Name of the Department:Energy Engineering

Name of the School:Engineering and Technology

Programme Name: Integrated B. Tech. and M. Tech. in Electrical Engineering with specialization in Energy Engineering

Course Structure Details

Programme Name	:	Integrated B. Tech. and M. Tech. in Electrical Engineering with specialization in Energy Engineering
Programme Objective (POs)	:	• To develop the Energy Engineering Department into a department of excellence, capable of producing competent Electrical Engineers who can contribute to the advancement of society. • The department is dedicated to giving students the knowledge, technical skills, and values that prepare them to excel as engineers and leaders. • The department is also committed to inducing a spark in students for life-long learning and to become good citizens.
Programme outcome	:	**PO1** **Engineeringknowledge:**Applytheknowledgeofmathematics,science,engineeringfundamentals,andanengineeringspecializationtothesolutionofcomplexengineeringproblems. **PO2** **Problemanalysis:**Identify,formulate,reviewresearchliterature,and analyzecomplexengineeringproblemsreachingsubstantiatedconclusionsusingfirstprinciplesofmathematics,naturalsciences,and engineeringsciences. **PO3** **Design/development of solutions:** Design solutions for complex engineering problems anddesignsystemcomponentsorprocessesthatmeetthespecifiednee dswithappropriateconsideration for the public health and safety, and the cultural, societal, and environmentalconsiderations. **PO4** **Conduct investigations of complex problems:** Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis oftheinformationto providevalid conclusions. **PO5**

		Modern tool usage: Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modeling to complex engineering activitieswithan understandingofthe limitations. **PO6** **The engineer and society:** Apply reasoning informed by the contextual knowledge to assesssocietal,health,safety,legalandculturalissuesandtheconsequentresponsibilitiesrelevanttotheprofessionalengineeringpractice. **PO7** **Environment and sustainability:** Understand the impact of the professional engineeringsolutionsinsocietalandenvironmentalcontexts,anddemonstratetheknowledgeof,andneedforsustainable development. **PO8** **Ethics:**Applyethicalprinciplesandcommittoprofessionalethicsandresponsibilitiesandnormsofthe engineeringpractice. **PO9** **Individual and teamwork:** Function effectively as an individual, and as a member or leaderindiverseteams, andin multidisciplinarysettings. **PO10** **Communication:**Communicateeffectivelyoncomplexengineering activitieswiththeengineeringcommunityandwithsocietyatlarge,such has,beingabletocomprehendandwriteeffectivereportsanddesigndocumentation,makeeffectivepresentations,andgiveandreceiveclearinstructions. **PO11** **Projectmanagementandfinance:**Demonstrateknowledgeandunderstandingoftheengineering and management principles and apply these to one's own work, as a member andleaderin ateam, tomanage projectsand inmultidisciplinaryenvironments. **PO12** Lifelong learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
Programme Specific Outcome (SPOs)	:	**PSO1** Solve and analyse electrical circuits, network systems and signal level electronic circuits. Design and interface a microprocessor/ microcontroller/embedded system, programming, measuring and sensing equipment. **PSO2** Ability to operate, program and simulate, calibrate and verify the prototypes of various electrical machines, measurement equipment, control system, signal level electronic circuits, power electronics converters, power system equipment, microprocessor and microcontroller in the laboratory.
Semester-I		

Course Code	Title of the Course	Course Type	Credit
PHY03101	Physics	Theory	4
MAT03101	Mathematics-I	Theory	4
EEN07101	Basics Electrical Engineering	Theory	4
EEN07103	Engineering Graphics & Design		2
ENG04101	Communicative English	Theory	3
EEN07105	Basics Electrical Engineering Lab	Laboratory	1
PHY03103	Physics lab	Laboratory	1
HSS04101	Design Thinking	Laboratory	1
Semester-II			
Course Code	**Title of the Course**	**Course Type**	**Credit**
CHM03102	Chemistry	Theory	3
MAT03102	Mathematics-II	Theory	4
MME07102	Biology for Engineers	Theory	3
CSE07102	Programming for Problem Solving	Theory	3
EEN07102	Workshop Manufacturing Practices	Practical	3
HSS04102	Universal Human Values	Theory	3
CHM03104	Chemistry Lab	Laboratory	1
CSE07104	Programming for Problem Solving Lab	Laboratory	2
NSS10102	NSS/NCC	Theory	0
Semester-III			
Course Code	**Title of the Course**	**Course Type**	**Credit**
MAT07201	Mathematics III	Theory	4
EEN012010	Electrical Machines-I	Theory	3
EEN012030	Signals, Systems and Networks	Theory	3
EEN012050	Analog and Digital Electronics	Theory	3
DCE07201	Engineering Mechanics	Theory	3
EEN012070	Electrical Machines-I Lab	Laboratory	1
DCE01213	Engineering Mechanics Lab	Laboratory	1
EEN012090	Analog and Digital Electronics Lab.	Laboratory	1
DCE10217	Disaster Management	Theory	0
EEN022110	MSC-1: Energy Resources and Utilization	Theory	4

Semester-IV			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN012020	Single Board Computers and IOT	Theory	2
EEN012040	Linear Control System	Theory	3
EEN012060	Power Electronics	Theory	3
EEN012080	Electrical Machines-II	Theory	3
EEN012100	Electromagnetic Theory	Theory	3
EEN082120	Open Elective-1:Basics of Renewable Energy Resources	Theory	3
EEN012140	Single Board Computers and IOT Lab	Laboratory	2
EEN012160	Control System Lab.	Laboratory	1
EEN012180	Electrical Machines-II Lab.	Laboratory	1
EEN012200	Power Electronics Lab.	Laboratory	1
EEN032220	Environmental Science	Theory	0
EEN022240	MSC-2: Solar Thermal Technology	Theory	3
EEN022260	Solar Thermal Technology lab.	Laboratory	1
Semester-V			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN013010	Power Systems Analysis	Theory	3
EEN013030	Digital Signal Processing	Theory	3
EEN013050	Electrical Drives	Theory	3
EEN013070	Measurements and Instrumentation	Theory	3
EEN063090	Engineering Economics	Theory	3
EEN083110	Open Elective -2: Basics of Solar Energy Engineering	Theory	3
EEN013130	Measurements & Instrumentation Lab	Laboratory	1
EEN013150	Advanced Power Electronics and Drives Lab.	Laboratory	1
EEN043170	Constitution ofIndia/Essence of Indian Traditional Knowledge	Theory	0
EEN023190	MSC-3: Solar PV Technology	Theory	3
EEN023210	Solar PV Technology Lab.	Laboratory	1
Semester-VI			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN013020	Power Systems Stability Operations and Control	Theory	3
EEN013040	Microprocessor & Microcontroller	Theory	3

EEN013060	Advanced Methods in Control Theory	Theory	3
EEN073xx0	Program Elective – 1	Theory	3
EEN073xx0	Program Elective – 2	Theory	3
EEN083080	Open Elective – 3: Basics of Fuel Cell and Hydrogen Energy	Theory	3
EEN013100	Power System Lab	Laboratory	1
EEN013120	Advance Programming Lab	Laboratory	1
EEN053140	Employment Enhancement Course Summer Internship	Internship	2
EEN023160	MSC-4: Energy Storage	Theory	3
EEN023180	Energy storage lab	Laboratory	1
Semester-VII			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN014010	Switchgear & Protection	Theory	4
EEN014030	Advance Power Converters	Theory	4
EEN074xx0	Program Elective – 3	Theory	3
EEN074xx0	Program Elective – 4	Theory	3
XXXXXX	Open Elective –4	Theory	3
EEN014070	Digital Signal Processing lab	Laboratory	1
EEN054090	Project-1 (Project work,seminar and internship inindustry or at appropriateworkplace)	Project/ Internship	5
EEN024110	MSC-5: Energy Management	Theory	3
EEN024130	Energy management and audit lab	Laboratory	1
Semester-VIII			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN074xx0	Program Elective – 5	Theory	3
EEN074xx0	Program Elective – 6	Theory	3
EEN074xx0	Program Elective – 7	Theory	3
EEN054020	Project-2 (Project work, seminar and internship in industry or at appropriate workplace)	Project/ Internship	8
Semester-IX			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN075xx0	Program Elective – 8	Theory	3
EEN075xx0	Program Elective – 9	Theory	3
EEN055010	Project-3 (Project work, seminar and internship in industry or at appropriate workplace)	Project/ Internship	16

Semester-X			
Course Code	**Title of the Course**	**Course Type**	**Credit**
EEN055020	Project-4 (Project work, seminar and internship in industry or at appropriate work place)	Project/ Internship	20

Program Elective List		
Program Elective	**CourseCode**	**CourseTitle**
PE-1	EEN073200	Smart Grid
	EEN073220	Bio-Energy Systems
	EEN073240	Introduction to Hybrid and Electric Vehicles
PE-2	EEN073260	Project Management
	EEN073280	Materials Science for Energy Applications
	EEN073300	EHV AC & DC Transmission
PE-3	EEN074150	Modern Power Converters
	EEN074170	Flexible AC Transmission Systems
	EEN074190	Energy and Environment
PE-4	EEN074210	Foundations of Optimization
	EEN074230	Advanced PV Technology
	EEN074250	Power Generation Economics
PE-5	EEN074040	Computer Aided Power System Analysis
	EEN074060	DigitalImageProcessing
	EEN074080	Fuzzy Logic and Evolutionary Algorithms
PE-6	EEN074100	Computational Intelligence for Power Applications
	EEN074120	Power Electronics for Renewable Energy Technologies
	EEN074140	Heat and Mass Transfer
PE-7	EEN074160	Fundamentals of Nano Electronics
	EEN074180	Energy Efficient Building
	EEN074200	Waste to Energy

PE-8	EEN075030	MachineLearning
	EEN075050	RealTimeEmbeddedSystem
	EEN075070	ElectricalMachineDesign
PE-9	EEN075090	AdvancedMicroprocessor&EmbeddedSystems
	EEN075110	ProcessControlandInstrumentation
	EEN075130	DigitalSystemDesign

Semester I

Course Code	Course Title	Course Type	Contact Hours						Credit
PHY03101	Physics	Theory	L	3	T	1	P	0	4

Pre-requisite	:10+2 with science
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :The objective of this course is to familiarize the students with basic laws of motion, rigid body dynamics, mechanical properties of matter, oscillations and waves, and relativity. lt aims to equip the students to deal with basic problems that they would be seeing in the real world.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To understand the basic laws of mechanics.
2. To use and apply the Moment of inertia, Rigid body kinematics, Rigid body kinetics.
3. To understand mechanical concepts of matter like Viscosity and Poiseulle's equation.
4. To explain Simple harmonic oscillation, damped harmonic oscillation and forced oscillation.
5. To understand the theory of relativity.

Unit – 1	**Review of Vector calculus**

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 vector from one coordinate system to another.

Unit – 2	**Static electric Field**

Coulomb's law, Electric field intensity, Electrical field due to charges. Line, surface, 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.

Unit – 3	**Static Magnetic field**

Biot-savert Law, Ampere Law, Magnetic Flux and Magnetic flux density, Scalar and Vector magnetic potentials, steady magnetic fields produced by current carrying conductors.

Unit – 4	**Rigid Body Motion and Mechanical Properties of Matter**

Rigid body, Moment of inertia, Rigid body kinematics, Rigid body kinetics, Motion of gyroscope.Modulus of rigidity, Poisson's ratio, relation connecting different elastic-constants, Viscosity, Poiseulle's equation of liquid flow through a narrow tube.

Unit – 5	**Oscillations and Waves**

Simple harmonic oscillation, damped harmonic oscillation and forced oscillation, Q factor and resonance. Differential equation of one-dimensional wave and its solution, reflection and transmission of waves.

Text Books

1. Physics Part-I: Resanick and Halliday Vol I, Edition 5 (2007).
2. Mechanics: D.S. Mathur S. Chand Publishing Edition Ist(2000).
3. Concepts in Physics Vol .I : H.C.Verma, Dhanpat Rai and Co. Edition Ist.
4. Mechanics: R.K. Shukla and Anchal Srivastava New Age International Publishers(2006).

Reference Books:

1. An Introduction to Mechanics: D. Kleppner and R.Kolenkow, Ist Edition, McGraw Hill (2017).
2. Mechanics (Berkeley Physics Course) Vol. I: C. Kettel, W. D. Knight, M.A. Ruderman and A.C. Helmholz edition 2nd, McGraw Hill Education, (2017).

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT03101	Mathematics-I	Theory	L	3	T	3	P	0	4

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives : The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Outcomes (COs): After completion of this course, the students shall be able to:

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. To explain the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. To discuss the tool of power series and Fourier series for learning advanced Engineering Mathematics.
4. To deal with functions of several variables that is essential in most branches of engineering.
5. To use the essential tool of matrices and linear algebra in a comprehensive manner.

Unit – 1	**Calculus**

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. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders, indeterminate forms, and L'Hospital's rule, Maxima and minima.

Unit – 2	**Sequences 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.

Unit – 3	**Multivariable Calculus (Differentiation)**

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.

Unit – 4	**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.

Text Books

1. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company,2022.
2. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
3. Erwin Kreyszig, Advanced Engineering Mathematics,10thEdition, John Wiley & Sons,2006.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi, 2008.

Reference Books:

1. W. E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
2. N. P. Bali and Manish Goyal, Atext book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. B.S. Grewal, Higher Engineering Mathematics, KhannaPublishers,36th Edition, 2010.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN07101	Basic Electrical Engineering	Theory	L	3	T	1	P	0	4

Pre-requisite	:Basic knowledge of physics and solving skills.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To impart basic knowledge about the Electric and Magnetic circuits.
2. To inculcate an understanding of the AC fundamentals.
3. To understand the working of various Electrical Machines.
4. To know about the single-line diagram of the power system.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To implement mesh and nodal analysis to analyze DC circuits.
2. To determine the analogy between electrical and magnetic circuits and thus explore the magnetic circuit.
3. Identify, characterize, and therefore analyze single and three-phase AC circuit.
4. To demonstrate the operation and application of transformer and induction motor.
5. To describe the operation and layout of a power system network.

Unit – 1	**DC circuits**

Review of Linear, Lumped, Finite, Passive,Bilateral Circuit Elements, Voltage sources,Current sources, Mesh Current, and NodeVoltage analysis of DC Circuits.

Unit – 2	**Magnetic circuits**

MMF, Magnetic flux, Reluctance, Flux density, Analogy with electric circuits, Analysis ofmagnetic circuits.

Unit – 3	**AC circuits**

Single-phase AC Circuit
Representation of sinusoidal voltages and currents, RMS value and average value, j operator, Phasors, Voltages and Currents relationship and instantaneous and average power in a pure resistor, pure inductor and pure capacitor, Impedance, Admittance, Analysis of circuits, Complex power, active and reactive powers, Power Triangle, Power factor, Three-phase AC Circuit. Symmetrical sinusoidal supply systems, voltage, current and power relationship in 3-phase balanced star and delta-connected loads, Analysis of three-phase balanced star and delta connected loads.

Unit – 4	**Transformers and three phase induction motors**

Transformers
Construction, working principle, Emf equation, Transformer on no-load, Phasor diagrams on no- load and full-load.Three-Phase Induction motors Principle of operation, slip, rotor induced emf, rotor frequency.

Unit – 5	**Power System**

Scheme of Power System from generation, transmission & and distribution.

Text Books

1. Basic Electrical Engineering: M S Naidu & S Kamakshiah: TataMcGraw Hill Publications
2. Basic Electrical Engineering: T K Nagasarkar and M S Sukhija: Oxford University Press

3. Electrical & Electronics Technolgy: Hughes: Pearson Publications

Reference Books:

1. Theory and Problems of Basic Electrical Engineering: D P Kothari & I J Nagrath: Prentice Hall Publication.
2. Principles of Electrical Engineering: V K Mehta: S Chand Publications.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN071030	Engineering Graphics & Design	Theory/Lab	L	1	T	0	P	2	2

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives : The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

Course Outcomes (COs): After completion of this course, the students shall be able to:
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
2. To prepare you to communicate effectively
3. To prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice.
4. The students will learn:
5. Introduction to engineering design and its place in society.
6. Exposure to the visual aspects of engineering design.
7. Exposure to engineering graphics standards.
8. Exposure to solid modelling.
9. Exposure to computer-aided geometric design.
10. Exposure to creating working drawings.
11. Exposure to engineering communication.

Unit – 1	**Introduction to Engineering Drawing and Orthographic Projections**

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes.

Unit – 2	**Projections of Regular Solids and Sections and Sectional Views of Right Angular Solids**

Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.
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).

Unit – 3	**Isometric Projections: Principles of Isometric projection and Overview of Computer Graphics**

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;
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]

Unit – 4	**Customisation & CAD Drawing ; Annotations, layering & other functions**

: Consisting of 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 tolerancing; 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;
Covering 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

Unit – 5	**Demonstration of a simple team design project that illustrates**

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 Modelling (BIM).

Text Books

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
2. Jain Pradeep, (2019) Engineering Graphics and Design, Khanna Book Publishing Company
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
6. (Corresponding set of) CAD Software Theory and User Manuals.

Reference Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
2. Jain Pradeep, (2019) Engineering Graphics and Design, Khanna Book Publishing Company
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
6. (Corresponding set of) CAD Software Theory and User Manuals.

Course Code	Course Title	Course Type	Contact Hours						Credit
PHY03103	Physics Lab	Laboratory	L	0	T	0	P	2	1
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								

Syllabus Version :	1

Course Objectives :To give students a foundational understanding of rigid body dynamics through basic experiments. To teach principles of motion, forces, and moments applied to solid objects. Develop skills in analyzing and predicting motion behaviors. Apply theoretical concepts to practical scenarios, fostering a strong grasp of mechanical systems and their behaviors.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Understand the concept of radius of gyration and its relation to rotational motion.
2. Gain a practical understanding of Ohm's law and its applications in electrical circuits.
3. Acquire knowledge of the concept of moment of inertia and learn the experimental procedure to determine the moment of inertia of rotating objects.
4. Familiarize oneself with the principles of different logic gates (AND, OR, NOT) in a logic system and comprehend their behaviour in digital circuits.

List of experiments

1. To determine the value of acceleration due to gravity and radius of gyration using bar pendulum.
2. To verify the ohm's law and hence determine the unknown resistance of the given material of the wire.
3. To determine the spring constant of a spring by
   (a) static method (b) dynamic method.
4. To study the principle of different logic gates in positive logic system.
5. To determine the moment of inertia of a flywheel.
6. To determine the value of acceleration due to gravity and radius of gyration using kater's pendulum.

Text Books

1. Practical of Physics by C.L. Arora,(S. Chand and Company Limited, Edition 1995).
2. Practical of Physics by Harnam Singh and P.S. Hemne, (S. Chand and Company Limited).

Reference Books:

1. Practical Physics by P. R. Sasi Kumar, (PHI Learning Pvt. Ltd., 2011).
2. Practical Physics by R K Shukla, (New Age International, 2007).

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN07105	Basic Electrical Engineering Lab.	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:Knowledge of basic electrical engineering course
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :The objective of this lab. is to provide hands- on training on the basic Electrical Engineering.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Students will learn on the practical implementation of Electrical fundamentals.
2. Students will visualize the concept of circuit laws and network theorems.
3. Students will acquire skills in electrical measuring devices.
4. Students will learn different applications of electrical machinery.

List of Experiments

1. Verification of KCL&KVL.
2. Study of AC R-L-C Series circuit.
3. Study of AC R-L-C parallel circuit.

4. Verification of Thevenin's theorem
5. Verification of Superposition theorem
6. Verification of Maximum Power Transfer theorem
7. To Measure the power and the power factor of a single phase load by 3-Voltmeter Method.
8. To Measure the power and the power factor of a single phase load by 3-Ammter Method.
9. Study of resonance in electrical circuit.
10. Transformer testing.

Text Books

1. Johnetta Keizer, (2021) Basic Electrical LAB Experiment Guide
2. M.Siva Ramkumar, A.Amudha, M.S Krishnan, G.Emayavaramban (2019) Basic electrical engineering laboratory : Fundamental of Electrical, Notion Press; 1st edition
3. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
4. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.

Reference Books:

1. Ritu Sahdev (2019), Basic Electrical Engineering, Khanna Book Publishing Company
2. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
3. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India.

