrol loops for process engineering plants.
7. Understand the experimental implementation of advanced process control schemes and the methods for process monitoring and diagnosis

Course Learning Outcomes: At the completion of this course, students will be able to:

- Understand the basic principles & importance of process control in industrial process plants;
- Specify the required instrumentation and final elements to ensure that well-tuned control is achieved;
- Understand the use of block diagrams & the mathematical basis for the design of control systems;
- Design and tune process (PID) controllers;
- Use appropriate software tools for the modelling of plant dynamics and the design of well tuned control loops;
- Understand the importance and application of good instrumentation for the efficient design of processcontrol loops for process engineering plants.
- Understand the experimental implementation of advanced process control schemes and the methods for process monitoring and diagnosis

PE-EE801(c):Power Generation and Economics :3-0-0-3:3

Course objectives: The subject aims to provide the student of electrical engineering discipline with:

1. An understanding of basic abstractions of electrical power generations from conventional and nonconventional sources of energy. The capability to use abstractions to comprehend and analyze the impact of various system on environments and economics aspects of energy generation.
2. Knowledge for learning advanced topics in electrical power system.
3. The capability to incorporate the knowledge of electrical power generation in other field of science, engineering and economics.

Economics of Generation: Cost of power generation- Thermal, Hydro and Nuclear. Types of Consumers in a distribution system-Domestic, Commercial, Industrial etc. Concept of load factor, plant capacity factor, plant use factor, diversity factor, demand factor. Choice of size and number of generation units.

Tariff-: Block rate, flat rate, two-part, maximum demand, Power factor and three-part tariffs. Subsidization and Cross subsidization. Availability tariff of generation companies. Pool tariff of transmission companies. Availability based tariff (ABT).

Unit Commitment: Constraints in Unit Commitment, Spinningreserve, Thermal unit constraints, Hydro constraints, Must run, Fuel constraints. Unit commitment solution methods,

Economic Dispatch: Transmission loss formulae and its application in economic load scheduling. Computational methods in economic load scheduling. Active and reactive power optimization.

State Estimation and load forecasting in power system:

Introduction, state estimation methods, concept of load forecasting, load forecasting technique and application in power system.

Text Books:

1. Economic operation of Power System, L.K. Kirchmayar John Wiely, Newyork.
2. Power system Analysis, operation & control, Chakrabarty&Haldar, 2nd edition, PHI.
3. Modern power system analysis, D.P. Kothari & I.J. Nagtrath, Tata McGraw Hill.

References:

1. Power generation operation & control, A.J. Wood & B.F. Wollenberg, Wiley India.
2. Operation and control in power system, P.S.R. Murthy, BSP Publication.

Course outcome (co): After learning the course the students will be able to:

CO1. Demonstrate the knowledge about the electric power generations and their impacts.
CO2. Assess the theory and practices of conventional and non-conventional power generation method.
CO3. Determine the operation, maintenance and working of power plants.
CO4. Determine the operation, maintenance and working of substations
CO5. Interpret the practices of various earthing systems.

PE-EE801 (d): UTILISATION OF ELECTRIC POWER:3-0-0-3:3

Objectives: This subject gives a comprehensive idea in utilization of electrical power such as drives, electric heating, electric welding and illumination, electric traction, electrolysis, refrigeration air conditioning and automobile electric system.

Module-1: Electric Traction (14 Hours)

Requirement of an ideal traction system, Supply system for electric traction, Train movement - speed time curve, simplified speed time curve, average speed and schedule speed, Mechanism of train movement-energy consumption, tractive effort during acceleration, tractive effort on a gradient, tractive effort for resistance, power & energy output for the driving axles, factors affecting specific energy consumption, coefficient of adhesion, **Electric traction motor & their control-** Parallel and series operation of Series and Shunt motor with equal and unequal wheel diameter, effect of sudden change of in supply voltage, Temporary interruption of supply, Tractive effort and horse power. Use of AC series motor and Induction motor for traction, DC series motor control, Multiple unit control, Braking of electric motors, Electrolysis by current through earth, current collection in traction system, Power electronic controllers in traction system.