Course Code	Course Title	Course Type	Contact Hours						Credit
ENG04101	Communicative English	Theory	L	2	T	0	P	2	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :The objective of this Course is to Help the students develop an overall knowledge and understanding of English Grammar and Phonetics and communicate ideas and information effectively. The students will be familiarized with the basics of communication and thus develop their ability to use English for performing some of the most vital communicative functions in academic, social and professional situations. The student will follow the writing conventions correctly without making any serious lapses in grammar or word choices.

Course Outcomes (COs):

1. Identify deviant use of English both in written and spoken forms
2. Recognize the errors of usage and correct them
3. Recognize their own ability to improve their own competence in using the language
4. Understand and appreciate English spoken by people from different regions
5. Use language for speaking with confidence in an intelligible and acceptable manner

Unit – 1

Communication: Definition, Process, Types-Verbal, Non-Verbal, Effective Communication, Communication Network in an organization, barriers of communication.

Unit – 2

Parts of Speech

Text Books

1. E. Suresh Kumar and P. Sreehari, Fluency in English – Part II, Communicative English, OUP, 2006.
2. Wren, P.C.; Martin, H.; Prasada Rao, N.D.V, High School English Grammar & Composition. New Delhi: S. Chand,1973.

Reference Books:
1. Alexander, L., Longman English grammar practice. New York: Longman,1999. Murphy, R., English grammar in use. Cambridge: Cambridge University Press, 2012.

Course Code	Course Title	Course Type	Contact Hours						Credit
HSS04101	Design Thinking	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Compare and classify the various learning styles and memory techniques and Apply them in their engineering education.
2. Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products.
3. Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products.
4. Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, techniques during prototype development.
5. Perceive individual differences and its impact on everyday decisions and further Create a better customer experience.

Unit – 1	

An Insight to Learning; Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting.
Remembering Memory; Understanding the Memory process, Problems in retention, Memory enhancement techniques

Unit – 2	

Emotions: Experience & Expression: Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers.
Basics of Design Thinking: Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test

Unit – 3	

Being Ingenious & Fixing Problem: Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving.
Process of Product Design: Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design

Unit – 4	

Prototyping & Testing; What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing.

Celebrating the Difference: Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences.
Unit – 5
Design Thinking & Customer Centricity: Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design of Tournament – Knock-Out, League/Round Robin & Combination. Feedback, Re-Design & Re-Create: Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".
Text Books
Reference Books:

Semester II

Course Code	Course Title	Course Type	Contact Hours						Credit
CHM03102	Chemistry-I	Theory	L	3	T	0	P	0	3
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :
The objective of the Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
2. To rationalise bulk properties and processes using thermodynamic considerations.
3. To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
4. To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
5. To list major chemical reactions that are used in the synthesis of molecules.

Unit – 1	**Atomic and Molecular Structure**

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. 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.

Unit – 2	**Spectroscopic techniques and applications; Intermolecular forces and potential energy surfaces**

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. Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.
Unit – 3 **Use of free energy in chemical equilibria**
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.
Unit – 4 **Periodic properties**
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.
Unit – 5 **Stereochemistry and Organic reactions and synthesis of a drug molecule**
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. Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.
Text Books
1. AICTE's Prescribed Textbook: Chemistry – I with Lab Manual, Khanna Book Publishing. 2. Engineering Chemistry, by Manisha Agrawal. 3. University chemistry, by B. H. Mahan 4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane 5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
Reference Books:
1. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan. 2. 7Physical Chemistry, by P. W. Atkins. 3. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT03102	Mathematics- II	Theory	L	3	T	1	P	0	4
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :Mathematics is fundamentally necessary to formulate, solve and analyze engineering problems.The objective of this course is to familiarize the prospective engineers with techniques in matrices, ordinary differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

1. Course Outcomes (COs): After completion of this course, the students shall be able to:
2. The essential tool of matrices and linear algebra in a comprehensive manner.
3. The effective mathematical tools for the solutions of differential equations that model physical processes.
4. The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

Unit – 1	**Matrices**

Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

Unit – 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.

Unit – 3	**Ordinary differential equations of higher orders**

Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

Unit – 4	**Complex Variable – Differentiation**

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit – 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.

Text Books

1. AICTE's Prescribed Textbook: Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable), Khanna Book Publishing Co.
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.

Reference Books:

1. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
2. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
3. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
4. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
5. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Code	Course Title	Course Type	Contact Hours						Credit
MME07102	Biology for Engineers	Theory	L	3	T	0	P	0	3
Pre-requisite	:Nill								

Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

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

Unit – 1	**Introduction and Classification**

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.
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) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or 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

Unit – 2	**Genetics**

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, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of 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.

Unit – 3	**Biomolecules: Purpose and Enzymes**

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
Tutorial: Exploring the Four Orders of Nature; Exploring Co-existence in Existence
To convey that without catalysis life would not have existed on earth, Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyze 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.

Unit – 4	**Information Transfer and Macromolecular analysis**

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. DICOM Image formats, The DNA Technology (Use and Application) Regulation Bill, 2019.
Purpose: How to analyses biological processes at the reductionistic level
Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Unit – 5	**Metabolism Purpose and Microbiology**

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 exergoinc 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
Microbiology
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 Books

1. General Biology, Uma Devi Koduru, Khanna Book Publishing Company.
2. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
3. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
4. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company

Reference Books:

1. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
2. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Code	Course Title	Course Type	Contact Hours						Credit
CSE07102	Programming for Problem Solving	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

1. Course Objectives :
2. To learn the fundamentals of computers.
3. To understand the various steps in program development.
4. To learn the syntax and semantics of C programming language.
5. To learn the usage of structured programming approach in solving problems.
6. To understated and formulate algorithm for programming script
7. To analyze the output based on the given input variables.

Course Outcomes (COs): After completion of this course, the students shall be able to:

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.

Unit – 1	**Introduction to Programming**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.). Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Unit – 2	**Arithmetic Expression and Arrays**

Arithmetic expressions and precedence.
Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.
Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Unit – 3	**Sorting algorithms**

Basic Algorithms, 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 – 4	**Functions and Recursion**

Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.
Recursion, 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 – 5	**Pointers and Structures**

Structures, Defining structures and Array of Structures.
Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation).
File handling (only if time is available, otherwise should be done as part of the lab).

Text Books

1. AICTE's Prescribed Textbook: Programming for Problem Solving, Khanna Book Publishing Co.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

Reference Books:

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Course Code	Course Title	Course Type	Contact Hours						Credit
CHM03104	Chemistry- I Lab	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :The objective of Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.
Course Outcomes (COs): After completion of this course, the students shall be able to: 1. To estimate rate constants of reactions from concentration of reactants/products as a function of time. 2. To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc. 3. To synthesize a small drug molecule and analyze a salt sample.
List of Experiments
Choice of 10-12 experiments from the following: 1. Determination of surface tension and viscosity. 2. Thin layer chromatography. 3. Ion exchange column for removal of hardness of water. 4. Determination of chloride content of water. 5. Colligative properties using freezing point depression. 6. Determination of the rate constant of a reaction. 7. Determination of cell constant and conductance of solutions. 8. Potentiometry - determination of redox potentials and emfs. 9. Synthesis of a polymer/drug. 10. Saponification/acid value of an oil. 11. Chemical analysis of a salt. 12. Lattice structures and packing of spheres. 13. Models of potential energy surfaces. 14. Chemical oscillations- Iodine clock reaction. 15. Determination of the partition coefficient of a substance between two immiscible liquids. 16. Adsorption of acetic acid by charcoal. 17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.
Text Books
Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
CSE07104	Programming for Problem Solving Lab	Laboratory	L	0	T	0	P	4	2
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understand and formulate algorithms for programming script.
6. To analyze the output based on the given input variables.

Course Outcomes (COs): After completion of this course, the students shall be able to:

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

Lists of experiments

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

Text Books

1. AICTE's Prescribed Textbook: Programming for Problem Solving, Khanna Book Publishing Co.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

Reference Books:

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN07102	Workshop Manufacturing Practices	Theory/Lab	L	1	T	0	P	4	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
2. To have a study and hands-on-exercise on plumbing and carpentry components.
3. To have a practice on gas welding, foundry operations and fitting
4. To have a study on measurement of electrical quantities, energy and resistance to earth.

5. To have a practice on soldering.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To fabricate components with their own hands.
2. To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
3. To design small devices of their interest by assembling different components

Unit – 1	

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

Unit – 2	

CNC machining, Additive manufacturing.

Unit – 3	

Fitting operations & power tools, Electrical & Electronics.

Unit – 4	

Carpentry, Plastic moulding, glass cutting

Unit – 5	

Metal casting
Welding (arc welding & gas welding), brazing

Practical:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Text Books

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

Reference Books:

1. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
2. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Course Code	Course Title	Course Type	Contact Hours						Credit
HSS04102	UniversalHuman Values-IIUnderstanding	Theory	L	3	T	0	P	0	3

	Harmony And Ethical Human Conduct								

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Course Outcomes (COs): After completion of this course, the students shall be able to:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship, and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1. Holistic vision of life
2. Socially responsible behaviour
3. Environmentally responsible work
4. Ethical human conduct
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all
7. This is only an introductory foundational input. It would be desirable to follow it up by
8. Faculty-student or mentor-mentee programs throughout their time with the institution
9. Higher level courses on human values in every aspect of living.

Unit – 1	**Introduction to Value Education**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education); Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity – the Basic Human Aspirations; Happiness and Prosperity – Current Scenario; Method to Fulfill the Basic Human Aspirations

Tutorial: Sharing about Oneself; Exploring Human Consciousness; Exploring Natural Acceptance

Unit – 2	**Harmony in the Human Being**

Understanding Human being as the Co-existence of the Self and the Body; Distinguishing between the Needs of the Self and the Body; The Body as an Instrument of the Self; Understanding Harmony in the Self; Harmony of the Self with the Body; Programme to ensure self-regulation and Health

Tutorial: Exploring the difference of Needs of Self and Body; Exploring Sources of Imagination in the Self; Exploring Harmony of Self with the Body

Unit – 3	**Harmony in the Family and Society**

Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; : 'Respect' – as the Right Evaluation; : Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order.

Tutorial: Exploring the Feeling of Trust; Exploring the Feeling of Respect; Exploring Systems to fulfil Human Goal

Unit – 4	**Harmony in the Nature/Existence**

Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence
Tutorial: Exploring the Four Orders of Nature; Exploring Co-existence in Existence

Unit – 5	**Implications of the Holistic Understanding – a Look at Professional Ethics**

Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Holistic Technologies, Production Systems and Management Models- Typical Case Studies; Strategies for Transition towards Value-based Life and Profession; Competence in Professional Ethics;
Tutorial: Exploring Ethical Human Conduct; Exploring Humanistic Models in Education; Exploring Steps of Transition towards Universal Human Order

Text Books

1. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53
3. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
4. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
5. The Story of Stuff (Book).
6. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
7. Small is Beautiful - E. F Schumacher.
8. Slow is Beautiful - Cecile Andrews
9. Economy of Permanence - J C Kumarappa

Reference Books:

1. Bharat Mein Angreji Raj – Pandit Sunderlal
2. Rediscovering India - by Dharampal
3. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
4. India Wins Freedom - Maulana Abdul Kalam Azad
5. Vivekananda - Romain Rolland (English)
6. Gandhi - Romain Rolland (English)

Semester III

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012010	ELECTRICAL MACHINES – I	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :To clearly understand the basic concepts of the electrical machines working in the modern power system such as transformers and d.c. machines. To learn the analytical methods to develop machine

models and to further solve problems associated operation of transformers, motors and generators.	
Course Outcomes (COs): After completion of this course, the students shall be able to: 1. Describe construction, operation and development of phasor diagram of transformer. 2. Analyze equivalent circuit, losses, efficiency, voltage regulation, and tests on transformer. 3. Evaluate parallel operation of transformers, operation of auto transformer. 4. Describe construction, operation, and characteristics of all types of dc machines (both motors and generators). 5. Analyze the speed control, losses, efficiency, and tests on dc machines.	
Unit – 1	**Transformer Fundamentals**
Transformers: Review of Construction, ratings & specification of transformer, Principle of operation of single phase transformer	
Unit – 2	**Phasor diagram, equivalent circuit, tests, voltage regulation, losses and efficiency.**
Phasor diagram (no- load and on-load). Development of equivalent circuit, O.C and S.C tests, Voltage regulation, losses and efficiency, All-dayefficiency	
Unit – 3	**Tests, Parallel operation, and Autotransformers**
Polarity test, Sumpner's test. Parallel operation of single phase and three phase transformers,Autotransformers.	
Unit – 4	**D.C. Machines fundamentals, excitation, and characteristics.**
DC Generators:Construction, principleof operation, Methodsof excitation, armaturereaction, commutation,characteristics of DCgenerators-OCC andexternalcharacteristics.DC Motors: Principleof operation,characteristics ofmotors, different typesof D.C. motor (shunt& series &compound).	
Unit – 5	**Speed control, starters, losses and efficiency**
Fieldandarmaturemethodsofspeedcontrol,principleofDC motor starting, 3 point starters.Losses and Efficiencyof DC machines,Swinburne's test,Hopkinson's test.	
Text Books	
1. P.S. Bhimbra – Electrical Machinery (Ed. 4) – Khanna Pub, 1986	
Reference Books:	
2. Clayton and Hankock – Performance and Design of DC Machines – Oxford IBH, 1994. 3. Nagrath and Kothari – Electrical Machines TMH, 1993. 4. M.G. Say – AC. Machines (Ed.5) – Pitman, 1993. 5. P.K. Mukherjee & S. Chakravorti – Electrical Machines (Ed.2) – Dhanpat Rai, 1993	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012030	SIGNALS AND SYSTEMS	Theory	L	3	T	0	P	0	3
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								
Course Objectives : 1. To introduce different types of signals, their behavior and significance. 2. To understand various classifications of systems and their characteristics. 3. Understand the representation of signals and systems in time and frequency domain. 4. To introduce the concept of transforms and their properties.									

5. To understand analog filters, their representation and characteristics.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Develop a fundamental understanding of signals and systems and their characteristics.
2. Apply Laplace transforms for signal analysis.
3. Apply mathematical modelling for Time domain representation and analysis of signals and systems.
4. Apply mathematical modelling for Frequency domain representation and analysis of signals and systems.
5. Develop basic understanding of filters, their characteristics and design techniques for analog filters.

Unit – 1	**Introduction to signals and systems.**

Definition of signal, Classification of signals with examples, Elementary signals, Basic operations on signals and related numericals.Definition of system, Classification of system and their Properties.

Unit – 2	**Laplace Transforms**

Introduction, bilateral and unilateral Laplace transforms and their region of convergence, Inverse Laplace transform, Properties of Laplace transforms.Numerical on Laplace transforms using properties and formulae. Application insolving circuit problems and differential equation.

Unit – 3	**Time-Domain Representations For Linear Time Invariant (LTI) Systems.**

Differential and difference equation representations (classical method), related numerical. Impulse response representations (convolution integration and convolution sum), properties of impulse response representations, block diagram representations.

Unit – 4	**Fourier Representation For Signals**

Introduction, Continuous Time and Discrete Fourier series,Continuous Time and Discrete Fourier Transforms.. Application of Fourier representations, Frequency response of LTIsystems and numerical on it.

Unit – 5	**Analog Filter Design**

Introduction, Classification of filters, filter characteristics.Design of Analog filters.

Text Books

1. Signal & System by Haykin Van Veen (John Wiley and Sons)
2. Signal & System by I.J.Nagrath,S.N. Sharan ,R Ranjan (TMH)

Reference Books:

1. Signal and System by D .k Cheng
2. Digital Filter Analysis, Design, and Application by Andrews Antononiu (TMH)

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012050	ANALOG AND DIGITAL ELECTRONICS	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To provide an understanding about semiconductor devices.

2. To learn about the behavior of P-N junction material to voltage, current and temperature.
3. To be able to analyze biasing of transistors. Methods of transistor biasing.
4. To provide an understanding of digital circuits and systems.
5. To learn about the basic elements or building blocks of digital circuits and systems, the methods and approaches leading to their practical design and real-time implementation.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Learn the basics of semiconductor devices, design of electronic devices and circuits.
2. Learn the basics characteristics of transistor and it's operation and applications.
3. Learn the basics of number systems and binary codes.
4. Learn the basics of logic gates.
5. Apply Boolean algebra for representation of digital logic.

Unit – 1	**P-N Junction**

Open circuited P-N Junction, Bias conditions, The current components in a P-N Junction diode. The volt-ampere characteristics Reverse saturation current, Breakdown. The effect of temperature on V-I characteristics.Diode resistance, Transition capacitance, Diffusion capacitance, Switching linesZener diodes, Semiconductor photo-diode, Light emitting diode,specifications.

Unit – 2	**Diode circuits and Transistor Characteristics**

Diode as a circuit element, load- line concept diode model, clipping circuits, clipping at two independent levels, clampingcircuits.Bipolar Junction Transistor, Bias conditions, Transistor current components common base configuration. Transistor amplifying action, Transistor as a switch, common emitter configuration, common collector configuration,Maximum voltage rating, Limits of operation,Transistor specifications

Unit – 3	**Number Systems and Codes**

Number Systems (Binary, decimal, octal, hexadecimal). Number system conversions. Sub topic 3: Binary Codes (Numeric and Alphanumeric codes.), Arithmetic operations (Binary arithmetic-addition, subtraction, multiplication and division, 1's and 2's complement arithmetic).

Unit – 4	**Logic Circuits & Logic Families**

Logic Gates (OR, AND, NOT, XOR, XNOR, NOR and NAND gates, truth tables), Logic families.

Unit – 5	**Boolean Algebra**

Boolean algebra (DE Morgan's theorems, Sum of products, product of sums (Minterm& max- terms). Boolean Function minimization (Function minimization using Karnaugh's map,Don't care conditions, variable entered mapping, minimization using variable entered maps)

Text Books

1. Donald P leach & Albert Paul Malvino-Digital Principles and Applications (Ed.4)-TMH, 1991.
2. Douglas V. Hall - Digital circuits and Systems -MGH, 1989.
3. William I. Fletcher- Engineering Approach to Digital Design PH I, 1990.
4. Taub & Schilling – Digital Integrated Electronics-MGH, 1977.

Reference Books:

1. Millman and Halkias - Integrated Electronics: Analog and Digital circuits and systems-TMH- 1992
2. Boylestad and Nashelsky - Electronic Devices and Circuit Theory (Ed. 5. -PHI, 1993.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012070	ELECTRICAL MACHINES LABORATORY	Laboratory	L	0	T	0	P	2	1
Pre-requisite	:Theoretical concept of electrical machines.								

Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :To provide facilities for performing experiments related to various types of electrical machines and analyzing them. To introduce the students to single-phase and three-phase electrical machines & various types of drives systems.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.Such hands-on experience provides students with critical practical knowledge of electrical machines.

List of experiments

1. Open circuit & Short Circuit test on a single phase transformer.
2. Sumpner's Test
3. Polarity Test & Parallel Operation of Two Single Phase Transformer.
4. Swinburne's Test
5. Hopkinson's Test (Regenerative Test)
6. Speed Control of DC Shunt Motor
7. Load Test on DC Shunt Generator
8. Load Characteristic of DC Shunt Motor

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012090	ANALOG & DIGITAL ELECTRONICS LAB	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:Theoretical concept of analog and digital systems.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :To provide facilities for performing experiments related to various types of electronic devices and analyzing them.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.Such hands-on experience provides students with critical practical aspects of analog and digital electronic design.

List of experiments

FIRST CYCLE: ANALOG SYSTEM DESIGN

1. Design of adder circuit using OP AMP.
2. OP-AMP as an integrator & differentiator.
3. Design a current to voltage and voltage to current converter using OP-AMP.
4. Design a Comparator circuit using OP-AMP-741 to compare between two Input.
5. Design a triangular wave generator using OP-AMP.
6. Design a Monostable and Astable Multi vibrator using 555 Timer.
7. Design of a 1st order and 2nd order Low-Pass filter using OP-AMP with cutoff frequency at 1

KHz& pass band gain 2.

Extra Experiment (beyond course curriculum)

8. Design of a 1st order and 2nd order High-Pass filter using OP-AMP with cutoff frequency at 1 KHz& pass band gain 1.58.