Module-2: Electric Heating (6 Hours)
Types of heating and Applications, Resistance heating, Induction heating, Arc furnace, Dielectric heating, Infra-red heating, Microwave heating, Simple design problems of resistance heating element

Module-3: Electric welding (6 Hours)
Advantages of electric welding, Principles of resistance welding, types –spot, projection seam and butt, welding and welding equipment used , Principle of arc production, electric arc welding, characteristics of arc, carbon arc, metal arc, hydrogen arc welding and their applications, Power supply required ,Advantages of using coated electrodes

Module-4: Illumination (8 Hours)
Law of illumination, Photometry (Photovoltaic cell, distribution photometry, integrating sphere, brightness measurement),Types of Lamps: Conventional and energy efficient, Basic principle of light control, Different lighting scheme & their design methods, Flood and Street lighting.

Module-5: Electrolytic processes (6 Hours)
Basic principles, Faraday's law of Electrolysis, Electro deposition, Extraction and refining of metals, Power supply of Electrolytic processes.

Text Books:
1. Generation Distribution and Utilization of Electrical Energy, C.L. Wadhawa, New Age International Publishers.
2. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.
3. Utilisation of Electric Energy, E. Openahaw Taylor, Orient Longman
4. Utlization of Electrical Power, R.K. Rajput, Laxmi Publications Pvt Limited

Learning Outcomes:
1. Able to maintain electric drives used in an industries
2. Able to identify a heating/ welding scheme for a given application
3. Able to maintain/ Trouble shoot various lamps and fittings in use
4. Able to figure-out the different schemes of traction schemes and its main components
5. Able to design a suitable scheme of speed control for the traction systems
6. Able to identify the job/higher education / research opportunities in Electric Utilization industry

OE-EC(EE)801(a) :VLSI & MICROELECTRONICS:3-0-0-3:3

Introduction to VLSI Design: VLSI Design Concepts, Moor's Law, Scale of Integration(SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA), Design principles (Digital VLSI –Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural, Physical),Y-Chart, Digital VLSI Design Steps.
MOS structure: E-MOS & D-MOS, Charge inversion in E-MOS, Threshold voltage, Flat band voltage, Potential balance & Charge balance, Inversion, MOS capacitances. Three Terminal MOS Structure: Body effect. Four Terminal MOS Transistor: Drain current, I-V characteristics. Current-voltage equations (simple derivation).Scaling in MOSFET: Short Channel Effects, General scaling, Constant Voltage & Field scaling. CMOS: CMOS inverter, Simple Combinational Gates - NAND gate and NOR Gate using CMOS.
Micro-electronic Processes for VLSI Fabrication: Silicon Semiconductor Technology- An Overview, Wafer processing, Oxidation, Epitaxial deposition, Ion-implantation &Diffusion, Cleaning, Etching, Photo-lithography– Positive & Negative photo-resist.
Basic CMOS Technology – (Steps in fabricating CMOS), Basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator Layout Design Rule: Stick diagram with examples, Layout rules.
Hardware Description Language – VHDL or Verilog Combinational & Sequential Logic circuit Design.

Text Books:
1. Digital Integrated Circuit, J.M.Rabaey, Chandrasan, Nicolic, Pearson Education.

2. CMOS Digital Integrated Circuit, S.M.Kang&Y.Leblebici, TMH.
3. Modern VLSI Design, Wayne Wolf, Pearson Education.
4. VHDL, Bhaskar, PHI.
5. Advance Digital Design Using Verilog , Michel D. Celliti, PHI

References:

1. Digital Integrated Circuits, Demassa& Ciccone, John Willey &Sons .
2. Modern VLSI Design: system on silicon, Wayne Wolf; Addison Wesley Longman Publisher
3. Basic VLSI Design, Douglas A. Pucknell& Kamran Eshranghian, PHI
4. CMOS Circuit Design, Layout & Simulation, R.J.Baker, H.W.Lee, D.E. Boyee, PHI

Course outcomes:

1. Calculate various parameters of a MOSFET
2. Explain various short channel effects and explain their effects on circuit performance
3. Ability to design Transistor-Level CMOS Logic circuit for a given functionality
4. An ability to estimate timing characteristics, noise margins, power consumption of a digital VLSI circuit.
5. Analyze Gate Function and Timing Characteristics of a multi input CMOS Logic gates
6. Estimate timing of a complex VLSI circuit using Logical Effort analysis.
7. To identify reasons for delay in a VLSI gate/circuit and apply various techniques to reduce delay of gate/circuit.
8. Design static CMOS and dynamic clocked CMOS circuits.
9. Draw layout of a CMOS circuit
10. Identify and explain the role of parasitic elements in a CMOS digital circuit
11. To compare various logic design styles on their performance metrics (speed, power consumption, area:
12. Analyze working of SRAM cell and DRAM cell