SECOND CYCLE: DIGITAL SYSTEM DESIGN

1. To implement and verify BCD to XS-3 code converter.
2. Implementation of R-S, J-K, D Flip-Flop.
3. To implement a 3 bit MOD – 6 Synchronous Counter.
4. Design a 3 bit Ring Counter & Twisted Ring Counter by the help of Synchronous circuit Design.
5. To implement a 3 bit MOD – 6 Asynchronous Counter

Extra Experiment (beyond course curriculum)

6. Design a 3 bit UP- DOWN counter with the help controlling Signal X. If X=1 It will count upward direction and if X =0 count downward direction.

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EE022110	Energy Resources and Utilization	Theory	L	3	T	1	P	0	4

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Understand the potential of the various energy sources.
2. Understand different types of conventional energy resources
3. Understand different types of non-conventional energy resources
4. Understand the methodologies for energy conversion processes and utilization
5. understand the environmental impact of the energy extraction and conversion technologies

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Gain complete knowledge about the both conventional and non-conventional energy resources.
2. Know how to convert the energy resources into useful energy.
3. Know about the utilization of energy.
4. Uunderstand the environmental impact of the energy extraction and conversion technologies.

Unit – 1

Conventional and non-conventional energy resources and their potential.
Solid fuels: resources, Ultimate, Proximate analysis and characterization and utilization

Unit – 2

Liquid and gaseous fuels: resources, chemical kinetics and combustion characteristics.
Combustion of fuels in engines, IC engines, and fuel cells.

Unit – 3

Nuclear fission fuels and enrichment (fertile and fissile fuels), Nuclear Fusion Fuel Resources: Deuterium extraction and Tritium Breeding. Nuclear Fuel Processing and Utilization, Nuclear Reactors and their components.
Unit – 4
Solar energy: resource and utilization. Wind energy: resource and conversion system. Hydro energy: resource and conversion system.
Unit – 5
Biomass energy: resources and conversion routes. Geothermal, Wave, Tidal and Ocean Thermal Energy. Environmental impacts of energy extraction and conversion technologies
Text Books
1. Twidell, J. and Weir, T., Renewable Energy Resources, Taylor & Francis, 3rd Edition, 2015. 2. Glassman, I., Yetter, R. A., and Glumac, N. G., Combustion, Academic Press, 5th Edition, 2014. 3. Duffie, J. A., Beckman, W.A., Solar Engineering of Thermal Processes, John Wiley and Sons, 4th Edition, 2013. 4. Boyle, G., Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd Edition, 2012. 5. Thorpe, D., Solar Technology: The Earthscan Expert Guide to Using Solar Energy for Heating, Cooling and Electricity, Roudtledge, 1st Edition, 2011 6. Wagner, H. and Mathur, J., Introduction to Hydro Energy Systems (Basics, Technology and Operation), Springer-Verlag Berlin Heidelberg, 2011 7. Stacey, W. M., Fusion: An Introduction to the Physics and Technology of Magnetic Confinement Fusion, Wiley-VCH Publication, ISBN: 978-3-527-62932-9, 2010.
Reference Books:
1. Cheng, J., Biomass to Renewable Energy Processes, CRC Press, 1st. Edition, 2009. 2. Manwell, J. F., McGowan, J. G. and Rogers, A. L., Wind Energy Explained. Theory, Design and Application, Wiley, 2nd Edition, 2009. 3. Lamarsh, J. R. and Baratta, A. J., Introduction to Nuclear Engineering, 3rd Edition, Prentice Hall, 2001.

SEMESTER IV

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012020	Single Board Computers and IOT	Theory/Lab	L	1	T	0	P	4	3
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :

1. To impart basic knowledge about single-board computers.
2. To inculcate an understanding of IDE and coding.
3. To understand the workings of various external devices and their interaction with SBC.
4. To design and develop a product.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To get experience with the open-source platform used for building electronics projects.
2. Use a variety of microprocessors and controllers.
3. Interact with buttons, LEDs, motors, speakers, cameras, TV and smart phones etc.

Unit – 1	**Arduino**

Arduino is an open source platform and its use for building electronics projects. Arduino's physical programmable circuit board or microcontroller and a software, IDE (Integrated Development Environment). Learn to write and upload computer code to the physical board.

Unit – 2	**Magnetic Circuits Arduino board**

Arduino board designs use a variety of microprocessors and controllers. Understanding sets of digital and analog input/output pins, USB connection which is used for loading programs from computers, power jack, reset button etc.

Unit – 3	

Interact with buttons, LEDs, motors, speakers, cameras, TV and smart phones etc.
Design of different driver circuit for electrical appliances and radio modules.

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012040	Linear Control System	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Introduction to fundamental aspects of linear control, i.e., developing dynamic models of the process and control strategies.
2. Determine the transient and steady-state performance of 1st and 2nd-order systems.
3. To develop transfer function and controller design.
4. Familiarization with root locus techniques and frequency domain analysis for stability and performance determination.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Modeling and determining the transfer function of the physical systems through block diagramreduction and signal flow graphs.

2. Determine the transient and steady-state performance of 1st and 2nd-order systems.
3. Determine the frequency response of a system & design of PID controllers.
4. Analysis of stability through root locus plot, Bode plot, and Nyquist criterion.
5. Design of lag, lead, and lag-lead compensator using time and frequency domain approach.

Unit – 1	**Modeling& Transfer Function**

Introduction to Control systems, Classification, comparison of open-loop and closed-loop systems, Representation of control systems by block diagrams, Mathematical models of electrical, mechanical, and electromechanical systems, Transfer function, and block diagram representations of dc generator. Block diagram reduction, signal flow graphs, Masons gain formula.

Unit – 2	**Time response of 1st and 2nd order system**

Time Response: Step response of first - and second-order systems, underdamped system response, over-damped, critically damped system - time domain specifications, Concept of the order of the system, type of systems. Steady-state errors, Error ratio, Static error Constants, Generalized error series. Dynamic error coefficients and steady-state errors are due to impulse, step, ramp, and parabolic inputs.

Unit – 3	**Frequency response & PID controllers**

Frequency response of a system, frequency domain specifications. Different types of controllers: Proportional control, proportional-plus- integral control, and proportional-plus-derivative control. Proportional-plus- integral-plus-derivative control, their realization.

Unit – 4	**Stability analysis in time and frequency domain.**

Stability- Concept and definition, BIBO stability, location of the roots of the characteristic equation in the S-plane, Routh-Hurwitz stability criterion, Bode Magnitude, and phase plots, Concept of gain margin and phase margin. Root locus method, Magnitude, and angle criteria, Root locus construction rules for positive K, interpretation of nature of system response from root locus plots, Polar plots, Nyquist criterion for stability, Nyquist diagrams.

Unit – 5	**Compensator Design**

Control system design, design specifications, series compensation, phase- lag and phase-lead compensation frequency response approaches, lag-lead compensation.

Text Books

1. K. Ogata - Modern Control Engineering.
2. Charles E. Rohrs. James L. Melsa and Donald G. Schultz-Linear Control systems- MGH, 1993.
3. B.C. Kuo- Automatic control system (ED. 7) -PHI, 1995.
4. David K. Cheng - Analysis of Linear System - Adison Wesley, London, 1994.

Reference Books:

1. Morris Driels - linear Control Systems Engineering- MGH, 1996.
2. Norman S. Nise- Control System Engineering-Wiley publisher

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012060	POWER ELECTRONICS	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :This course aims to familiarize the students with the fabrication, structure, and operation of various power devices and power converters required to control and convert electrical energy in the desired form.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Describe the fabrication, structure, characteristics, and operation of various power devices.
2. Design gate drive circuits, firing circuits and protection of various power devices. Also, analyze commutation circuits.
3. Describe the operation of rectifier circuits its analysis with its applications.
4. Describe operation of dc-dc converters, ac regulators, and their applications.
5. Evaluate dc-ac converters, inverters and their applications. Also analyze PWM techniques for inverter control.

Unit – 1	**Introduction**

Basic structure, Equivalent circuit, Operation. V-I characteristics, turn-on, turn-off mechanisms, gate characteristics, gate drive requirements, firing circuits, di/dt, dv/dt and overload protection, commutation circuits: Resonant commutation, complementary commutation, auxiliary commutation, calculation of committing components. TRIAC, BJTs, Power MOSFET, IGBT

Unit – 2	**Single-phase converters, & Three-phase converters**

Half wave, bridge converters,operation with RL and back emfloads, performance with freewheeling diode, full wavecontrolled bridge rectifier withcontrolled free wheeling, effect of source inductance. Fully controlled three-phase converters

Unit – 3	**DC-DC Converters, AC regulators**

Basic principle of time ratiocontrol, constant and variablefrequency, Step down and step upchopper, classification ofchoppers. Single-phase ACvoltage regulators.

Unit – 4	**DC-AC Converters**

Single phase and three phasebridge inverters, square waveoperation, 120 and 180 degreemodes, potential diagrams.Qualitative treatment of linecommutated inverters.

Unit – 5	**PWM Inverters, and PWM Technique**

Voltage control, Unipolar andBipolar voltage switching,Harmonic reduction. Sinetriangular modulation, spacevector modulator.

Text Books

1. Muhammad H. Rashid - Power Electronics- Circuits, Devices and Applications – PHI.
2. P.S.Bimbhra - Power Electronics(scanned book)-Khanna Publishers (2006) Reference Books:
3. Mohan, TM Undeland, W. P. Robbins – Power Electronics - John wiley and Sons (SEA).

Reference Books:

1. Vedam Subramaniam- Power Electronics -New Age International Publications.
2. G.K. Dubey, S.R. Doradla, A. Joshi , Thyristorised Power Controllers, John Wiley & Son (1986)

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012080	ELECTRICAL MACHINES – II	Theory	L		T		P		

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :To clearly understand the basic concepts of the electrical machines used in industry and power plants such as induction motors and synchronous machines. To learn the analytical methods to develop

the machine models and to further solve problems associated operation of induction motors and synchronous machines.	
Course Outcomes (COs): After completion of this course, the students shall be able to: n and operation of three-phase induction motor, single-phase induction motor and induction generator. circuit, torque equation, parameter identification tests and starters. n and operation of synchronous machines. circuit, voltage regulation and parallel operation of alternators. curves, hunting and starting methods of synchronous motor.	
Unit – 1	**Fundamentals of three-phase induction motors**
Review of construction and principle of operation of three- phase induction motor	
Unit – 2	**Equivalent circuit, Torque equations, and characteristics.**
Development of equivalent circuit. Torque equation,Torque-slip characteristics.	
Unit – 3	**Tests, starters, induction generator, single-phase induction motors.**
No load and blocked rotor tests, Starters,induction generator,Single Phase InductionMotors.	
Unit – 4	**Synchronous Generators**
Constructionalfeatures, EMFequation, Armaturereaction. Leakagereactance,Synchronousimpedance,Equivalentcircuit. Phasordiagram, Voltageregulation by EMF,MMF, ZPF, Tworeaction field theoryand Phasor diagram forsalient pole machinesand slip test.	
Unit – 5	**Synchronization and Synchronous motors**
Synchronizing powerand torque, Paralleloperation of twoalternators and loadsharing, Construction,Principleof operation,V-curves, Hunting.Starting methods.	
Text Books	
1. P.S. Bhimbra – Electrical Machinery (Ed. 4) – Khanna Pub, 1986	
Reference Books:	
2. Langsdorf A. - Theory of AC Machinery- TMH, 1994. 3. Lawrence and Richards- Principles ofAC Machinery (ED. 4.)- MGH. 1953. 4. M.G. Say- AC Machines (ED. 5)- Pitmam, 1983. 5. Nagrath and Kothari-Electrical Machines- TMH, 1093. 6. P.K. Mukherjee and S. Chakravorti- Electrical Machines (ED. 2)- DhanpatRai. 1993.	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012100	ELECTROMAGNETIC THEORY	Theory	L	3	T	0	P	0	3
Pre-requisite	:Knowledge of basic vector calculus and co-ordinate system, concept of electrostatics.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								
Course Objectives : 1. To provide an understanding of co-ordinates system and vector analysis. 2. To learn about the electromagnetic and electrostatic field and its applications. 3. To be able to analyze transmission of charge. 4. To provide knowledge about wave propagation.									

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Analysis the basic mathematical concepts related to vector calculus and coordinate system.
2. Realize the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.
3. Demonstrate the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.
4. Demonstrate the concepts related to Faraday‘s law, induced emf and Maxwell‘s equations.
5. Analysis Maxwell‘s equations to solutions of problems relating to transmission lines and uniform plane wave propagation.

Unit – 1	**The coordinate systems and revision of vector calculus**

The Co-ordinate Systems, Revisionof vector calculus.Electrostatics: Electric Flux andFlux Density.Gauss‘s law -Energy and Potential, Capacitors and Capacitances-Method of Images

Unit – 2	**Steady Electric Currents and Faraday‘s Law of Induction**

The Equation of Continuity. Jouleslaw- Magnetostatics: The Biot-Savart law.Ampere’s Force Law - Magnetic VectorPotential.- Ampere‘s Circuital law.Self and Mutual inductance.Maxwell‘s Equations from Ampere‘s andGauss‘s Laws. Maxwell‘s Equations inDifferential and Integral forms; Equation ofContinuity.

Unit – 3	**Concept of Displacement Current**

Concept of Displacement Current.Electromagnetic Boundary Conditions.

Unit – 4	**Plane wave Propagation**

Helmholtz wave Equation-Plane wave solution.-Plane wave propagation in lossless and lossy dielectric medium and conducting medium.Polarization of EM wave - Linear, Circular and Elliptical polarization.

Unit – 5	**Transmission Lines**

LCR ladder model for transmission lines.Solution for lossless lines. Wave velocity and wave impedance

Text Books

1. Cheng, D.K., “Field and Wave Electromagnatics”, Pearson Education (Singapore) Pte. Ltd., 2nd Edn., 1989.
2. Hayt, W.H., J.A. Buck, “Engineering Electromagnetics”, Tata McGraw Hill.
3. Edward C. Jordan & Keith G. Balmain, “Electro-magnetic waves & Radiating System”, PHI.
4. Deepak Sood, “Field & Wave, A Fundamental Approach”, University Science Press.
5. S. C. Matapatra, SudiptaMahapatra, “Principles of Electromagnetics”, Tata McGraw Hill.

Reference Books:

1. Matthew Sadiku, “Principles of Electromagnetics”, Oxford University Press.
2. A.R. Harish, M. Sachidananda, “Antennas & Wave Propagation”, Oxford University Press.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN082120	Basic of Renewable Energy Resources	Theory	L	3	T	0	P	0	3
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								

Syllabus Version :	1

Course Objectives :

Course Outcomes (COs): After completion of this course, the students shall be able to:

1.
2.
3.
4.
5.

Unit – 1	**Introduction**

Challenges in the field of energy engineering, perception on energy technology, Dimensions of the energy problem, Historical perspective on energy technology and system development: Technology development for power generation (Wind mills to super-critical power plant), transportation (Bullock cart to future car concepts) and a few application sectors (candle kerosene lamp to solid state lighting).

Unit – 2	**Energy Resources**

Conventional energy resources, Depletion of conventional energy sources and its exponential rise in consumption; Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources. Resource assessment-Solar energy (Photovoltaic and Solar thermal), Wind energy, Biomass and Bioenergy, Geothermal energy and Ocean & Tidal energy, artificial photosynthesis.

Unit – 3	**Energy Scenario**

Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics. Conventional Energy Sources and Overall Energy demand and availability, Energy Consumption in various sectors and its changing pattern; Environmental impact of Fossil fuels, Renewable Sources Potential, Energy cycle of the earth, World Energy Scenario, Indian Energy Scenario, India's Solar Energy Mission, Jawaharlal Nehru National Solar Mission(JNNSM).

Unit – 4	**Energy Security**

Chemical and Nuclear: Non Proliferation, Energy Security, Energy Consumption and its impact on environmental climatic change. Role of renewables in energy security and climate change; International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries and EU.

Unit – 5	

Text Books

1. J. M. Fowler, Energy and the Environment, McGraw Hill, 2nd Edn, New York,1984.
2. T. B. Johannson, H. Kelly, A. K. N. Reddy and R. H. Williams (Ed), Renewable Energy: sources for fuel and electricity, Island Press, Washington DC, 1993.
3. A.Duffie and W.A.Beckmann, Solar Engineering of Thermal Processes-John Wiley (1980)

Reference Books:

1. F.Kreith and J.F.Kreider, Principles of Solar Engineering , McGraw-Hill (1978)
2. T.N.Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill (1978)

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012160	CONTROL LAB	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:Theoreticalconceptofcontrolsystem.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :Tomakethestudentfamiliarwithdifferentcontroltechniquesof LTIsystem.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Suchhands-onexperienceprovidesstudentswithcriticalpracticalaspectsofelectricalandelectronicscontrolsystemengineering.

List of experiments

1. Tostudythetorque-speed characteristics,stepresponse andtofindthe transferfunctionofthed.c. motors.
2. Tostudytheperformancecharacteristicsofad.c.motorangularpositioncontrolsystem.
3. Tostudythetimeresponseofvarietyofsimulated Linearsystemsandtocorrelatethestudieswiththeoreticalvalues.
4. Tostudythecharacteristicsofalinearvariabledifferentialtransformer.
5. Tostudytheperformancecharacteristicsofanangular positionerrordetectorusingtwopotentiometers.6.Tostudytheperformanceof varioustype ofcontrollersused to controlthetemperatureofan oven.
7. Tostudytheperformancecharacteristicsofad.c.motorspeedcontrolsystem.
8. Tostudydigital controlof asimulated systemusingan 8-bit microprocessor.
9. Tostudythecharacteristicsofasynchrotransmitterreceiverpairandusetheseastorque-synchroandangularerrordetector.
10. Tostudytheeffectsofdifferentcascadecompensationnetworks.

ExtraExperiments(beyondcoursecurriculum)

1. Tostudytheconfigurationandevaluatetheperformancecharacteristicsofafeedbacklightintensitycontrolsystem.
2. TostudytheperformancecharacteristicsofananaloguePIDcontrollerusingsimulatedsystems.
3. Tostudysimpleinput-outputoperationsofamicroprocessorthroughprogrammableperipheralinterface,8255.
4. To study the features and characteristics of a number of digital to analog converter circuits including an ICtype AD7533.
5. Tostudythecharacteristics ofasmallac servomotoranddetermineitstransferfunction.

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012180	ELECTRICALMACHINESLABORATORY	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:Theoreticalconceptofelectricalmachines II.
Course Assessment Methods :	40 marks internal examination & 60 marks external

	examination
Syllabus Version :	1
Course Objectives : To provide facilities in performing experiments related to various types ofelectrical machines andanalyzingthem.Tointroducethestudentstosinglephaseandthreephaseelectricalmachines&varioustype sdrivessystems.	
Course Outcomes (COs): After completion of this course, the students shall be able to: 1.Such hands-on experience provides students with critical practical aspects of electricalmachines II.	
List of experiments	
1. NoLoadandBlockedRotortestonathree-phaseinductionmotor. 2. TorqueSlipCharacteristicsofSlipRingInductionMotorbyvaryingrotorresistance. 3. LoadTestonthree-phasesquirrel cageInductionMotor. 4. MeasurementofDirectAxisandQuadratureaxisreactanceofsalient poleSynchronousMachine 5. PredeterminationofVoltageRegulationofAlternatorbyEMFandMMFmethods. 6. LoadTest onthree-phaseInductionGenerator. 7. VcurveandInvertedV curveof SynchronousMotor.	
Text Books	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN012200	POWERELECTRONICSLAB	Laboratory	L	0	T	0	P	2	1
Pre-requisite	:Knowledgeof powerelectronics, dcandacmotors.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								
Course Objectives :To have hands-on exposure to operation of various power electronics converters and devices. Tolearndiagnosingandtestingthecharacteristicsofpower convertersandverifyingtheoperatingprinciples. PracticalExposureofvariousmotordrives.Speedcontroltechniquesinopenloopandclosedloop.									
Course Outcomes (COs): After completion of this course, the students shall be able to: 1.Operational steady state characteristic of the various power devices. Operating differentpower									

converters, checking the waveforms at various test points. Exposure to different schemes of ac and dcmotorcontrol.

List of experiments

1. ObserveandstudyvariousforcedcommutationtechniquesofSCR
   i. Self-Commutation
   ii. impulseCommutation

   Determinetheaverage output voltageat
   a) constantfrequency,variabledutyratio,
   b) constantdutyratio,variablefrequency,
   c) frequencyatwhichcommutationfailsand
   d) deviceandcircuitturn-offtimeineachcommutationtechniquementionedabove.

2. Observeandstudyvariousforced commutationtechniquesofSCR
   i. ResonantCommutation
   ii. ComplementaryCommutation.

   Determinetheaverage output voltageat
   a) constantfrequency,variabledutyratio,
   b) constantdutyratio,variablefrequency,
   c) frequencyatwhichcommutationfailsand
   d) deviceandcircuitturn-offtimeineachcommutationtechniquementionedabove.

3. Observeandstudyoutputvoltagewaveformof a
   i. single–phaseFull-wave,fully-controlled AC-DCconverterunderdifferentloadconditions.
   ii. 3-phasehalfwaveuncontrolledrectifier

   Determine the output average voltage, ripple factor and circuit turn-off time. Also check the effect offreewheelingdiode ontheinputpowerfactoroftheconverter.

4. Operate Buck DC-DC converter at (a) constant frequency; variable duty ratio and (b) constant duty ratio;variablefrequency. Alsodeterminethedevice and circuitturn-off time.
5. Studyand plotthestaticV-Iand Transfer characteristics of
   i. MOSFET
   ii. IGBT

6. Observeandstudyoutputvoltagewaveformof SCRbasedACphase controller.

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours	Credit

EEN022240	Solar Thermal Technology	Minor Specialization course/Departmental Honors Course	L	3	T	1	P	0	4

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The course will enable the students to

1. understand the solar thermal energy
2. temporal and spatial solar radiation resource availability
3. understand the basics of solar thermal conversion process
4. understand the types of solar thermal conversion systems
5. understand design and working of different solar thermal conversion systems

learn about the design procedure

Course Outcomes (COs): After completion of this course, the students shall be able to:

Afterstudyingthecourse, thestudent willbeableto:

1. gain complete knowledge of available solar radiation resource,
2. explain basics of the process of solar thermal conversion and system design,
3. estimate the quantum of radiative and thermal energy flow,
4. explain the options to enhance the temperature and efficiency of the systems,
5. offer design options for different and niche application and utilizable, and
6. undertake system design and sizing.

Unit – 1	**Solar Radiation and its Measurement**

Introduction, Solar constant, Solar radiation outside the Earth's Atmosphere, Solar radiation at the earth's surface, Solar radiation geometry: Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams. Solar radiation measurements, Sunshine recorder, Pyranometers, Pyrheliometer, Estimation of Average Solar radiation, Solar radiation on tilted Surfaces. Analysis of Indian solar radiation data and applications; Estimation of solar radiation resource based on geo-spatial data.

Unit – 2	**Solar thermal Energy Conversions and Applications and Flat Plate collectors**

Solar thermal energy conversion, Physical principles of solar radiation conversion,
Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Air flat-plate Collectors: types; Thermal analysis; Selective Surfaces: Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization;

Unit – 3	**Concentrating Collector Designs**

Classification, design and performance parameters; Tracking systems; Compound parabolic concentrators; Parabolic trough concentrators; Concentrators with point focus; Heliostats; Comparison of various designs: Central receiver systems, parabolic trough systems; Solar power plant; Solar furnaces.

Unit – 4	**Solar Heating & Cooling System**

Liquid based solar heating system: Natural, forced and gravity flow; Solar dryers; Solar distillation/still; Solar cooking; Solar cooling and refrigeration: Vapour absorption refrigeration cycle; Water, ammonia & lithium bromide-water absorption refrigeration systems; Solar operated refrigeration systems; Solar desiccant cooling; Solar passive heating and cooling systems: Trombe wall; Greenhouse technology: Fundamentals, design, modeling and applications.

Unit – 5	**Solar Pond and Thermal Energy Storage, Solar thermal energy applications and Design and sizing of solar thermal systems**

Solar Pond; Sensible storage; Latent heat storage; Thermo-chemical storage.
Industrial process heat: Temperature requirements, consumption pattern; Applications of solar flat plate water heater & air heater for industrial process heat; Designing thermal storage; Transport of energy.

Performances of solar collectors: ASHRAE code; Modeling of solar thermal system components and simulation; Design and sizing of solar heating systems: f – chart method and utilizability methods of solar thermal system evaluation; Development of computer package for solar heating and cooling applications.
Textbooks 1. Goswami D Y, Kreith Frank and Kreider J F, Taylor & Francis (1999); Principles of Solar Engineering, Taylor & Francis, USA 2. Sukhatme S P and Nayak J K(2017); Solar Energy, McGrawHill, India
Reference Books: 1. Tiwari, G.N (2002); Solar Energy, Fundamentals design, modeling and Apllications, Narosa New Delhi 2. Duffie J. A. and W. A. Beckman, (2006); Solar Engineering of Thermal Processes, Johnn Wiley

SEMESTER V

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013010	POWERSYSTEM ANALYSIS	Theory	L	3	T	0	P	0	3
Pre-requisite	:KnowledgeofDifferentialEquations,andNumericalAnalysis.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :

- Tounderstandthemathematical modelingofdifferentpower systemcomponents.
- Tounderstandthedifferentfaultconditionandtypesoffaults.
- To analyze the severity of the fault and find the fault current which will help to determine the rating ofthecircuitbreaker.
- Toanalyzetheprefault andpostfaultconditions.
- To study the Z-build algorithm which determines the Z-Bus matrix that is mostly used in contingencyanalysisandfindingthe faultcurrent.
- Load flow analysis determines the voltage angle which in turndetermines the line flow and losses andthe voltage at each bus. Different methods of load flow methods are studied and its advantage anddisadvantageare also compared.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Demonstrateanunderstandingofthenatureofthemodernpowersystem,includingthe behavioroftheconstituentcomponentsandsub-systems.
2. Describetheconstruction,operationandequivalentcircuitoftransmissionline& transformers.
3. Demonstrateanunderstandingofperunitsystemitsadvantagesandapplicationinpowersystem.
4. Applyloadflowanalysistoanelectricalpowernetworkandinterprettheresultsoftheanalysis.
5. Analyzeanetworkunderbothbalancedandunbalancedfaultconditionsandinterpretthe results.

Unit – 1	**Introduction topower systemanalysis, perunitsystem.**

Representationofpowersystems:One line diagram, impedance & reactancediagrams.Per unit notation selection &changeof baseforperunitquantities.Thevenin'smodelforPowersystem.Introduction to power systemoperationinIndia.Differentoperatingstates.	
Unit – 2	**Modeling of Power System Components**
Modelingofmediumandlongtransmissionline. Fixedtapchangingtransformerswithoff-nominal turn'sratio.Modelingofphaseshiftingtransformer. Modellingofequivalentcircuit of threewindingtransformers.	
Unit – 3	**Load FlowAnalysis**
Formation of Y bus matrix.Load flow solution techniques(using bus only) Gauss-Seidel, NewtonRaphson (inpolar coordinates only),Accelerationfactors.Decoupled, fast Decoupledmethod.	
Unit – 4	**SymmetricalFaults**
Formation of Z bus matrices, Zbusalgorithm,significanceofSymmetricthreephaseShort circuitcalculationsusingZbus.Symmetrical 3 phase faults: Shortcircuit currents and reactance of Synchronousmachines. Short circuit current calculations ofunloaded&loadedGeneratorsandpowersystems. Selectionofcircuitbreakers,current-limiting reactors. Sequence componentsof line and phase voltages and currents of star-deltatransformerbanks.	
Unit – 5	**UnsymmetricalFaults**
Sequence impedance's andnetworks of power system elements. Analysis ofunsymmetrical faults in generator and powersystemundernoload.	
Text Books:	
1. A Chakraborti & Halder – Power System Analysis, Operation & Control, PHI 2. Nagrath and Kothari- Modern Power System Analysis (ED.2) - TMH, 1989 3.. 3. Stevenson - Elements of Power System Analysis (Ed 3) -MGH, 1975.	
Reference Books:	
1. Elgerd OI - Power system analysis- TMH. 2. Shipley – Matrices & Power Systems – John Willy.	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013030	DIGITALSIGNALPROCESSING	Theory	L	3	T	0	P	0	3
Pre-requisite	:Basicsofsignalsandsystems.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :

1. Toprovideanintroductiontodigital signalprocessinganditssignificance.
2. Studythe processof obtainingdigitalsignalsfromanalogsignals
3. Understandvarioussignalprocessingoperationsondiscretetimesignals.
4. Studytimedomainandfrequencydomainrepresentationsofdiscretetimesystems.
5. Tounderstanddigitalfiltersandtheirdesigningprocess.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Developafundamentalunderstandingofdigitalsignalprocessingandtimedomainanalysis ofdiscretetimesystems.
2. ApplydiscreteFouriertransformforanalysisofdiscretetimesignalsandsystems.
3. Apply z-transform for analysis of discrete time signals and systems.
4. DesignFIRdigitalfilters.
5. DesignIIRdigitalfilters.

Unit – 1	**Introductionto digitalsignalprocessingand timedomainanalysis ofdiscretetimesystems.**

Definition,importance,classificationandapplicationsofsignalprocessing.Introductiontodigitalsignalprocessing, its basic elements, advantages anddrawbacks.
Conversion of analog to digitalsignal and samplingtheorem.
TimedomainAnalysisofDiscrete-time system:-(Output response ofDiscrete-TimeLTISystem,LinearConvolution,stabilityofDiscrete-timeLTIsystem,CorrelationofDiscrete-TimeSignals)

Unit – 2	**Discrete-FourierTransform.**

DiscreteFouriertransform(DFT),relationwithDiscretetimeFourierTransform(DTFT)
InverseDFT.Fast FourierTransform(FFT).

Unit – 3	**Z-transform**

Z-Transform(definitionanditsrelationwithDTFT),Existenceof z-transformandregionofconvergence.
InverseZ-transform.

Unit – 4	**Introductionto DigitalFilters andFIR filterdesign.**

Definition&classificationofdigital filters (FIR and IIR digital filters), idealandpracticalfiltercharacteristics.FIRfilterDesignusingFouriermethod.FIRfilterdesigningusingandwindowingmethod.BasicFIRdigitalfilterstructures.

Unit – 5	**IIRDigital Filter Design**

IntroductiontoIIRfilterdesign, AnaloglowpassButterworthfilter/Chebyschev filtercharacteristics.
Frequencytransformationin analogdomain(analoglowpasstohighpass, bandpassand band stop).
Frequencytransformationfromanalogtodigital domain:Impulseinvariant transformation(IIT)method/bilinear transformation).
BasicIIRDigitalfilter structures.

Text Books

1. DigitalSignal Processing–JohnProkais
2. DigitalSignal Processing–Sanjit.K.Mitra

Reference Books:

1. Digital Signal Processing–RameshBabu, SCITechPublishers

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013050	ELECTRICAL DRIVES	Theory	L	3	T	0	P	0	3
Pre-requisite	:Understanding of basics of various types of electric motors, drive systems, and knowledge ofpower electronics circuits.								

Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives : This course focuses on the fundamental of electrical drives and its dynamics and control;selection of motor rating; starting, braking, transient operation, and speed control of dc motor and inductionmotor. This also deals with imparting education in the field of electrical machines, drives, and to some extentof power electronics. The course also emphasizes on modelling and analysis of conventional and advancedelectrical drives.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Evaluatethethermal model ofelectricmotorsandanalysistheclosedloopcontrolofelectricdrives.
2. Analyzetheperformancecharacteristicsofdcmotordrivesundersteady-stateandtransientconditions.
3. Designofvariousdrivecomponents/systemsandmethodsforcontrolthespeedofdcmotordrives.
4. Analyzetheperformancecharacteristicsofacmotordrivesundersteady-stateandtransientconditions.
5. Illustrate the vector controlled induction motor using different reference frames, namely- stator, rotorandsynchronousrotatingreferenceframes.

Unit – 1	**ElectricDrivesRatings**

Advantages of Electric drives,Factorsaffectingthechoiceofelectricdrives,Methodsofclosedloopcontrolofdrives,Selectionof motorpower rating. Thermal model of motor forheatingandcooling,classesofmotorduty,determination of motor rating, equivalentcurrent,torqueandpowermethods,short timeduty,intermittentduty.

Unit – 2	**DC Motor Drives**

Performance characteristics ofdcseries,shuntandcompoundmotors,Braking-Regenerative,dynamicandplugging.Transient analysis of separatelyexcited motor with armature voltage control,Starting,dynamicbrakingandenergyloss.

Unit – 3	**Speed Control of D.C. Drives**

Armaturevoltagecontrol,Flux control,Armatureresistancecontrol.Methodsofspeedcontrol of singlephaseandthreephaseconverter fed separatelyexciteddcmotor(Block diagram approachonly),Speedcontrolofchopper fed dcmotor(Blockdiagramapproach only).Fourquadrant dc drive.

Unit – 4	**AC MotorDrives**

Inductionmotordrive:Performance characteristics of squirrel cageandslipringinductionmotors,Braking-Regenerative,Dynamicand Plugging.Transientanalysis-StartingandPlugging, Calculation of energy loss. Speedcontrol-Statorvoltagecontrol,Slippower recovery,E/f,V/fandfluxweakening methods.

Unit – 5	**Basics of Vector Control**

Vectorcontrolledinductionmotordrives:Introduction,principleofvectorcontrol.

Text Books

1. Fundamentalsof ElectricDrivesbyG.K.Dubey,NAROSA,1995.
2. ElectricMotorDrives:Modeling,Analysis,andControlbyR.Krishnan,PearsonEducation,2006.

Reference Books:

1. FirstCourseonElectricDrivesbyS.K.Pillai,WileyEastern,1990.
2. PowerElectronicControlACMotorsbyJ.M.D.Murphy&F.G.Turnbull,PergamonPress,1988.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013070	MEASUREMENT AND INSTRUMENTATION	Theory	L	3	T	0	P	0	3

Pre-requisite	:Knowledgeofbasiccircuittheory.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Introductiontounitsofmeasurementsandbasicoperatingprinciplesofelectromechanicalindicating anddigital instrumentsformeasurementof voltage,current, powerandenergy.
2. Analysisofmeasurementofresistance,inductanceandcapacitancethroughvariousbridgecircuits.
3. Todeveloptransferfunctionandcontrollerdesign.
4. Familiarization with root locus techniques and frequency domain analysis for stability and performancedetermination

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Analyseoperatingprinciplesofelectromechanicalindicatinganddigitalinstruments for measurementofvoltage,current,powerandenergy.
2. Analyse the measurement of resistance, inductance and capacitance through various bridgecircuits and able to identify the appropriate bridge circuit for measurement of resistance,inductanceand capacitance.
3. Designandanalysisofsignalgeneratorsandinstrumenttransformers.
4. Identifyandsummarizetheimportantfeatureofelectricaltransducers.
5. TestanddeterminethespecificationofagivensignalthroughCathodeRay Oscilloscope(CRO)andwaveanalyzers.

Unit – 1	**Electromechanical indicatingand Digital Instruments**

ThefundamentalunitsofSI,derivedunits, conversionfactors.Errors- definition; typesoferrorsinmeasurement. TheD'ArsonvalGalvanometer,principleof operationanduseasanammeterand voltmeter.Basicideaabout instruments withnon-linearresponse-movingiron type, electrodynamometer, multimeterand energymeter; rectifier-type instrument. Single-phase and three-phase energy meters.Digitalvoltmetersand multimeters.

Unit – 2	**Measurementof resistance, inductance and capacitance**

Classificationofresistance; Wheatstone bridge(W.B.),limitationsofW.B., Kelvin's doublebridge.Conceptofearth resistance anditsmeasurement;Megger.AC Bridges- Maxwell'sbridge,Maxwell-Wein bridge,

Unit – 3	**Signal generator& Instrumenttransformer.**

Fixed and variable, AF oscillators, standardandAFsineandsquarewavesignalgenerators,functionGenerators,squarepulse, randomnoiseand sweep.Currenttransformer(CT)andpotentialtransformer(PT);constructionandoperationformeteringandprotection applications;Silsbee'smethod.

Unit – 4	**Transducers**

Introduction and classification. Strain gauges,force-summingmemberssuch as diaphragms,bourdon tubes and piezo- electricdevices.Hall-Effect transducers. Temperature sensors- resistance-type temperature sensors esp. platinum resistancethermometer,thermistors and thermocouple-properties,materialsused for construction reference junction compensationofthermocouples. Current, voltage,andtorquetransducers.

Unit – 5	**CathodeRay Tube(CRT)and WaveAnalyzer**

Construction, working and general applications. Measurement of voltage, current, phase and frequency (using Lissajouspatterns)onaCRO.Introduction and qualitative treatment of frequencyselective wave analyzer and heterodyne waveanalyzer;discussions on basicspectrumanalyzer.Data acquisition system,includingtheconceptofvirtual instrumentation.
Text Books:
1. CooperW.O.andHelfrickA.D.-ModernElectronic InstrumentationandMeasurementTechniques. 2. A K. Sawhney - A course in electrical and electronic Measurements and Instrumentation.
Reference Books:
1. E.W.Golding&F.C. Widdis-ElectricalMeasurementsandMeasuringInstruments.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN083110	Basics of Solar Energy Engineering	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The course will enable the students to
1. understand importance of solar energy
2. understand the basics of solar radiation resource availability
3. understand different routes of solar energy conversion and their importance
4. understand the basics of photothermal, photovoltaic, and photocatalytic conversion and applications
5. know the different photothermal systems and their applications
6. understand the basics of solar photovoltaics, cells, and panels

Learn about the design aspects of solar photovoltaic systems and power plants

Course Outcomes (COs): After completion of this course, the students shall be able to:
1. explain solar energy resource and different conversion routes
2. explain the basics of solar thermal conversion, applications and systems
3. explain the basic design and working of solar cell, panels and plants
4. explain the photocatalytic conversion systems and potential applications.
5. compare different solar systems in terms of economic and financial viability.

Unit – 1	**Importance of Solar Energy:**

Clean fuel; Hydrogen as clean fuel; Carbon mitigation potential; Hydrogen Economy

Unit – 2	**Estimation and measurement of available Solar Radiation:**

Solar Constant, Extra-terrestrial and terrestrial solar radiation availability; Measuring instruments – Pyranometer and pyrheliometer; Available solar energy and its dependence on season, location, tilt and orientation; Analysis of Indian solar radiation data

Unit – 3	**Solar thermal conversion, applications, and systems :**

Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coatings, advanced collectors, Concentrators: optical design of concentrators, solar water heaters, solar dryers, solar stills, solar cooling and refrigeration. Thermal storage, Active and passive conditioning of buildings. Conversion of heat

into mechanical energy, Solar thermal power generation.	
Unit – 4	**Solar Photovoltaic conversion, applications, and design:**
principle of photovoltaic conversion of solar energy. Technology for fabrication of photovoltaic devices. Applications of solar cells in PV power generation systems. New generation solar cells and emerging technologies.	
Unit – 5	**Solar Photocatalysis and Economics of solar systems**
Mechanism; Kinetics; Nano-catalysts: System design; Performance parameters; Applications. Comparison of economics of different routes of solar energy conversion	
Text Books	
2. J K Nayak and S.P. Sukhatme(2009), Solar Energy: principles of Thermal Collection and Storage, The McGraw-Hill, 2009 3. J. A. Duffie and W. A. Beckman; Solar Engineering of Thermal Processes, John Wiley 2013 4. Green, Martin (2005), 3rd Generation Photovoltaics: Advance Solar Energy, Springer 5. Goswami D Y, Frank Kreith and J F Kreider, Taylor & Francis (1999) ; Principles of Solar Engineering, Taylor & Francis, USA	
Reference Books:	
1. Garg H.P. and Prakash S (1997); Solar Energy: Fundamental and Application Tata McGrow-Hill, New Delhi 2. Kreith F. and J. F. Kreider, (1978); Principles of Solar Engineering , McGraw-Hil, 1978 3. Kreider J.F. and F. Kreith, (1981) ; Solar Energy Handbook McGraw-Hill , 1981Bent Sorensen; Renewable Energy, Academic press, New York.,2000	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013130	MEASUREMENTANDINSTRUMENTATION LAB	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:Theoreticalconceptofmeasurementandinstrumentation.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
To provide facilities in performing experiments related to various types of electrical and electronicmeasurement devicesandanalyzingit.

Course Outcomes (COs): After completion of this course, the students shall be able to:
Suchhands-onexperienceprovidesstudentswithcriticalpracticalaspectsofanalogganddigital electronicmeasurement.