OE-EC(EE)801(b): Bio-Medical Electronics 3L:0T:0P 3 credits

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio-electrodes and bio-potential amplifiers for ECG, EMG, EEG, etc. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging.Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

Text/Reference Books:

1. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
2. J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
3. A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the application of the electronic systems in biological and medical applications.
2. Understand the practical limitations on the electronic components while handling biosubstances.
3. Understand and analyze the biological processes like other electronic processes.

OE-EC(EE)801(c): Embedded Systems 3-0-0-3:3

The concept of embedded systems design, Embedded microcontroller cores, embedded memories. Examples of embedded systems, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. subsystem interfacing, interfacing with external systems, user interfacing. Design trade offs due to

process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:
1. Suggest design approach using advanced controllers to real-life situations.
2. Design interfacing of the systems with other data handling / processing systems.
3. Appreciate engineering constraints like energy dissipation, data exchange speeds etc.

OE-EC(EE)801(d):Wavelet Transform:3-0-0-3:3

Course Objective:

1. To understand the concept of Fourier transform and short time Fourier transform.
2. To understand the concept of continuous time wavelet transform,
3. To analyze the concept of interpolation and decimation.
4. To understand the types of filter bank.
5. To analyze the concept of image compression.

Continuous Wavelet Transform: Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT.
Discrete wavelet Transform: Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter bank implementation of DWT.
Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two-dimensional wavelet transform.
Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, mathematical preliminaries for polyphase factorization, Dealing with Signal Boundary.
Applications: Image Compression: EZW Coding, SPIHT, Wavelet Difference Reduction Compression Algorithm, Denoising, speckle removal, edge detection and object isolation, audio compression, communication applications – scaling functions as signalling pulses, Discrete Wavelet Multitone Modulation. Beyond Wavelet: Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications

.

Course Outcomes:

After successful completion of this course, students should able to;
1. Classify various wavelet transform and explain importance of it.
2. Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).
3. Explain the properties and application of wavelet transform.
4. Develop and realize computationally efficient wavelet-based algorithms for signal and image processing.
5. Explain brief features and strength of transform beyond wavelet.

OE-EC(EE)801(e) :Satellite Communication and Remote Sensing : 3-0-0-3:3

Historical background, Basic concepts, Frequency allocation for satellite services, orbital & spacecraft problems, comparison of networks and services, modulation techniques used for satellite communication. Orbits- Two body problem, orbital mechanics, geostationary orbit, change in longitude, orbital maneuvers, orbital transfer, orbital perturbations. Launch Vehicles- principles of Rocket propulsion, powered flight, Launch vehicles for communication satellite. RF link- noise, the basic RF link, satellite links (up and down) , optimization RF link, inter satellite link, noise temperature, Antenna temperature, overall system temperature, propagation factors, rain attenuation model. Tropospheric and Ionospheric EFFECT. Multiple access- FDMA, TDMA, CDMA techniques, comparison of multiple access techniques, error connecting codes. Satellite subsystems and satellite link design- AOCS, TT&C , power system, spacecraft antenna, transponder, Friis transmission equation, G/T ratio of earth station. Remote Sensing: Basic of remote sensing, Electromagnetic Radiation principles, Atmospheric window, Indian satellite sensing satellite system, Active, Passive, ground based and space based remote sensing. Spatial, spectral, Radiometric and temporal resolution, satellite sensors, detectors and scanning technique, FOV and error sources, Image analysis and Interpretation weather RADAR, LIDAR, acoustic sounding systems, TRMM, AURA-MLS, Megha Tropiques .Altimeter ,Scatterometer, Radiometer. Ground based and radio oceulation techniques, spectral response of water, Sea surface temperature, wind speed, colour monitor, clouds and a crosal, water vapor, convective system, Trace gases.

Ref.:

1. Remote Sensing and GIS - B. Bhatta (oxford university press)
2. Remote sensing of the Environment – J.R. Jenson (Pearson)
3. Global Navigation satellite systems - B. S. Rao (TMH)
4. Satellite communication – D. Roddy (TMH)
5. Remote Sensing - R.A. Schowengerdt)Academic press)

Course Outcomes:

1. A good graduate engineer educated in this curriculum will be knowledgeable in theory and practice related to the Satellite Communication and remote sensing area.
2. The student will be conversant with the satellite and earth motion, the placing and controlling the satellite
3. The engineer will also keep knowledge about the modern electronic communications and its systems. It will prepare the candidate, eligible for his professional life in this valuable field
4. Here the engineer also will get good exposure of remote sensing utilizing satellite.

OE-CS(EE)801(a) :Internet of Things: 3-0-0-3:3

Course description and objectives:

Students will be explored to the interconnection and integration of the physical world and the cyber space. They are also able to design & develop IOT Devices.

Unit I Introduction & Concepts: Introduction to Internet of Things, Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels.

Unit II Domain Specific IOTs: Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style.

Unit III M2M & System Management with NETCONF-YANG: M2M, Difference between IOT and M2M, SDN and NFV for IOT, Software defined Networking, Network Function Virtualization, Need for IOT Systems Management, Simple Network Management Protocol, Limitations of SNMP, Network Operator Requirements, NETCONF, YANG, IOT Systems management with NETCONF-YANG.

Unit IV Developing Internet of Things & Logical Design using Python: Introduction, IOT Design Methodology, Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time

Operations, Classes, Python Packages Unit V IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device, Board, Linux on Raspberry Pi, Interfaces, and Programming & IOT Devices.
TEXT BOOKS: Vijay Madisetti, Arshdeep Bahga," Internet of Things A Hands-On- Approach",2014, ISBN:978 0996025515 REFERENCE BOOKS: 1. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0 2. Daniel Kellmereit, "The Silent Intelligence: The Internet of Things". 2013, ISBN 0989973700

Course Outcomes:

1. Able to understand the application areas of IOT
2. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks ·
3. Able to understand building blocks of Internet of Things and characteristics.

OE-CS(EE)801(b):Big Data Analysis:3-0-0-3:3

Course Objectives: 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. Mainly the course objectives are: conceptualization and summarization of big data and machine learning, trivial data versus big data, big data computing technologies, machine learning techniques, and scaling up machine learning approaches.

1. Overview of big data analytics, Introduction to big data, Big data analytics applications 7
2. Technologies and tools for big data analytics, Introduction to Map Reduce/ Hadoop, Data analytics using Map Reduce/Hadoop, Data visualization techniques, Spark 13
3. Theory and methods for big data analytics Selected machine learning and data mining methods (such as support vector machine and logistic regression), Statistical analysis techniques (such as conjoint analysis and correlation analysis), Time series analysis D. Big data graph analytics 15
4. Case studies 10

Reference Books:

1. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2011.
2. Ron Bekkerman, Mikhail Bilenko and John Langford, Scaling up Machine Learning:Parallel and Distributed Approaches, Cambridge University Press,2011.
3. TomWhite,Hadoop:The Definitive Guide, O"ReillyMedia,ThirdEdition,2012.
4. Bill Franks, Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Wiley,2012.
5. Michael Minelli, Michele Chambers, and Ambiga Dhiraj, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley,2013.
6. Frank J. Ohlhorst, Big Data Analytics: Turning Big Data into Big Money, Wiley,2012.
7. Arvind Sathi, Big Data Analytics: Disruptive Technologies for Changing the Game, MC Press,2012

Learning Outcomes :
The students learning outcomes are designed to specify what the students will be able to perform after completion of the course:

- Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.
- Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.
- Ability to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
- Ability to understand and apply scaling up machine learning techniques and associated computing techniques and technologies.

- Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.
- Ability to integrate machine learning libraries and mathematical and statistical tools with modern technologies like hadoop and mapreduce.

OE-CS(EE)801(c): Data Warehousing & Data Mining: 3-0-0-3:3

Course objectives

1. To introduce students to the basic concepts and techniques of Data Mining.
2. To introduce a wide range of clustering, estimation, prediction, and classification algorithms.
3. To introduce mathematical statistics foundations of the Data Mining Algorithms.
4. To introduce basic principles, concepts and applications of data warehousing.