List of experiments

1. Measurement ofinductance by
   a. MaxwellInductanceCapacitanceBridgeand
   b. AndersonsBridge.
2. MeasurementofcapacitancebyScheringBridge.
   (a) Measurement ofmediumresistance(Wheatstonebridge).
   (b) Measurement oflowresistance(Kelvindoublebridge).
3. Adjustmentandcalibrationofsingle-phaseenergymeter.
4. Adjustmentandcalibrationofthreephaseenergymeter.

5. ADC-Measurementofconversiontimeandquantizationerror.
6. DAC-Unipolarandbipolarconnections,measurementofaccuracy.
7. TomeasurethevoltageusingPiezo-electrictransducer.
8. Tomeasurepressureintermsof voltageusingapressuretransducermodule.
9. Measurementsusingordinarydualtraceoscilloscope
10. To measure the Young's modulus using Cantilever beam instrument and also real time implementationin Lab View.
11. TomeasuretheHall voltageandcurrent usingHallEffectTransducertrainer.

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013150	ADVANCE POWERELECTRONICSANDDRIVESLAB	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:Knowledgeof powerelectronics, dcandacmotors.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
To have hands-on exposure to operation of various power electronics converters and devices. Tolearndiagnosingandtestingthecharacteristicsofpower convertersandverifyingtheoperatingprinciples. PracticalExposureofvariousmotordrives.Speedcontroltechniquesinopenloopandclosedloop.

Course Outcomes (COs): After completion of this course, the students shall be able to:
Operational steady state characteristic of the various power devices. Operating differentpower converters, checking the waveforms at various test points. Exposure to different schemes of ac and dcmotorcontrol.Exposuretodifferentschemesof acanddc motorcontrolinsimulation platformandPLC.

List of experiments

1. Speed control of 3-phase squirrel cage induction motor by voltage control and voltage frequency controlbyV/F method(byusingdigital/Analogkeypad ofPWMbased ACmotordrive system).
2. StudyofIGBT based3-phase ACmotordrive.
3. StudyofPhaseControlledRectifiedDCMotorDriveusingaFullConverter
4. StudyofChopper ControlledDCMotorDrive
5. Construct a 3-phase VSI (Voltage Source Inverter) in either 180-degree or 120-degree conduction modeinMATLAB/SimulinkPlatform.

6. TodemonstratethespeedcontrolofDCmotorinMATLAB/SimulinkPlatform.
Text Books
Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN023190	Solar PV Technology	Theory	L	3	T	0	P	0	3
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :
The course will enable the students to

1. understand semiconductor physics relevant to photovoltaic devices
2. understand the fundamental of solar cells
3. Understand characterization techniques for solar cells
4. learn the manufacturing of solar cells
5. understand the major commercial and developing technologies for solar cells
6. learn how to design of solar PV systems
7. potential & drawbacks of currently manufactured technologies

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Learn how solar cells convert light into electricity
2. Understand about different solar PV technologies are currently on the market
3. Gain complete knowledge about solar PV system design
4. Understand the economic and environmental issues relevant to photovoltaic system

Unit – 1	**Solar Cell Basics and Materials**

Properties of Semiconductor: Intrinsic, extrinsic and compound semiconductor; Energy levels; Electrical conductivity; Fermi energy level; Carrier transport: Drift, diffusion, Absorption of light; Recombination process

Unit – 2	**Solar Cell Physics**

p-n junction: homo and heterojunctions, Metal-semiconductor interface; Dark and illumination characteristics; Figure of merits of solar cell; Efficiency limits. Loss mechanisms for real diodes, recombination, series and shunt resistance, Introduction to multijunction concepts. Tandem structure, other next generation solar cells.

Unit – 3	**Material Fabrication Technologies**

Preparation of metallurgical, electronic and solar grade Silicon; Production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) method, MBE, MOCVD, LPE, VPE. Thin film deposition methods: evaporation, sputtering, wet chemical, spray pyrolisis, and screen printing.

Unit – 4	**Solar Cell Fabrication Technology**

Device Fabrication, Doping, alloying, diffusion and implantation, Procedure of masking, photolithography and etching, Device processing methods, Deposition of anti-reflection coatings, Dry and wet etching. Surface texturing and passivation techniques. Design of a complete silicon, GaAs, CdS, CdTe, InP solar cell; High efficiency III-V, II-VI multijunction solar cell; a-Si-H based solar cells; PV Module fabrication, Quantum well solar cell, Organic solar cells, Thermo-photovoltaic, Photovoltaic; Thermal(PV/T) hybrid systems.

Unit – 5	**Solar Photovoltaic System Design**

Solar cell array system analysis and performance prediction; Shadow analysis: Reliability; Solar cell array design concepts; PV system design; Design process and optimization; Detailed array design; Storage autonomy; Voltage regulation; Maximum tracking; Use of computers in array design; Quick sizing method; Array protection and trouble shooting. Understand the economic and environmental issues relevant to photovoltaic systems, cost calculation, environmental impact, and energy payback time of a photovoltaic system.

Unit – 6	**PV Power Systems**

Centralized and decentralized SPV systems, Stand alone, hybrid and, grid connected system, System installation, Operation and Maintenance, Application of PV for lighting, Water pumping. Refrigeration, Telecommunication, Cathodic Protection etc., Solar PV Power Plant-Status-Case Studies, Hybridization Engineering, Hybrid systems, Grid integration. Building Integrated PV Systems, PV market analysis and Economics of SPV systems

Text Books

1. J. Nelson, Physics of Solar Cells, Imperial College Press, 2003.
2. M. A. Green, Solar Cells: Operating Principles, Technology and System Applications, Englewood Cliffs, N.J.; Sydney: Prentice Hall, 1992.
3. P. Wurfel. Physics of Solar Cells: From Basic Principles to Advanced Concepts
4. C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2016.
5. S. R Wenham, M. A Green, M.l E Watt, R. Corkish, Applied Photovoltaics, Routledge; 2nd Ed edition,2006
6. T. Bhattacharya, Terrestrial Solar Photovoltaic , Narosa Publishers Ltd, New Delhi, 1998

Reference Books:

1. L. Fahrenbruch, and R. H. Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, New York , 1983.
2. L. D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995.
3. H S Rauschenbach, Solar Cell Array Design Handbook, , Van Nostrand Reinfold, Company, New York, 1980

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN023210	Solar PV Technology Lab.	Laboratory	L	0	T	0	P	2	1

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The objective of this lab. is to provide hands- on training on solar cells characterization and Solar PV System design.

Course Outcomes (COs): After completion of this course, the students shall be able to: 1. Hands-on laboratory sessions explore how a solar cell works in practice. 2. Students will visualized solar cell fundamentals 3. Students will able to design solar PV system by its own. 4. Students will acquire skills in Solar PV installation. 5. Students will apply this knowledge towards developing a real project.
List of experiments
1. Dark and illuminated *I-V* characteristics of a solar cells varying light intensity 2. *I-V* and *P-V* characteristics of PV module with varying radiation and temperature levels 3. *I-V* and *P-V* characteristics of series and parallel connected PV modules 4. Effect of variation in Tilt angle on PV module power 5. Demonstration of the Effect of shading on PV module output power 6. demonstrate the working of diode as bypass diode and blocking diode 7. Solar cell design using PC1D simulation software 8. Solar PV system design using PVsyst software 9. Workout power flow calculations of stand alone PV system of DC load with battery 10. Workout power flow calculations of stand-alone PV system of AC load with battery. 11. Workout power flow calculations of stand-alone PV system of DC and AC load with battery 12. Carrier lifetime measurement for a solar cell 13. Spectral response measurement of solar cells 14. To draw the charging and discharging characteristics of the battery 15. Fabrication and characterization of Dye-sensitized solar cells 16. Fabrication and characterization of new generation solar cells 17. Solar cell simulation using software (SEQUEL)
Text Books
1. M. Green, Solar Cells: Operating Principles Technology (The Red Book), UNSW Photovoltaics. 2. P. Wurfel. Physics of Solar Cells: From Basic Principles to Advanced Concepts.
Reference Books:
1. *C. S. Solanki,* Solar photovoltaic technology and systems: a manual for technicians, trainers and engineers*, PHI Learning Pvt. Ltd., 2013*

SEMESTER VI

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013020	POWERSYSTEM STABILITY,OPERATION&CONTROL	Theory	L	0	T	0	P	3	3
Pre-requisite	: Knowledgeof PowerSystemAnalysis.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								

Syllabus Version :	1

Course Objectives :

1. Tounderstandthedifferentoperatingstatesofpowersystem.
2. Tounderstandtheautomaticfrequencycontrolofsingleareaandmulti areasystem
3. Tounderstandthevoltagecontrolstrategiespracticedinpowersystem
4. Differentstabilityissuesanditscontrol measuresisalsotaught.
5. Differentelectricitymarketmodelsandmarketstructuresisalsoexplained.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Gainknowledgeondifferentoperatingstatesofpowersystem.
2. Evaluatetheoperationalconstraints(equipmentandstability),controlobjectivesandtheir
3. Analysethedifferenttechniquesoffrequencyandvoltagecontrol inpowersystem.
4. Powersystemstabilityisanimportantissueafterthiscoursethestudentsgetaclearpictureaboutthedifferentstability issuesinpowersystemandthecontrolmeasurestomakethegrid stable.
5. Theacquirethebasicknowledgeondifferentelectricitymarket modelspracticedalloverthe world.

Unit – 1	**Introduction to power system operation, ALFC.**

IntroductiontopowersystemoperationinIndia. Different operatingstates.Introduction,Speedgoverningsystemandmodelling.Turbine modelling, Generator-loadmodelling.Steady-stateanddynamicresponseofALFC loop. The secondary ALFC loop, Integralcontrol.Introduction, Pool operation, Twoareasystems, Modelingof tie line.Static and dynamic response of twoareasystem,Tie-linebiascontrol,Tie-linecontrol, Digitalelectrohydraulic(DEH)controlsystem,Implementationof DEHsystem.

Unit – 2	**Excitation system and Voltage control**

Introduction,Methodsofvoltagecontrol.Powercapacitorsanditsapplicationtodistributionand transmissionsystem.Staticvarsystem.Introduction,Elementsofanexcitationsystem.Typesofexcitationsystem.Digitalexcitationsystem.

Unit – 3	**Power system security**

Introduction, Factors affectingpower systemsecurity.Introductiontocontingencyanalysis.

Unit – 4	**Electricity market structure**

Introduction,Regulationvs.Deregulation, Competitive Market for Generation.TheAdvantagesofCompetitiveGeneration,ElectricSupplyIndustryStructureUnder Deregulationin India.RestructuringModels.

Unit – 5	**Power System Stablility**

IntroductiontoPowersystemStability**c**lassification.Small signal and Transient stability,Rotorangle &VoltageStability.Stabilityproblem,swingequationanditsnumericalsolution.Determination of initial state in amulti-machinesystem,BasecaseYBUSandmodifiedYBUS,Computationalalgorithm, Improvementofstability.

Text Books

1. ElectricEnergySystemsTheoryanIntroduction-OlleI.Elgerd
2. Power GenerationOperationandControl-A.J.Wood,B.F.Wollenberg
3. Power SystemDeregulationbyLoiLeiLai

Reference Books:

1. Power SystemStabilityandControl-P. Kundur
2. ElectricPower DistributionSystemEngineering-T.Goneen

3. Power SystemAnalysis– Grainger &Stevenson
4. PowerSystemAnalysis,Operation&Control-Chakraborti&Haldar

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN010304	MICROPROCESSORANDMICROCONTROLLER	Theory	L	3	T	0	P	0	3

Pre-requisite	:Basicsofcomputerandprogramming.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Toteachthebasicof8085architectureandassemblyprogramming.
2. Toteachtheinterfacingof8085 withmemorydevicesandperipherals.
3. Toteachthebasicof 8051microcontrollers

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Solvedifferentproblemswithprograms.
2. Tobeabletointerfacedevicestomicroprocessor.
3. Tohaveknowledgeaboutmicrocontrolleranditsapplications

Unit – 1

Introduction to Microprocessor architecture,MemoryMapping.8085 CPU Architecture, Signal descriptions,8085 system,8085 Instruction Set, addressingmodes, Programming using 8085 Instructionset, '

Unit – 2

InterfacingDevices-Tristatedevices,Buffers.Latches,74LS138,74LS245,74LS148, 74LS373. HardwareInterfacing-interfacingmemory,InterfacingI/O:MemorymappedandI/OMapped

Unit – 3

Instructioncycle,Machinecycles,Timingdiagrams.8085Interruptssystem.Stackmemoryoperations,call returninstructions.

Unit – 4

InterfacingADCAD558andInterfacingDACusingstatuscheckwith 8085.Peripherals:Programmable PPI 8255ProgrammableIntervalTimer-8253.Introduction to DMA with relevance to 8085CPU. Interfacing these peripherals to 8085 CPU andtheirapplications.

Unit – 5

Introduction to Micro controller architecture:8051microcontrollersArchitecture,Memoryaddressing, Addressing modes, Instruction Set,I/OPort programming, Timer/CounterProgramming,Interruptprogramming

Text Book:

1 Ramesh S. Gaonkar- microprocessor Architecture, Programming andApplications with8085/8080A(Third Edition)– PenramInternational
2 The8051Microcontroller&EmbeddedSystems-M.AliMazidi-LPE edition

Reference Books:
1. FundamentalsofMicroprocessors-B.Ram, DhanpatRai 2. Intel-C.H.Embedded ControllerHandbookVol-I8 bit -IntelCorporation,1988. 3. WiatrowskiCandHouseC.H.-LogicCircuitsandMicrocomputer SystemsMGH,1980.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013060	ADVANCEDCONTROLTHEORY	Theory	L	3	T	0	P	0	3
Pre-requisite	: KnowledgeofLinearControlSystem.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :
Theobjectiveofthiscourseistoprovideanintroductiontobasicconceptsandmethodologies for Advance Control Theory. The limitation of transfer function model in analysis of controlsystem and the advantages of state space model over the transfer function model for the system design. Studyofnon-linearsystems and discrete domain systems.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1. Todesign anyphysicalsysteminstate spacedomain.
2. Toanalyse thestabilitycriterion ofany systemin statespace
3. Tomodeland controlanynon-linearsystem
4. Toevaluate acontrollable andobservablesystem
5. Tomodel andcontrolanydiscretesystem

Unit – 1	**StateSpaceAnalysis**

Introduction to State Space Analysis,ConceptofState,Statemodelsofmechanicalsystems,Statemodelsofelectrical systems, Realization of statemodelsfromtransferfunctions,Solutionofstateequation,StateTransitionMatrix, CascadeDecomposition,ParallelDecomposition,Cayley-Hamiltontheorem.

Unit – 2	**Stability in state space**

AsymptoticandBIBOStability,Lyapunovfirstmethodofstability,Lyapunov second method of stability,Lyapunovstabilitytheorem,LyapunovKrasovskii stability theorem, VariableGradientMethod.

Unit – 3	**Non-Linear System**

CommomPhysicalNonlinearities,Derivation of describing function forrelays,Derivationofdescribingfunctionforrelays,Derivationofdescribingfunctionforrelayswithdeadzone and hysteresis, Stability AnalysisbyDescribingFunctions,BasicconceptsofPhasePlaneMethod,Singularpoints,Phasetrajectory

Unit – 4	**Evaluationof Controllability and Observability**

ControllabilitycriterionGilbert'stest, Kalman'stest,Factor'scancellation testand PBH test. Observability criterionGilbert'stest,Kalman'stest, Factor'scancellationtestandPBHtest.

Unit – 5	**Digital Control System**

Ideal sampler, sampling process,Shannon's sampling theorem, Z transfer function, Jury'sStability criterion

Text Books

1. K.Ogata-ModemControlEngineering(ED.2)-PHI, 1995.
2. KOgata-StateSpaceAnalysisofControlSystems-PHI, 1967.

Reference Books:

1. M.Gopal-Digital Controlengineering-WileyEastern,1988.
2. CharlesLPhillipsand RoyeeD. Harbor-Feed BackControlsystems(ED.2)-PHI,1991

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN073200	SMARTGRID	Theory	L	3	T	0	P	0	3

Pre-requisite	:Basic knowledge of power systems, computer and communicationsnetworks and renewableenergysystems.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Tointroducethefundamental conceptsofmoderndaypower grid(smart Grid).
2. Tounderstandvarioustechnologiesinvolvedinsmartgird.
3. Tounderstandmicrogridandits operationandcontrol.
4. Identifydifferenttools andapproaches tomodellingaSmart Grid

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Developabasic understandingoftheelementsandstructureofsmart grid.
2. Learndifferentcommunication,measurementandcontroltechnologiesusedinsmartgrid.
3. Learnthepowerelectronicsand energystoragetechnologiesusedinsmart grid.
4. Developbasicunderstandingofmicrogrid,itsoperationandcontrol.
5. Conductperformanceandstabilityanalysisofsmart gridandcasestudiesonsmart grid.

Unit – 1	**Introduction to Smart Grid**

SmartGrid:Needandattributes,comparisonwithconventionalpowergrid,Smart grid scenario in Indian power sector,standardsfor smart grid system.Smart gridarchitecture.

Unit – 2	**Communication, Measurement andcontrol Technologiesin SmartGrid**

Communicationchannels, communicationNetworkStructuresand communicationtechnologies..Sensing,measurement,control andautomationtechnologies: SmartMeters, AdvancedMeteringInfrastructure(AMI)and AutomatedMeterReading(AMR),Phasor MeasurementUnit(PMU),SCADAand WAMSsystem,Demandsideintegration. Geographical InformationSystem, Multi- agenttechnology,artificialintelligenceand machinelearningforSmartgridapplications.

Unit – 3	**Power Electronicsand Energy storage technologies in SmartGrid.**

Roleofpowerelectronicsin smartgridanditsapplications.Energystoragesystems, applicationsinsmartgrid. Advantagesandchallengesofdifferent energystoragesystems.

Unit – 4	**MicroGrid**

Micro grid: Benefits, distributedgeneration,control,islandedandnon-islandedoperation,synchronousandasynchronousoperation.

Unit – 5	**Operation &Controlconcepts inSmart grid andcase studies ofsmart grid.**

Stateestimation,loadflow,optimal load flow, security constrained loadflow, stabilityanalysis,economicdispatch,self-healing,resilienceandreliability.Case study and simulations:Designofsmartgridandpracticalsmartgridcasestudy.

Text Books

1. AliKeyhani,"DesignofSmartPowerGridRenewableEnergySystems",JohnWiley&Sons,IEEEPress2011.
2. JamesMomoh,"SmartGrid-FundamentalsofDesignandAnalysis",JohnWiley&Sons,IEEEPress2012.

Reference Books:

1. JanakaEkanayake, N. Jenkins, K. Liyanage, J. Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN073240	INTRODUCTION TO HYBRIED ELECTRIC VECHILE	Theory	L	3	T	0	P	0	3

Pre-requisite	:Understanding of basic of various types of electric motors, drive systems, battery storage, andknowledgeofelectroniccircuits.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
Thiscourseintroducesthefundamentalconcepts,principles,analysisanddesignofhybridand electric vehicles. The course goes deeper into the various aspects of hybrid and electric drive train such astheir configuration, types of electric machines that can be used, energy storage devices, etc. Each topic will bedeveloped in logical progression with up-to-date information. A number of chosen problems will be solved toillustratetheconceptsclearly. Thereshallbea suiteofexercisesbasedon MATLABand Simulink.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Illustratetheblockdiagramtounderstandthefundamentalsofelectricandhybriddrivetrains.
2. Analyzevariousdrive-traintopologiesviz.,hybridandelectric.
3. Designofvariousdrivecomponents/systemsandmethodsforcontrolthespeedofelectricand
4. Analyzethepowerflowcontrol inhybridandelectricvehiclestopologies.
5. Evaluateofelectricpropulsionunitperformanceandsizingofdrivesystem.

Unit – 1	**Introductionto HybridElectricVehicles**

Historyofhybridandelectricvehicles, social and environmentalimportance of hybrid and electricvehicles, impact of modern drive-trainson energysupplies.

Unit – 2	**ConventionalVehicles**

Conventional Vehicles: Basics ofvehicleperformance,vehiclepowersource characterization,transmissioncharacteristics,and mathematical models to describevehicleperformance.

Unit – 3	**HybridElectricDrive-trains**

Basicconceptofhybridtraction,introductiontovarioushybriddrive-traintopologies,powerflowcontrolinhybrid drive-train topologies, fuelefficiencyanalysis.Introductionto electriccomponentsusedinhybrid and electric vehicles, ConfigurationandcontrolofDC Motordrives,Configurationand controlofInductionMotordrives.Configurationand control of Permanent Magnet Motordrives,Configurationand control ofSwitchReluctance Motor drives, drive system efficiency. Basic concept of electrictraction, introduction to various electric drive-train topologies,powerflowcontrolin electricdrive-traintopologies,fuel efficiencyanalysis.

Unit – 4	**ElectricPropulsionunit**

Introductiontoelectriccomponentsusedinhybridand electric vehicles,Configuration and control of

DCMotordrives,ConfigurationandcontrolofInductionMotordrives.ConfigurationandcontrolofPermanentMagnetMotordrives,ConfigurationandcontrolofSwitchReluctance Motordrives,drivesystemefficiency.
Unit – 5 **Sizing thedrivesystem**
Matchingtheelectric machine and the internalcombustion engine (ICE), Sizingthepropulsionmotor,sizingthepower electronics.Selecting the energystoragetechnology,Communications,supportingsubsystems.CaseStudies:DesignofaHybridElectricVehicle(HEV),DesignofaBatteryElectricVehicle(BEV).
Text Books
1. MehrdadEhsani,YimiGao,SebastianE.Gay,AliEmadi,ModernElectric,HybridElectricandFuelCellVehicles:Fundamentals, Theoryand Design, CRCPress, 2004
Reference Books:
1. IqbalHussein,ElectricandHybridVehicles:DesignFundamentals,CRCPress,2003. 2. JamesLarminie,John Lowry,ElectricVehicleTechnologyExplained,Wiley,2003.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN073220	Bio-Energy Systems	Theory	L	2	T	1	P	0	3
Pre-requisite	:NILL								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :
Course Outcomes (COs): After completion of this course, the students shall be able to: 1. 2. 3. 4. 5.
Unit – 1 **Introduction**
Production of biomass, photosynthesis - C3 & C4 plants on biomass production. Biomass resourceassessment. CO_2 fixation potential of biomass. Classification of biomass. Physicochemical characteristics of biomass as fuel.
Unit – 2 **Biomass Conversion Techniques**
Biomass conversion routes: biochemical, chemical and thermo-chemical. Biochemical conversion of biomass to energy: anaerobic digestion, biogas production mechanism, technology, types of digesters, design of biogas plants, installation , operation and maintenance of biogas plants, biogas plants manure-utilization and manure values. Biogas storage, biogas formotive power generation etc. Alcohol production from biomass. Types of Materials of alcohol production-process description, distillation etc.
Unit – 3 **Biofuel Conversion Techniques**
Chemical conversion processes, hydrolysis and hydrogenation. Biofuels-different processes of production, Economics on utilization. Biodiesel – the mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel engine utilization etc.
Unit – 4

Thermochemical conversion of biomass-combustion in excess oxygen, combustion in oxygen deficient atmosphere--products--fuel characteristics. Pyrolysis, Carbonization, Charcoal production biomass gasification-different types' power generation from gasification – cost benefic analysis of power generation by gasification.
Unit – 5
Waste land utilization through energy plantation- basis of selecting the plants for energy plantation, biomass based power generation.
Text Books
1. Maheswari R. C., (1997); Bio Energy for Rural Energisation , Concepts Publication 2. Khandelwal KC, Mahdi SS, (1986); Biogas Technology - A Practical Handbook, Tat Mcgraw Hill 3. Sorensen Bent, Renewable Energy, (2nd Ed 2000), Academic press, New York 4. Johansson Thomas B, (1993): Renewable Energy: Sources for fuels and electricity Earthscan Publishers, London
Reference Books:
1. Rosillo-Calle Frank, Francisco Rosillo, 2007; The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment Published by Earthscan 2. Rai G.D, (2007) ; Non-conventional energy sources by , Khanna Publishers., 3. Mittal K. M , (1996) ; Biogas systems: Principles and applications, New Age International

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN073300	EHVACANDDCTRANSMISSION	Theory	L	3	T	0	P	0	3

Pre-requisite	:Knowledgeof powersystemstructureandanalysismethods.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
To learn the reason and history of EHV AC & DC power systems, significant milestones.To inculcate the understanding about the EHV AC & DC transmission together with its components andcontroland an introductionto FACTS.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1. Understand the aspects of EHV ACand DCtransmission lines.
2. Calculate variousparameters ofEHVline.
3. Understandtheprinciplesandmodellingof EHVDCtransmissionlines.
4. Understand the adverse effects of system harmonics and it filtration and mitigation.
5. Controlof HVDClinesandunderstandthe varioussystemelementsinvolved.

Unit – 1
Aspects of EHV AC and DCtransmission. General Background andState of art of EHV AC TransmissionTechnologyBundled conductors,Maxwell's Coefficients, Inductanceandcapacitance matrices.
Unit – 2

Surface Voltage gradient on bundledconductors,Mangold'sformula,Gradientfactors.CoronaEffects: PowerLoss,BI.Groundlevelelectrostaticfieldof EHV Lines
Unit – 3
IntroductiontoHVDCtransmission:ComparisonwithEHVACpowertransmission,HVDCsystemconfigurationandcomponents.PrinciplesofAC/DCconversion:Converterconnections,Waveforms, RelevantEquations.
Unit – 4
Harmonics and Filters : Waveforms ofa-c bus currents in Star/Star, Star/delta&12-phaseconvertersandtheirFourier-seriesrepresentations,Non-characteristicharmonics,HarmfulEffectsofHarmonics,DCsideharmonics,Filtersanddetuning,Cost considerationsoffilters.
Unit – 5
HVDC system control : FrequencyControl of A.C. system, Stabilisation&dampingof A.C.networks.HVDCsystemselements:Convertertransformers,D.C.smoothing reactors,Earthelectrodes &earth return.
Text Books
1. R.D.Begamudre,ExtraHighVoltageACTransmissionEngineering,WileyEasternLtd.,1986. 2. S.Rao,EHV ACandHVDCTransmissionEngineering&Practice,KhannaPublishers,Delhi,1990.
Reference Books:
1. HVDCPowerTransmission SystemsbyK. Padiyar,WileyEasternLtd. 2. EHV ACandHVDCTransmissionEngineeringandPracticesbyS.S. Rao,KhannaPublications.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN073280	Material Science for Energy Applications	Theory	L	2	T	1	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
Course Outcomes (COs): After completion of this course, the students shall be able to: 1. 2. 3. 4. 5.

Unit – 1	**Introduction**
Historical perspective of Materials Science, Classification of materials. Advanced Materials, Future materials and modern materials. Atomic structure, Atomic bonding in solids, Crystal structures, Crystalline and non-crystalline materials. Miller indices, Lattice structure, Braggs Law and determination of lattice structure of materials, Anisotropic elasticity, Elastic behavior of composites, Structure and properties of polymers. Structure and properties of ceramics.	

Unit – 2	**Solid State Physics**

Band theory of Solids: Periodic well potentials, Block Functions, Kronig-penny model, Energy bands in metals, insulators, and semiconductors, the concept of a "hole" Intrinsic and extrinsic semiconductors. Defects: Point defects, Line defects and dislocations, Diffusion: Steady and non-steady state diffusion, Factors that influence diffusion, Phase Equilibrium and Phase Diagrams, Phase Transformation.

Unit – 3	**Electrical properties of Materials**

Conductivity, Electron Mobility, Electrical Resistivity of Metals & Alloys, Semiconductors, Hall Effect, Carrier concentration, Dielectric Properties, Capacitance, Types of polarizations, Ferro electricity, Piezoelectricity, Thermal properties: Heat capacity, Thermal expansion, Thermal conductivity. Magnetic properties: Diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferromagnetism. Influence of temperature on magnetic behavior, domains and hysteresis. Superconductivity.

Unit – 4	**Optical properties of materials**

Interaction of solids with radiation, Atomic and electronic interaction, Optical properties of Metals and nonmetals: reflection, absorption, refraction and transmission. Applications of Optical Phenomena: Luminescence, Photoconductivity, Color, Laser, Optical Fibers in communications.

Unit – 5	**Composites, Corrosion and Degradation of Materials, Characterization of Materials and Economic, Environmental and Social Issues of Material Usage**

Particle reinforced composites. Fiber reinforced composites. Structural composites, Corrosion of metals, Corrosion of ceramics, Degradation of polymers. Introduction to spectrophotometry and its application in material science. Crystallography, X-Ray Diffraction Methods, Fluorescence spectroscopy, Raman spectrograph and its application. Electron Diffraction- diffraction pattern in specific modes, advanced microscopic techniques for material characterization – SEM, TEM, STM AFM.Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design

Text Books

1. L. H. Van Vlack, Elements of Materials Science and Engineering, Addison-Wesley, New York, 1989.
2. W. D. Callister, Jr., Materials Science and Engineering: An Introduction, John Wiley, New York, 1997.
3. K. M. Ralls, T. H. Courtney, and J. Wulff, Introduction to Materials Science and Engineering, Wiley, New York, 1976.
4. V. Raghavan, Material Science and Engg. A first course, Prentice Hall of India, 1988

Reference Books:

1. Z. D. Jastrzebski, the Nature and Properties of Engineering Materials, John Wiley, New York, 1987.
2. Ben G. Streetman, Solid State electronic devices, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN073260	PROJECT MANAGMENT	Theory	L	2	T	1	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.
2.
3.
4.

5.
Unit – 1
Functions of Project Management, Project Life Cycle, the Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.
Unit – 2
Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modelling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting.
Unit – 3
Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.
Unit – 4
Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management.
Unit – 5
Concept, need, its existence in India and abroad, traits of an entrepreneur, development of entrepreneurial talents, motivation, achievement, risk taking, goal setting, creativity, obligation, pitfalls and steps for successful entrepreneurship. Entrepreneurship development through promotional organization, concept and growth of such organizations especially with respect to state. Procedure for starting small scale industry, incentives for their promotions.
Text Books
1. Systems analysis techniques for water resources planning and management. Mohammad Karamouz. 2. Water resources engineering Fourth Edition, McGraw-Hill International Editions
Reference Books:
1. Industrial Engineering and Management, O.P.Khanna, DHAN publishers

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN083080	Basics of Fuel Cell and Hydrogen Energy	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The course will enable the students to

1. understand importance of clean fuel and hydrogen
2. understand the basics of electrochemical conversion
3. understand similarities and differences between batteries and fuel cell
4. understand the basic design and working of fuel cell
5. know the characteristics parameters of fuel cell and components
6. understand the different types/designs and working of fuel cells
7. learn about the hydrogen energy generation, storage, conversion and transportation

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. correlate clean fuel and hydrogen,
2. explain basics of the electrochemical conversion process vis-à-vis batteries and fuel cell,
3. explain the basic design and working of fuel cell,
4. explain the different component and characterization technique,
5. offer fuel cell design options for different and niche applications and fuel options,
6. suggest methods for hydrogen production based on different raw materials,
7. explain methods for hydrogen energy storage and transportation,

Unit – 1	**Clean fuel and hydrogen:**

Clean fuel; Hydrogen as clean fuel; Carbon mitigation potential; Hydrogen Economy

Unit – 2	**Basics of electrochemical conversion:**

Difference and similarities between batteries and fuel cell; combustion versus electrochemical conversion of hydrogen

Unit – 3	**Basic design and working of fuel Cell:**

Fuel cell definition, fuel cell history, Types and components of Fuel Cells, principle of working, Fuel cell thermodynamics - second law analysis of fuel cells, efficiency of fuel cells, fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation.

Unit – 4	**Fuel Cell components and Characterization:**

Cell components, stack components, system components; Fuel Cell Characterization: In-situ and Ex-situ; System and components' characterization

Unit – 5	**Different Designs/types of fuel Cells:**

Overview of intermediate/high temperature fuel cells - Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells ,Heat and mass transfer in polymer electrolyte fuel cells, water management in PEFCs, Current issues in PEFCs, Direct methanol fuel cells (DMFC) - Electrochemical kinetics methanol oxidation, Current issues in MFCs, Fuel crossover in DMFCs, Water management in DMFCs, high methanol concentration operation, limiting current density

Unit – 6	**Hydrogen Generation:**

Hydrogen: Its merit as a fuel, Applications. Hydrogen production methods: Production of hydrogen from fossil fuels, electrolysis, thermal decomposition, photochemical and photo-catalytic methods.

Unit – 7	**Hydrogen Storage and transportation:**

Hydrogen storage methods: Metal hydrides, metallic alloy hydrides, carbon nanotubes, sea as source of deuterium

Unit – 8	**Hydrogen Energy Conversion:**

Direct conversion of hydrogen, in-situ and ex-situ conversion using hydrocarbon fuel; Combustion for thermal applications

Text Books

1. J Larminie and A Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley,2003
2. Xianguo Li, Principles of Fuel Cells, Taylor and Francis, 2005
3. S Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer

Reference Books:

1. O'Hayre, SW Cha, W Colella and FB Prinz, Fuel Cell Fundamentals, Wiley, 2005
2. A Faghri and Y Zhang, Transport Phenomena in Multiphase Systems, Elsevier 2006

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013100	POWERSYSTEML AB	Laboratory	L	0	T	0	P	2	1
Pre-requisite	:Knowledgeof the subject Powersystemanalysis.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								
Course Objectives : Tohavepracticalexposureforfaultanalysisinpowersystem,loadflowanalysisandpowersystemprotectiondevices.									
Course Outcomes (COs): After completion of this course, the students shall be able to: Conversantwithprotectionofdifferentpowersystemequipment.Simulationofpowersystemfaults.									
List of experiments									
1. Determination of ABCD parameter of scale down model of a 620 MVA, 275 kV, 400 km transmission line using AC network analyzer. 2. Time-Current characteristics of an over current relay. 3. Tie-Line modeling of multi area AGC system in Simulink environment. 4. Load flow analysis using ETAP. 5. Fault analysis using DC Network analyzer and ETAP. 6. Microcontroller based static VAR compensator. 7. Measurement of earth resistivity and earth resistance using megger. 8. Earth grid mat design using ETAP.									
Text Books									
Reference Books:									

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN013120	AdvanceProgrammingLab	Laboratory	L	0	T	0	P	2	1
Pre-requisite	: None								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								
Course Objectives : To develop the programming skills									
Course Outcomes (COs): After completion of this course, the students shall be able to: The students will be able to write programs for any optimization algorithm.									
List of experiments									
1. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using Bracketing method. 2. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using exhaustive method. 3. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using region elimination									

technique.

4. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using Fibonacci Search method
5. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using Newton-Raphson method.
6. Write a program in matlab to minimize the function $f(x_1, x_2) = (x_1^2 + x_2 - 11)^2 + (x_1 + x_2^2 - 7)^2$ Using Hook Jeevs Pattern search method.
7. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using Secant method.
8. Write a program in matlab to minimize the function $f(x) = x^2 + \frac{54}{x}$ Using Bounding Phase method.

Text Books

Reference Books:

SEMESTER VII

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN014010	SWITCHGEARANDPROTECTION	Theory	L	3	T	0	P	0	3

Pre-requisite	:Knowledgeof powersystem.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The course aims at various switchgear and protective system practices adopted in themodern day power system. The course content includes various practices adopted for over voltage protection,typescharacteristicandselectionofsuitablesurgedivertersandformulatingaappropriateinsulationcoordination scheme for the given power system. The course also includes various neutral grounding schemesadopted in the power systems. The student is also exposed to various circuit interrupting devices includingswitchesused, theircharacteristic,relativemerits,ratingsandselection. Thecoursealsoincludesrelayprotection system used, types of relays including solid state devices. The students also study the variousprotectiveschemesforprotectionofalternators motors,transmissionlines,transformer etc.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Analyzeoperationandperformanceofrelayforpowersystemprotection
2. Designprotectionsystemfordifferentcomponentsofpower system
3. Designandanalyzedifferentovervoltageprotectionsysteminpowersystem.
4. Analyzedifferenttypesoffuseandgroundingtechniquesinpowersystem
5. Analyzedifferenttypesofcircuit breaker

Unit – 1	**Operationandperformanceofrelay**

Functionsofprotectiverelaying,Fundamental characteristics of relays, andStandard definition of relay terminologies,Relay classifications, operating principlesofsingleanddoubleactuatingquantitytype electromechanicalrelays.Directionalrelay,reversepowerrelay.
Unit – 2 **Relayfor different components of power system**
DifferentialprotectionschemesforBus bars,Transformer and Alternator. And transformers. Buchholtz relayfor Transformerprotection.Alternator protection: Negative phase sequencerelay,Lossoffieldprotection, ReversepowerprotectionLineprotection:VarioustypesofDistance relays,performanceofdistancerelays.InductionMotor Protection: Abnormal operating conditions, Contactors and circuitbreakersformotors.Solidstaterelays:Phaseandamplitude comparators,Dualitybetweenphaseand amplitudecomparators,generalequation forcomparators.Computeraidedrelaying:Introductionto microcomputer based relays, Digital Protectiongeneralfunctionaldiagramof microcomputerbasedrelays.Advantagesoverconventional relayingtechniques.
Unit – 3 **OverVoltageProtection**
TypesofSystemTransients:Surgephenomena,typeandmagnitudeofswitchingandlightningover voltages. Methods of over voltage protection - rodgap,valve,ZnOtype-construction,workingmeritsandapplications,voltageandcurrentratings,Protectionoftransmissionlinesagainstover voltages
Unit – 4 **FuseandGroundingTechniques**
Fusesandswitches:Re-wirablefuses,HRCfeatures,construction,fuseelements,phenomena of cut off, selection of fuses,comparison of fuses and circuit breakers.Neutralgrounding-capacitorcoupling,disadvantagesofungroundedsystems,effectively grounded, resistive and reactivegrounding.
Unit – 5 **CircuitBreaker**
Circuit breakers- principle of working, arcphenomenon,methodsofarcextinction,recoveryandrestrikingvoltage.Circuit breaker ratings- breaking capacity ,making capacity, various times associatedwithcircuitbreakers,Oil circuit backers and air circuit breakers-construction, principle of working, meritsandapplicationSF6 circuit breaker, principle, constructionofdifferent,working,meritsandapplicationofSF6 breakers.Vacuum circuit breaker, arc extinction invacuum,working,constructionand applicationofvacuumcircuit breakers
Text Books
1. S.S.Rao -SwitchgearandProtection-KhannaPublishers,N.Delhi,1990. 2. I.J. Nagrathand D. P.Kothari_PowerSystemEngineering,TMH,1994 3. Chakraborti,Soni Gupta–ATextbookonPower SystemEngineering– Dhanpat Rai &Co. 4. Mason - The Art and Science of Protective relaying – Wiley Eastern publications,N.Delhi,1992. 5. Badriram and D._.Vishwakarma - Power System Protection and Switchgear - TMH,1995
Reference Books:
1. WarringtonA.R. andVan C-ProtectiveRelays-TheirTheoryand PracticeVol.I&II-Chappman andHall, London, 1969. 2. Ravindranath B. and Chander.M - Power System Protection andSwitchgear - WileyEastern, 1994. 3. Y.G.Paithankar–Fundamentals ofPowerSystemProtection–PHI

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN014030	ADVANCEPOWERCONVERTERS	Theory	L	3	T	0	P	0	3
Pre-requisite	:Understandingofbasicelectricalandelectronicdevicessuchasdiodes,transistors,MOSFETs,thyristor,IGBT,inductors,capacitors,resistorsetc.Knowledgeof power electronics								

Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Tointroducevariouspowerconversionprocessesortechniques.
2. To provide an understanding of various power converters and power semiconductor devices, theircontrol,protection aspectsand application.
3. Toexpose studentstovarious topologies ofthepowerconverters.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Identifyandchoosetheappropriatesemiconductorswitchforagivenpowerconverter application.
2. Designandanalysisofnon-isolatedDC-DCconverterin continuousanddiscontinuousconductionmode.
3. Designandanalysis ofisolated DC-DCconverter.
4. Designandanalysisofresonantconvertersandanalysisofpulsewidthmodulation(PWM)technique.
5. Designandanalysisofmultilevelinvertersanduniversalpowersupplies(UPS).

Unit – 1	**Advanced solid-state devices**

MOSFETs,IGBT,SiCandGaNbaseddevices. etc,theirpowermodules, intelligentpowermodules,thermaldesign, protection, gating circuits, digital signal processors used in theircontrol.