1. Introduction
   Introduction to Data Mining, Importance of Data Mining, Data Mining functionalities, Classification of Data mining systems, Data mining architecture, Major Issues in Data Mining, Data mining metrics, Applications of Data Mining, Social impacts of data, Data Mining from a Database Perspective 6
2. Data Pre-processing: Introduction, Descriptive Data Summarization, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization. 7
3. Classification and Prediction Basic issues regarding classification and predication, Classification by Decision Tree, Bayesian classification, classification by back propagation, Associative classification, Prediction, Statistical Based Algorithms, Decision Tree Based Algorithms, Neural Network Based Algorithms, Rule Based Algorithms, Other Classification Methods, Combining Techniques, Classifier Accuracy and Error Measures 9
4. Clustering Similarity and Distance Measures, Hierarchical Algorithms, Partitioned Algorithms, Clustering Large Databases, Clustering with Categorical Attributes 8
5. Association Rules Basic Algorithms, Advanced Association Rule Techniques, Measuring the Quality of Rules 8
6. Applications and other Data mining techniques, Data Mining Applications, Mining Event Sequences, Mining, Web Mining, The WEKA data mining Workbench Visual DM,Text 7

Text Books:

1.J. Han and M. Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufman, 3/E, 2011.
2.Alex Berson, Stephen J. Smith, "Data Warehousing, Data Mining, and OLAP", MGH,1998.

Course outcomes:
After successful completion of this course, student will be able to
- Identify the key processes of data mining, data warehousing and knowledge discovery process.
- Understand the basic principles and algorithms used in practical data mining and their strengths and weaknesses.
- Apply data mining techniques to solve problems in other disciplines in a mathematical way.

OE-CS(EE)801(d) ;Digital Image Processing: 3-0-0-3:3

Course Objectives:
- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.

Introduction to structure of human eye, Image formation in the human eye, Brightness adaptation and discrimination, Image sensing and acquisition, storage, Processing, Communication, Display Image Sampling and quantization, Basic relationships between pixels.
Image Transforms (implementation):Introduction to Fourier transform, DFT and 2-D DFT, Properties of 2-D FT, FFT, IFFT, Walsh transform, Hadamard transform, Discrete cosine transform, Slant transform, Optimum transform: Karhunen – Loeve Hotelling) transform.
Image Enhancement in the Spatial and Frequency Domain: Gray level transformations, Histogram processing, Arithmetic and logic operations, Spatial filtering: Introduction, Smoothing and sharpening filters. Frequency domain filters: Homomorphic filtering.
Image Data Compression: Fundamentals, Redundancies: Coding, Inter pixel Psycho-visual, fidelity criteria, Image compression models, Error free compression, Lossy compression, Image compression standards: Binary image and Continuous tone Still Image compression standards, Video compression standards.
Morphological Image Processing: Introductions, Dilation, Erosion, Opening, closing, Hit -or-miss transformation, Morphological algorithm operations on binary Images, Morphological algorithm operations on gray-scale Images. Image Segmentation, Representation and Description: Detection of discontinuities, Edge linking and Boundary detection, Thresholding regionbased segmentation, Image Representation schemes, Boundary descriptors, and Regional descriptors.

Text Books:
1. Digital Image Processing, R.C Gonzalez and R. Woods, Pearson publication.
2. Digital Image Processing, Anil K. Jain, Prentice-Hall, India.
Reference Books:
1. Digital Image Processing, W.K. Pratt 2nd Edition, John Wiley & Sons.
2. Digital Image Processing and Analysis, B. Chanda & D. Dutta Majumder Prentice-Hall, India.
3. Image Processing- Theory, Algorithms & Architecture, M. A. Sid-Ahmed, McGraw-Hill.

Course Outcomes :
1. Review the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms.
3. Evaluate the techniques for image enhancement and image restoration.
4. Categorize various compression techniques.
5. Interpret Image compression standards.
6. Interpret image segmentation and representation techniques.