Unit – 2	**Non-isolated DC-DC converter**

Generalizedcomparison between switched modeandlinearDCregulator;Operationand steadystateperformanceofBuck,Boost, Buck-BoostandCukConvertersincontinuous-conductionmode,discontinuous-modeand boundary between continuous and discontinuous mode of operation.

Unit – 3	**IsolatedDC- DC converter**

Flyback convertersanditstopologies; Forwardconverters–Switchingtransition; Push-pullconverter- Switching transition, limitationofthepush-pullcircuit;Half-bridge andFullbridgeDC-DCconverters–their switching transitions.

Unit – 4	**Resonant converters and PWM**

Introductionandclassification;zerocurrentswitch(ZCS);zerovoltageswitch(ZVS);ZCS-clampedvoltageconverters(ZCS-CV).PWMconverter–Singlepulsemodulation,multiplepulsemodulation,sinusoidalpulsewidthmodulation.

Unit – 5	CompensatorDesign

Advantages, configurations: Diode clamped,flying capacitor and cascade multi-levelinverters,applications.RedundantandNon-Redundant UPS.

Text Books

1. Mohan, Undeland, Robbins_Power Electronics: Converters, Application and Design, John Wiley &sons, 1989
2. A.I.pressman-Switchingmodepowersupplydesign-MGH,1992

Reference Books:

1. M.H.Rashid-PowerElectronics,PHI,2004

Course Code	Course Title	Course Type	Contact Hours	Credit

EEN074150	MODERNPOWERCONVERTERS	Theory	L	3	T	0	P	0	3

Pre-requisite	: Understandingofbasicelectricalandelectronicdevicessuchasdiodes,transistors,MOSFETs,thyristor,IGBT,inductors,capacitors,resistorsetc.Knowledgeof powerelectronics.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Tointroducevariouspowerconversionprocessesortechniques.
2. Toprovide anunderstandingofvariouspowerconvertersandpowersemiconductordevices,theircontrol,protection aspectsandapplication.
3. ToexposestudentstovariousDC-DC,AC-DCandDC-ACtopologiesofthepower converters.
4. Toanalyzevariousmodulationtechniquesapplicableforpower converters.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Designandanalysisofnon-isolatedDC-DCconverterincontinuousanddiscontinuous conductionmodewithidealandnon-idealconditions.
2. DesignandanalysisofisolatedDC-DCconverter.
3. Designandanalysisofresonantconverters
4. Designandanalysisofresonantconvertersandanalysisofpulsewidthmodulation(PWM)technique.
5. Analysisofsinepulsewidthmodulation(SPWM),spacevectormodulation(SVM),selectiveharmoniceliminat ion(SHE)andhysteresismodulationtechniquesapplicableforDC-AC converters.

Unit – 1	**Non- isolated DC-DC converter**

Generalizedcomparisonbetweenswitched modeandlinearDCregulator;Operationand steadystate performance of Buck, Boost, Buck-Boost and Cuk Converters incontinuous-conductionmode,discontinuous-modeandboundarybetweencontinuousand discontinuousmodeofoperation;Output voltageripplecalculation;Effectofparasitic elements.

Unit – 2	**Isolated DC-DC converter**

Flyback convertersandits topologies; Forwardconverters-Switchingtransition; Push-pull converterSwitching transition, limitationofthepush-pullcircuit.

Unit – 3	**Resonant converters**

Introductionandclassification;Loadresonant -seriesandparallelloadedconvertersin continuous and discontinuousmode ofoperation; Hybrid resonant DC-DC converters; zero current switch (ZCS); zero voltage switch(ZVS); ZCS- clamped voltageconverters(ZCS-CV).

Unit – 4	**DC-AC converters**

Voltage source and current source inverter;single-phaseandthree-phasebridgeinverters;square wave operation, 120 and 180 degreemodes;potentialdiagrams.

Unit – 5	**Modulation techniques**

Currentregulated(Hysteresis)Modulation;Selectiveharmonicelimination;sinetriangularmodulation;linearmodulation;overmodulation; harmonics in the output voltage,staircasePWM,spacevectormodulator.

Text Books

1. Mohan, Undeland, Robbins_Power Electronics: Converters, Application and Design, John Wiley &sons, 1989
2. A.I.pressman-Switchingmodepowersupplydesign-MGH,1992

Reference Books:

3. M.H.Rashid-PowerElectronics,PHI,2004

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074170	FLEXIBLEACTRANSMISSION SYSTEM	Theory	L	3	T	0	P	0	3

Pre-requisite	:ElectricalpowerTransmission,PowerElectronics,Transformers,ACpower.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. Toenablethestudentsacquireacomprehensiveideaofvariousaspectsof FACTSsystems.
2. ToacquiretheknowledgeonFlexibleACtransmissionsystemanditsimportanceinmodernpowersystem.
3. TounderstandVarious FACTSDevices,their operation andapplications.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.Conduct investigations on Transmission line with and without compensation
2.Understand the basics and modelling of shunt connected FACTS devices
3.Understand the basics and modelling of series connected FACTS devices
4.Understandthebasicsofshuntandseries connected FACTS devices
5.ApplyvariousFACTSdevicesformanipulating/controllingvariousTransmissionlineparameterandpower oscillation damping

Unit – 1

AC Transmission Line and ReactivePowerCompensation:AnalysisofUncompensatedACline,PassiveReactivePowerConsumption,Compensation by a Series CapacitorConnected at the Midpoint of the line,ComparisonbetweenSeriesandShuntCapacitor,CompensationbySTATCOMandSSSC.

Unit – 2

Static Var Compensator: Analysis ofSVC,ConfigurationofSVC,SVCController,ModellingofSVC,Applicationof SVC.StaticSynchronousCompensator(STATCOM):PrincipleofSTATCOM, analysis of STATCOM,analysisof6-pulseVSCusingswitchingfunction,multi-pulseconverters,multilevel,voltageconverters,harmonictransferandresonance inVSC

Unit – 3

Thyristor and GTO Controlled SeriesCapacitor:Basicconceptsofcontrolled series capacitor, Operationof TCSC, Analysis of TCSC, ControlofTCSC,ModellingofTCSCforstability,GTOcontrolledseriescapacitor.StaticSynchronousSeriesCompensator:OperationofSSSCand thecontrolofpowerflow,modelling andcontrol ofSSSC.

Unit – 4

UnifiedPowerFlowControllerandotherMulti-ConverterDevices:Operation of UPFC, control of UPFC,Protection of UPFC, Interline powerflowcontroller,convertiblestaticcompensator.

Unit – 5

Power Oscillation Damping: BasicIssues in the Damping of Lowfrequency Oscillations in LargePowerSystems,designofdampingcontrollers.Damping of Power oscillations usingseriesFACTScontrollers,DampingofPoweroscillationsusingshuntFACTScontrollers.

Text Books

1. UnderstandingFACTS:ConceptsanfTechnologyofFlexibleACTransmissionSystems, NarainG.Hingorani,Laszlo Gyugyi.
2. PowerElectroniccontrolinElectricalSystems: EAcha,V.G.Agelidis,O.Anaya-Lara,T.J.EMiller

Reference Books:

3. FACTScontrollersinPowerTransmissionandDistribution,K.R.Padiyar,NewAgePublication.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074190	Energy & Environment	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The objective of this course is to acquaint the students with some basic knowledge of environmental issues in energy related projects. The students can solve the various engineering problems applying ecosystem during the generation of energy. They can also use relevant air, water, soil, thermal and noise pollution control method to solve domestic and industrial problems.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Understand the ecosystem and terminology to solve various engineering problems applying ecosystem knowledge during the production of energy.
2. Understand the suitable air, water, noise pollution control measures and appropriate acts used to control the pollution.
3. Understand the environmental issues during the efficient process of energy harvesting.
4. Understand about the Sustainability, Solid Waste Management and guidelines for Environmental Impact Assessment of energy projects..

Unit – 1	**Energy and Environment**

Environmental effects of energy extraction, conversion and use; Sources of pollution; primary and secondary pollutants; Consequence of pollution growth; Air, water, soil, thermal, noise pollution- cause and effect; Causes of global, regional and local climate change; Pollution control methods; Environmental laws on pollution control. GHGs emission and energy activities; Dealing with Climate change on sequences: Emission targets; Measures to reduce GHGs; Climate Change Act.

Unit – 2	**Energy and Climate Change**

Green House Gas Emissions, Depletion of Ozone layer, Global Warming, Climate Change in India, Impact of Climate Change on Glaciers, Rivers and Water Resources, Clean Energy Technologies, Energy economy, Role of Renewable Energy; Risk and opportunities;

Unit – 3	**Impact of Energy on Environment**

Overview of global environmental problems, Environmental degradation due to Energy production and use, Pollution due to thermal power stations , Environmental aspects of Wind Energy Farms ,Environmental aspects of Nuclear power generation, Nuclear waste disposal, Impact of Hydro power generation on Ecology and Environment, Guidelines for Environmental impact assessment (EIA) of Energy Projects

Unit – 4	**Sustainability**

Global warming; Green House Gas emissions, impacts, mitigation; Sustainability; Future Energy Systems; United Nations Framework Convention on Climate Change (UNFCC); Sustainable development; Kyoto Protocol; Conference of Parties (COP); Clean Development Mechanism (CDM); Prototype Carbon Fund

(PCF). **Carbon Trade**: Carbon Market; Commerce of Carbon Market, Environmental Transformation Fund; Technology, Perspective: Strategies for technology innovation and transformation. Indian National Action Plan on Climate Change (NAPCC), Jawaharlal Nehru National Solar Mission (JNNSM).

Text Books

1. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000.
2. R. Wilson and W. J. Jones, Energy, Ecology and the Environment, Academic Press Inc, 1974.
3. D.W. Davis, Energy: Its Physical Impact on the Environment, John Wiley and Sons, 1982.

Reference Books:

1. J.M. Fowler, Energy and the Environment, 2nd Ed, McGraw Hill, New York, 1984.
2. A.K.N. Reddy, RH Williams, TB Johansson, Energy after Rio, Prospects and challenges, UNDP, United Nations Publications, New York, 1997.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074210	FOUNDATIONSOFOPTIMIZATION	Theory	L	3	T	0	P	0	3

Pre-requisite	: KnowledgeofMATLAB,numericalanalysistechniques.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. The focus of the course is on convex optimization though some techniques will be covered for non-convexfunction optimization too.
2. Afteranadequateintroductiontolinearalgebraandprobabilitytheory,studentswilllearntoframeengineeringminimamaxima problemsintheframeworkofoptimizationproblems.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Knowledgeofbasicoptimizationproblem.
2. Abilitytoformulatedecisionproblemsasoptimizationproblems.
3. Abilitytosolvesimplesingleandmultivariableoptimizationproblems.
4. Abilitytoapplynontraditionaloptimizationalgorithmstosolveproblems.
5. Capabletousedifferenttoolstosolveoptimizationproblem.

Unit – 1	**Introduction**

Optimal problem formulation,Design variables constraints, Objectivefunction,Variablebounds,Engineeringoptimization problems, Optimizationalgorithms.

Unit – 2	**SingleVariableOptimization**

Optimality Criteria, Bracketingmethods: Exhaustive searchmethods,Region - Elimination methods;Interval halving method, Fibonacci searchmethod,Point-estimation method;Successivequadraticestimationmethod.Gradient-based methods:Newton-Raphsonmethod,Bisectionmethod,Secantmethod,Computerprograms.

Unit – 3	**Multivariableoptimizationalgorithm**

Optimality criteria,Unidirectionalsearch,Directsearchmethods.Evolutionary optimizationmethod, Simplex search method, Hooke-Jeevespatternsearch method.Gradient basedmethods:Cauchy's (Steepest descent) method,Newton'smethod.

Unit – 4	**Constrained optimization algorithm**

Characteristicsof aconstrained problem.Direct methods:Thecomplex method,Cuttingplanemethod, Indirect method: TransformationTechnique,Basicapproach in thepenaltyfunctionmethod,Interior

penaltyfunctionmethod,Convexmethod.	
Unit – 5	**Nontraditional optimization algorithm**
GeneticAlgorithm,Working principles,GAsforconstrainedoptimization, OtherGAoperators,AdvancedGAs, DifferencesbetweenGAsandtraditional methods,Computerprograms.Simulatedannealingmethod, workingprinciples,Computerprograms.	
Text Books	
1. KalyanmoyDeb,OptimizationforEngineeringDesign-AlgorithmsandExamples,2ndEdition.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074250	POWER GENERATION ECONOMICS	Theory	L	3	T	0	P	0	3

Pre-requisite	: None.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. The primary objective of this course is to analyze efficient and optimum operation of electric power generation systems and to provide an overview about the control techniques adopted to ensure the economic operation of a power system.
2. This course also introduces optimization methods and their application in practical power system operation problems.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Apply knowledge of India's power scenario, power system structure and related agencies.
2. Explain about various types of power plants i.e., hydro, thermal, gas and nuclear.
3. Harness power from conventional and renewable sources.
4. Select the methods and size of plant generating power for overall economy.
5. Decide the tariff structure for different type of users.

Unit – 1	Introduction:

Energy sources and their availability, Principle types of power plants, their special features and applications, Present status and future trends. Hydro Electric Power Plants: Essentials, Classifications, Hydroelectric survey, Rainfall run-off, Hydrograph, Flow duration curve, Mass curve, Storage capacity, Site selection, Plant layout, various components, Types of turbines, Governor and speed regulation, Pumped storage, Small scale hydro–electric plants (mini and micro). Thermal Power Plant: General developing trends, Essentials, Plant layout, Coal–its storage, Preparation, Handling, Feeding and burning, Cooling towers, Ash handling, Water treatment plant, High pressure boilers and steam turbines, Components of thermal power plant. Gas Turbine Power Plants: Field of use, Components, Plant layout, Comparison with steam power plants, combined steam and gas power plants. Nuclear Power Plant: Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect. Non-Conventional Power Generation: Geothermal power plants, Electricity from biomass, Direct energy conversion systems (Solar and Wind), Thermo-electric conversion system, Fuel cells, Magneto-Hydro dynamic system. Cogeneration: Definition and scope, Cogeneration technologies, Allocation of costs, Sale of electricity and impact on cogeneration. Power Plant Economics: Cost of electrical energy, Selection of

type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle, Load curves, Effect of load on power plant design, Load forecasting, electric tariffs, Peak load pricing.

Text Books

1. Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., a Text Book on Arora, S.C
2. and Domkundawar, S., a course in Power Plant Engineering, DhanpatRai (2002).
3. Deshpande, M.V., Power Plant Engineering, Tata McGraw Hill (2004).
4. Gupta, B.R., Generation of Electrical Energy, S. Chand (1998).
5. Deshpande, M.V., Electrical Power System Design, McGraw Hill (2004).
6. Wood, A.J. and Wollenberg, B.F., Power Generation and Control, John Wiley (2004).

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074230	Advanced PV Technology	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.
2.
3.
4.
5.

Unit – 1	**Introduction**

Cell and Module Concepts: Flat plate and concentrator cells and modules. Multijunction concepts. Overview of cell types and technology status. Resource limitations to terawatt photovoltaics. Potential Earth-abundant materials for photovoltaics, Approaches to low-cost thin-film photovoltaic cells.

Unit – 2	**Emerging PV Devices**

High efficiency crystalline silicon designs. Passivation, light trapping and contact structures. Cost reduction strategies. III-V devices, high concentration, quantum wells devices, multijunction structures, Thin film solar cells, structures and fabrication, novel device designs, Organic photovoltaic cells, Dye-sensitized solar cells, thermophotovoltaic devices, Multijunction tandem cells and concentrating systems. Efficiency limits. Approaches to low-cost thin-film and 3-dimensional photovoltaics. Terawatt low-cost wafer silicon photovoltaics, Perovskite solar cell, Quantum dot (QD) solar cells, Multi-junction solar cells.

Unit – 3	**Advance Characterization Methods**

Material characterization, X-ray diffraction, optical characterization, minority carrier lifetime and diffusion length measurement. Cell measurement, solar simulation, conversion efficiency and spectral response. I-V-T and C-V-f measurements. Measurement and performance standards.

Unit – 4	**Basic System Design**

PV arrays, electrical connections and wiring issues BOS components Overview of stand alone and grid

connected systems System sizing, stand alone System: Applications, Performance assessment, Standards and regulations. PV system for grid interactive applications: Inverter systems, electrical supply issues Grid connection regulations, Harmonic content, reactive power, wiring issues, PV based hybrid system, Design of large scale systems, Very Large Scale Photovoltaic (VLSPV), PV Instrumentation.	
Unit – 5	**Building Integrated Systems**
System design and sizing, Energy in buildings, building components, Installation and operation Concentrator systems: Design of concentrator systems, Operation and maintenance	
Unit – 6	**Monitoring & Performance**
Monitoring specifications Yield and performance ratio, MTBF, Operational issues and maintenance, Standards for construction and operation, Regulations governing system design and operation, Health and safety issues	
Unit – 7	**Space systems**
Array configurations, Quality control and assessment, Design of systems	
Unit – 8	**Economics, Policy and Environment**
Economic Analysis: Economic theory, Production economics, Subsidies and tariff issues, financing mechanisms. Policy Issues: Market development, Government policies, Climate change issues, Environmental Impact Assessment, Module production, Energy analysis, Life cycle analysis, CO_2 emissions.	
Text Books	
1. Solar Cell Device Physics, by S. J. Fonash (2nd edition, Academic, 2010) 2. Basic Research Needs for Solar Energy Utilization (Report of the Basic Energy Sciences Workshop on Solar Energy Utilization, April 18-21, 2005 3. Crystalline Silicon Solar Cells, by A. Goetzberger, J. Knobloch, and B. Voss (Wiley, 1998) 4. Third Generation Photovoltaics: Advanced Solar Energy Conversion, by M. A. Green (Springer, 2006) 5. Solar Electricity, by T. Markvart (2nd edition, Wiley, 2000) 6. Alternative Energy Resources: The Quest for Sustainable Energy, by P. Kruger (Wiley, 2006) 7. Renewable Energy: Technology, Economics, and Environment, by M. Kaltschmitt, W. Streicher, and A. Wiese (Springer, 2007)	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN084050	Energy Policy and Economics	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The course will enable the students to

1. understand basic concepts need of correlating economics, policy and energy
2. understand the basics of engineering economics
3. undertake financial evaluation of energy technologies based on renewables

4. understand demand and supply analysis
5. understand energy project financing including through CDM
6. understand energy policy and regulations
7. Learn to undertake simulation studies on energy planning

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Correlate economics, policy, and energy
2. Illustrate Basics of engineering economics
3. Carry out financial evaluation of energy technologies.
4. Suggest ways to handle energy – economy interaction and financing.
5. Carry out energy demand and supply economics.
6. Interpret energy policies and regulations.

Unit – 1	**Correlating economics, policy and energy**:

Basics of engineering economics, Need of financial evaluation of energy technologies; Relevance of financial and economic feasibility evaluation of energy technologies and systems

Unit – 2	**Basics of engineering economics:**

Rate of interest, financial evaluation parameters: Payback period, NPV, Cost-Benefit analysis, internal rate of return

Unit – 3	**Financial evaluation of energy technologies**

Solar thermal systems; bioenergy systems; Case studies on techno-economics of energy conservation and renewable energy technologies.

Unit – 4	**Energy – economy interaction and financing**

Energy investment planning and project formulation. Energy pricing. Policy and planning implications of energy-ecology interaction, Clean development mechanism. Financing of energy systems

Unit – 5	**Energy demand and supply economics**

Energy demand analysis and forecasting, Energy supply assessment and evaluation, Energy demand – supply balancing, Energy models.

Unit – 6	**Energy policy**

Energy policy related acts and regulations; Electricity Act 2003; Simulation Software for energy planning(MARKAL, LEAP)

Text Books

1. Kandpal T. C. and Garg H. P. (2003): *Financial Evaluation of Renewable Energy Technology*,
2. Macmilan
3. Bhattacharyya S. C. (2011): *Energy Economics*, Springer
4. Ferdinand E. B. (2000): *Energy Economics: A Modern Introduction*, First Edition, Kluwer
5. Stoft S. (2000); *Power Systems Economics*, Willey-Inter Science
6. Munasinghe M. and Meier P. (1993): *Energy Policy Analysis and Modeling*, Cambridge
7. University Press
8. Samuelson P. A. and William D. N. (1992): *Economics*, 14th edition, McGraw Hill
9. Thuesen G. J. and Fabrycky W. J. (2001): *Engineering Economy*, Ninth Edition, Prentice Hall

Reference Books:

1. Hamies; Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington, 1980.
2. Bureau of Energy Efficiency; Study material for Energy Managers and Auditors Examination: Paper I to IV. 2003.