OE-CS(EE)801(e): Computer Graphics & Visualization: 3-0-0-3:3

1. Introduction: History of computer graphics, applications, graphics pipeline, physical and synthetic images, synthetic camera, modeling, animation, rendering, relation to computer vision and image processing, review of basic mathematical objects (points, vectors, matrix methods) 6
2. Introduction to OpenGL: OpenGL architecture, primitives and attributes, simple modeling and rendering of two and three dimensional geometric objects, indexed and RGB color models, frame buffer, double buffering, GLUT, interaction, events and callbacks, picking 6
3. Geometric transformations: Homogeneous coordinates, affine transformations (translation, rotation, scaling, shear), concatenation, matrix stacks and use of model view matrix in OpenGL for these operations 6
4. Viewing Classical three dimensional viewing, computer viewing, specifying views, parallel and perspective projective transformations; Visibility z Buffer, BSP trees, OpenGL culling, hidden surface algorithms 7

5. Shading: Light sources, illumination model, Gouraud and Phong shading for polygons. Rasterization Line segment and polygon clipping, 3D clipping, scan conversion, polygonal fill, Bresenham's algorithm 7
6. Discrete Techniques : Texture mapping, compositing, textures in OpenGL; Ray Tracing Recursive ray tracer, ray sphere intersection 7
7. Representation and Visualization Bezier curves and surfaces, Bsplines, visualization, interpolation, marching squares algorithm 6

Text Books:

1. Edward Angel, Interactive Computer Graphics. A Top Down Approach Using OpenGL (fifth Edition), Pearson Education,2008
2. Donald Hearn and Pauline Baker, Computer Graphics with OpenGL (third edition), Prentice Hall,2003
3. F.S. Hill Jr. and S. M. Kelley, Computer Graphics using OpenGL (third edition), Prentice Hall, 2006
4. Peter Shirley and Steve Marschner, Computer Graphics (first edition), A. K. Peters,

Learning Outcomes:

After learning the course the students should be able to

1. Explain fundamental concepts within computer graphics such as geometrical transformations, illumination models, removal of hidden surfaces and rendering
2. Explain the ideas in some fundamental algorithms for computer graphics and to some extent be able to compare and evaluate them
3. Explain and apply fundamental principles within interaction programming
4. Explain and understand fundamental concepts within information visualization and scientific visualization.

OE-CS(EE)801(f): Object Oriented Programming: 3-0-0-3:3

Object oriented Design: Concept of Object oriented programming language, Major and minor elements, Object, Class, relationship among objects, aggregation, links, relationship among classes-association, aggregation using instantiation, meta-class, grouping constructs.

Object oriented concept: Difference between OOP and other conventional programming, advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism.

Basic concepts of Object oriented programming using Java: Class & Object properties: Basic concepts of Java programming-advantages of Java, byte-code & JVM, data types, access specifiers, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, garbage collection, nested and inner classes, basic string handling concepts, -String (discuss char(), compare(), equals(), Equals Ignore case(), indexOf(), length(), substring(), to CharArray(), toLowercCase(), tostring(), methods), concept of mutable and immutable string, command line arguments, basics of I/O operations-keyboard input using Buffered Reader & Scanner classes. Reusability properties: Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, use of abstract classes, &methods, interfaces. Creation of packages, importing packages, member access for packages. Exception handling &Multithreading : Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread synchronization, inter thread communication, deadlocks for threads, suspending & resuming threads.

Applet Programming (using swing): Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applet in applets, concept of delegation event model and listener, I/O in applets, use of repaint(), getDocumentBase(), getCodeBase() methods, layout manager (basic concept), creation of buttons (JButton class only) & text fields.

Text Books:
1. Object Oriented Modeling and design, James Rambaugh& Michael Blaha, PHI.
2. Object Oriented Programming with C++ and Java, D. Samanta, PHI
3. Programming with Java: A Primer, E. Balagurusamy, TMH.

Reference Books:
1. Object oriented system Development, Ali Bahrami, McGraw Hill.
2. The complete reference Java2, Patrick Naughton & Herbert Schildt, TMH

Expected Course Outcomes:

Upon completion of this course, the students will be able to:

1. Understand the difference between the top-down and bottom-up approach
2. Describe the object-oriented programming approach in connection with C++
3. Apply the concepts of object-oriented programming
4. Illustrate the process of data file manipulations using C++
5. Apply virtual and pure virtual function & complex programming situations

PR-EE881:Project-II;12-0-0-12:6

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under EC P1, 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 EEP1;
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.

PR-EE882: Viva-Voce: 0-0-0-0:2

PR-EE883: Summer Industry Internship: No credits

Minimum of six weeks in an Industry / Research Institute / Educational Institution. 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.

****