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN014070	DIGITAL SIGNAL PROCESSING LAB	Laboratory	L	0	T	0	P	2	1
Pre-requisite	:Knowledgeof the subject Digital Signal Process.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								
Course Objectives : Tohavepracticalexposureof different types of signals and signal processing techniques.									
Course Outcomes (COs): After completion of this course, the students shall be able to: The students will learn different signal processing techniques.									
Unit – 1									
1. Simulation of Signals Simulate the following signals using Python/ MATLAB. a. Unit impulse signal b. Unit pulse signal c. Unit ramp signal d. Bipolar pulse e. Triangular signal. 2. Linear convolution a. Write a C function for the linear convolution of two arrays. b. The arrays may be kept in different files and downloaded to the DSP hardware. c. Store the result as a file and observe the output. 3. IFFT with FFT a. Use the FFT function in the previous experiment to compute the IFFT of the input signal. b. Apply IFFT on the stored FFT values from the previous experiments and observe the reconstruction. 3. Overlap Add Block Convolution a. Use the file of filter coefficients from the previous experiment. b. Realize the system shown in the previous experiment for the input speech signal x[n]. c. Segment the signal values into blocks of length N = 2000. Pad the last block with zeros, if necessary. d. Implement the overlap add block convolution method. 4. Design of FIR low pass filter.									
Text Books									
Reference Books:									

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN024110	Energy Management	Theory	L	3	T	1	P		4
Pre-requisite	:NILL								

Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
The objective of the Energy Management course is to acquaint the students with the broad concepts of energy management and audit, the student faces during course of their study in the industrial applications. The student with the knowledge of energy management and audit, will understand and explain scientifically the various energy management related issues in the industry or engineering field. The student will also able to understand the basic principles of energy conservation for industry, nation and globe. The introduction of topics related to various industrial applications will make the engineering student upgraded with the new technologies.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To perceive the role of energy mangers in the industries and to investigate the methodology of detailed energy auditing.
2. To rationalize the thermal and electrical energy management using latest technologies.
3. To list the major energy conservation techniques such as; Co-generation and Waste heat recovery, that are used widely in the industries.
4. To enlighten the concept, potential and economics of total energy systems.

Unit – 1	**Introduction**

Energy Scenario - Principles and Imperatives of Energy Conservation. Energy Consumption Pattern, Resource Availability, Role of Energy Managers in Industries. Energy Audit-Purpose, Methodology with respect to process. Industries - Power plants, Boilers etc, Characteristic method Employed in Certain Energy Intensive Industries

Unit – 2	**Thermal energy Management**

Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management.

Unit – 3	**Electrical Energy Management**

Potential Areas for Electrical Energy Conservation in Various Industries-Energy Management opportunities in Electrical Heating, Lighting system, Cable selection, Energy Efficient Motors - Factors involved in Determination of Motor Efficiency Adjustable AC Drives, Applications & its use variable speed Drives/Belt Drives Importance of Energy Management, Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing.

Unit – 4	**Co-generation**

Advantages of Cogeneration Technology. Cogeneration Application in various industries like Cement, Sugar Mill, Paper Mill etc. Sizing of waste heat boilers, Performance calculations, Part load characteristics selection of Co-generation Technologies. Financial considerations. Operating and Investments - Costs of Cogeneration.

Unit – 5	**Waste heat recovery**

Recuperates, Regenerators, economizers, Plate Heat Exchangers, Waste Heat Boilers. Classification, Location, Service Conditions, Design Considerations, Unfired combined Cycle - supplementary fired combined cycle, fired combined cycle applications in Industries. Fluidized bed heat exchangers, heat pipe exchangers, heat pumps, thermic fluid heaters selection of waste heat recovery technologies, financial considerations, operations and investment costs of waste heat recovery.

Unit – 6	**TotalEnergy system**

Concept of Total Energy, Advantages & Limitations, Total Energy system & Application - Various Possible Schemes Employing Steam Turbines Movers Used in Total Energy Systems -Potential & Economics of Total Energy Systems

Text Books
1. C. H.Butler, Cogeneration, McGraw Hill Book Co., 1984. 2. J. H. Horlock, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987. 3. S. Sengupta, S.S. EDS, Lee, Waste Heat Utilization and Management, Hemisphere, Washington, 1983. 4. C.B. Smith, Energy Management Principles, Pergamon Press, NewYork, 1981 5. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington, 1980 6. P.R. Trivedi, K. R. Jolka, Energy Management, Commonwealth Publication, NewDelhi, 1997 7. L. C Witte, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington,1988. 8. R.M.E. Diamant, Total Energy, Pergamon, Oxford, 1970.
Reference Books:

SEMESTER VIII

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074080	FUZZYLOGICANDEVOLUTIONARY ALGORITHM	Theory	L	3	T	0	P	0	3

Pre-requisite	:Knowledgeof MATLAB.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. The course addresses about Fuzzy logic concepts. Algebraic and logic operations on fuzzy sets.Semiconductordevices.
2. Design of fuzzy membership functions and rule-based system.Defuzzification techniques. Comparisonand evaluation of defuzzification methods. It is of interest to understand how the fuzzy sets could beusedfor variousapplications.
3. Understandingoftheneedforstabilityanalysisoffuzzybasedcontrol system.
4. An understanding of Genetic algorithms its working principle and application. Difference andsimilaritiesbetween GAandother traditionalmethods.
5. Learningvariousapplication-basedoptimizationtechniques.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Comprehendthefuzzylogiccontrolandadaptivefuzzylogic.
2. IdentifyanddescribeFuzzyLogicandArtificialNeuralNetworktechniquesinbuilding intelligentmachines.
3. ApplyArtificialNeuralNetwork&FuzzyLogicmodelstohandleuncertaintyandsolve engineeringproblems.
4. RecognizethefeasibilityofapplyingaNeuro-Fuzzymodelforaparticularproblem
5. Integrateneuralnetwork andfuzzy logicto extend the capabilitiesforefficientandeffective problemsolvingmethodologies

Unit – 1	**Fuzzysets fuzzyrelation and membership functions**

Definitions ofclassical&Fuzzy set,Representationoffuzzysets,fuzzymeasure, cardinalityofafuzzyset,α-cuts,normalised fuzzyset,heightofafuzzyset,Basicsettheory operationsonfuzzyset,Algebraicoperationson fuzzyset,Logicaloperationsonfuzzyset.Fuzzy relations,operationsonfuzzyrelations,Fuzzy Cartesianproductandcomposition,equivalence relation,binaryrelationonfuzzysets,properties.Featuresofmembershipfunction, Fuzzification,Membership

function shapes, assignmentofmembershipfunctiontofuzzy variables,evaluationof membershipfunction	
Unit – 2	**FuzzyLogic andFuzzyrulebased system**
Tautologies, Contradiction, equivalence, logical proofs, fuzzy logic, approximatereasoning.introduction,Naturallanguage,Designoffuzzymembershipfunction,designof predicates,rule-basedsystem,formationof controlrules	
Unit – 3	**Fuzzy tocrispconversion,Fuzzymodeland controlsystems**
Defuzzificationtechniques,Lambdacuts,defuzzificationmethods-application,comparisonandevaluationofdefuzzificationmethodsFuzzy models, structured fuzzymodels, stability analysis of fuzzy model basedcontrolsystem,casestudies(classificationofequivalencerelations,fuzzyclassification,fuzzypatternrecognition,multifeaturedpatternrecognition)	
Unit – 4	**Fundamentals ofGenetic algorithmand Genetic modeling**
Basicconcepts,CreationofOff springs,WorkingPrinciple.Encoding, Fitness Function, Reproduction. InheritanceOperators,CrossOver, InversionandDeletion,MutationOperator,Bit- wiseOperator,bit-wiseoperatorusedinGA, generationalcycle,convergenceofGenetic Algorithm.Application, Multi-Level Optimization, Differences and Similarities betweenGAandOthertraditional Method.	
Unit – 5	**Fuzzylogic controlled genetic algorithms, advanced optimization techniques, Application offuzzylogic andgenetic algorithms.**
Softcomputingtools,Problem description of optimum design, Fuzzy constrains,Illustrations,GAinFuzzyLogic ControllerDesign,Fuzzylogiccontroller,FLC- GAbasedstructuralOptimization.Identification of dynamic system model with G.A, familiarizationofF.L.&G.AToolboxofMATLAB.BasicconceptofAntcolony optimization,particleswarmoptimization,Tabu searchoptimizationmethod,differencebetween PSO&GA.AtleastTWOapplicationsofFuzzy logicandGeneticAlgorithmsindetailaretobe taught.	
Text Books	
1. Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Application by S. Rajasekaran , G.A.VijayalakshmiPai.PHI2003. 2. FuzzyLogic with Engineeringapplications byTimothyJ. Ross.Wiley,2005 3. Neural NetworkDesign:MartinT Hagon,HowardBDemuthMarkBeale,Thomsonlearning2005.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074040	COMPUTER AIDED POWER SYSTEM ANALYSIS	Theory	L	3	T	0	P	0	3
Pre-requisite	: None.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :

1. This course introduces the computational aspects of the power system analysis. The thrust of this course is description of the computer algorithms for analysis of any general power transmission system.
2. Starting with load flow analysis, which is essentially the backbone of any power system analysis tool, this course further deals with computer algorithms for contingence analysis, state estimation and phase domain fault analysis method of any general power transmission system.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Remember proper mathematical models for analysis.
2. Conclude methodologies of load flow studies for the power network.
3. Apply contingency Analysis.
4. Analyze power system studies.
5. Short circuit analysis using Z bus.

Unit – 1	

Review of modeling of power system components and formulation of YBUS matrix. Basic power flow equations and Gauss-Seidel load flow method. Newton-Raphson load flow in polar co-ordinate. Newton-Raphson load flow in rectangular co-ordinate and introduction to Fast Decoupled load flow method. Fast Decoupled load flow method and AC-DC load flow method. Sparsity and optimal ordering methods. LU decomposition and contingence analysis. Line outage sensitivity factor and method of least square. Method of least square (contd..) and Introduction to AC state estimation. AC state estimation (contd..) and test for bad data detection. Formulation of YBUS matrix of three phase unbalanced system. Fault analysis in phase domain.

Text Books

1. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw-Hill Education, 2003.2.
2. J. J. Grainger and W. D. Stevension, Jr., "Power System Analysis", McGraw-Hill International Edition, 1994.3. T.K.
3. Nagsarkar and M.S. Sukhija, "Power System Analysis", Oxford University Press, 2016.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074060	DIGITAL IMAGE PROCESSING	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To define the scope of the field that we call image processing.
2. To give a historical perspective of the origins of this field.
3. To give an idea of the state of the art in image processing by examining some of the principal areas in which it is applied.
4. To discuss briefly the principal approaches used in digital image processing.
5. To give an overview of the components contained in a typical, general-purpose image processing system.
6. To provide direction to the books and other literature where image processing work normally is

reported.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. The objective of this course is to introduce basic concepts and methodologies for digital image processing.
2. Cover the basic theory and algorithms that are widely used in digital image processing.
3. Expose students to current technologies and issues that are specific to image processing systems.
4. Develop hands-on experience using computers to process images.
5. Familiarize with MATLAB Image Processing Toolbox.

Unit – 1	**Introduction and Elements of digital image processing:**

DIP Fundamentals, Steps of DI Processing System.
Image acquisition, storage, processing, communication, display.
Convolution and correlation, sampling, FFT algorithm, the inverse FFT.

Unit – 2	**Some basic mathematical concepts and image enhancement**

Neighbors of a pixels, connectivity, labeling of connected components.
Some simple intensity transformation, histogram processing, image subtraction, image averaging.
Background, smoothing filters, sharpening filters

Unit – 3	**Image compression models:**

Low pass filtering, high pass filtering, homomorphic filtering.
The source encoder and decoder,the channel encoder and decoder

Unit – 4	**Error free and Lossy compression**

Variable length coding, bit plane coding, lossless predictive coding.
Lossy predictive coding, transform coding, image compression standards

Unit – 5	**Image segmentation:**

Edge detection, Line detection, Curve detection, Detection of discontinuities, edge linking and boundary detection, extraction, thresholding, region orientated segmentation, recognition and interpretation.

Text Books

1. Rafael C. Gonzalez, Richard E. Woods "Digital Image Processing.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074120	POWERELECTRONICSFORRENEWABLE ENERGY TECHNOLOGIES	Theory	L	3	T	0	P	0	3

Pre-requisite	:Basic knowledge of power systems, computer and communicationsnetworks and renewableenergysystems.
Course Assessment Methods :	40 marks internal examination & 60 marks

	external examination
Syllabus Version :	1

Course Objectives :
After the completion of this course the students will be able to design DC-DC converter forcontrolling the renewable energy. They will be able to design AC-DC-AC or AC-AC converter forcontrollingof windenergy.Theywillalso learnto modelthe convertersusingMATLAB.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Illustratetheworkingofdc-dcconverter forrenewableenergysystems.
2. Designtheclosedloopcontrolsystemwhichmainlyfocuseson convertercontrol.
3. Conductperformanceandstabilityanalysiswithsimulationofdc-dcconventionalconverter withopenandclosedloopcontrol.
4. Developbasicunderstandingofinverterwithdifferentmodulationstrategiesand Converters instandalonepowersystemsandgridconnected.
5. Explorethedynamiccharacteristicsofpowersemiconductorswitcheswithexperimental validations.

Unit – 1	**Introductionto convertersfor renewableenergysystems**

DC-DC converters: Buck, boost, buck-boost,Ćuk converters: operation and waveforms inCCM and DCM. Forward, fly-back and push-pull converter circuits, half bridge, full bridgeconverters.Resonant DC-DCconverters:
operatingprinciple,waveforms

Unit – 2	**Convertercontrol**

PWM,closedloopcontrol,feedforwardandcurrentmodecontrol.Drivercircuits:unipolar,bipolarandisolated drives.

Unit – 3	**Simulation of DC-DC converterswith closeloopcontrol**

Simulation of DC-DC converters with closeloop control. Inverters: Overview, three phaseconverters, rectifier and inverter modes ofoperation for RL load. Inverter Control: PWMinverter modulation strategies, unipolar andbipolar switching scheme, sine wave PWM,space vector modulation, multi-level inverter - basictopologyandwaveform,improvement in harmonics.

Unit – 4	**Inverter with different modulation strategies**

Convertersinstandalonepowersystems,Grid connectedinverters.Simulationofinverterwithdifferentmodulation strategies.

Unit – 5	**Dynamic characteristics ofpower semiconductor switches**

Dynamic characteristics of power semiconductorswitches:MOSFET,IGBT– switchingtrajectoryand losses.Snubbers:turn- offandturn-onsnubbers.Magneticdesign: inductorandtransformerdesign.Simulation: Snubberimplementationinconvertercircuits. LaboratoryExperimentsinabove modules.

Text Books

1. NedMohan,ToreM.UndelandandWilliam P.Robbins,"PowerElectronics:Converters,ApplicationsandDesign",Third Edition,John Wiley&Sons, 2007
2. L.Umanand,"PowerElectronics:EssentialsandApplications",WileyIndia,2009.
3. Erickson,Maksimovic,andDragan"FundamentalsofPowerElectronics",Kluweracademicpublishers,2001.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074100	COMPUTATIONALINTELLIGENCEFORPOWER APPLICATIONS	Theory	L	3	T	0	P	0	3

Pre-requisite	: Knowledgeof Powersystem,MATLABandengineeringmathematics.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. ThecourseaddressesaboutFuzzylogicconcepts.Algebraic andlogicoperationsonfuzzysets.
2. Design of fuzzy membership functions and rule-based system. Defuzzification techniques. Comparisonand evaluation of defuzzification methods. It is of interest to understand how the fuzzy sets could beusedfor variousapplications.
3. Understandingoftheneedforstudyandapplicationsbasedonneural network.
4. An understanding of Genetic algorithms its working principle and application. Difference andsimilaritiesbetween GAandother traditionalmethods.
5. Learningvariousapplicationbasedonindividualandhybridtechniques.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. FundamentalsonFuzzyLogicandsettheory
2. Studyoftechniquessuchasfuzzificationanddefuzzificationwithapplications
3. UnderstandingtheconceptandapplicationsonNeuralNetwork
4. UnderstandingtheconceptandapplicationsonGeneticAlgorithm
5. UnderstandingtheapplicationsinPower System

Unit – 1	**Fuzzy sets ,FuzzyrelationMembershipfunctions,Fuzzy Logicand Fuzzyrule basedsystem**

Introduction to ComputationalIntelligence, Intelligence machines,Computational intelligence paradigms, Rule-Based Expert Systems and Fuzzy ExpertSystems,Rule-based expertsystems,Uncertainty management, Fuzzysets and operations of fuzzy sets, Fuzzy rulesandfuzzyinference, Fuzzyexpertsystems,Case study: fuzzy logic controller for washingmachines

Unit – 2	**Neural Network, Supervised and Un- supervised learning.**

ArtificialNeuralNetworks, Fundamentalneurocomputingconcepts: artificialneurons,activationfunctions,neural networkarchitectures,learningrules. Supervisedlearningneuralnetworks:multi-layerfeedforwardneuralnetworks,simple recurrentneural networks,time-delayneural networks Supervisedlearningalgorithms, Unsupervisedlearningneuralnetworks:self-organizingfeaturemaps,Radial basisfunction networks,Deepneuralnetworksandlearning algorithms.Casestudy: anomalydetection

Unit – 3	**Fundamentalsof Geneticalgorithm andGeneticmodeling**

Evolutionary computation,Chromosomes, fitness functions, and selectionmechanisms.crossover andmutation,Genetic programming,Evolutionstrategies,probabilisticreasoning

Unit – 4	**HybridNetwork**

HybridIntelligentSystems, Neuralexpertsystems,Neuro-fuzzysystems,Evolutionaryneuralnetworks,

Unit – 5	**Applications**

Case study and Simulation of artificial intelligence, fuzzy evolutionaryalgorithms in power system applications

Text Books
1. TimothyJ Ross,"FuzzyLogicwithEngineeringApplications",WileyIndiaPrivateLimited,2010. 2. LaureneFausett,"FundamentalsofneuralNetwork,Architecture,Algorithms,andApplications",P earson Education,2002. 3. JohnYenandRezaLangari,"Fuzzylogic,IntelligencecontrolandInformation",PearsonEducation,2003
Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074140	Heat and Mass Transfer	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.
2.
3.
4.
5.

Unit – 1	**Introduction**

Typical heat transfer situations, Modes of heat transfer, Introduction to laws, some heat transfer parameters. Conservation equations for mass, momentum and energy.

Unit – 2	**Conduction**

Fourier's law and thermal conductivity, Differential equation of heat conduction, boundary conditions and initial conditions, Simple one dimensional steady state situations – plane wall, cylinder, sphere (simple and complex situations), concept of thermal resistance, concept of U, critical radius. variable thermal conductivity. Special one dimensional steady state situations – heat generation, pin fins. Two dimensional steady state situations. Transient conduction Lumped capacitance model One dimensional transient problems – analytical solutions One dimensional Heisler charts Product solutions. Numerical methods in conduction Steady state one dimensional and two dimensional problems One dimensional transient problems – Explicit and implicit.

Unit – 3	**Radiation**

Basic ideas, spectrum, basic definitions, Laws of radiation, black body radiation, Planck's law, Stefan Boltzman law, Wien's Displacement law, Lambert cosine law, Kirchhoff's law and gray surface approximation, Radiation exchange between black surfaces, shape factor, Radiation exchange between gray surfaces – Radiosity-Irradiation method Parallel plates, Enclosures (non-participating gas),Gas radiation.

Unit – 4	**Forced Convection**

Concepts of fluid mechanics, Differential equation of heat convection, Laminar flow heat transfer in circular pipe – constant heat flux and constant wall temperature, thermal entrance region, Turbulent flow heat transfer in circular pipe, pipes of other cross sections, Heat transfer in laminar flow and turbulent flow over a flat

plate, Reynolds analogy, Flow across a cylinder and sphere, flow across banks of tubes, impinging jets. Natural convection: Introduction, governing equations, Vertical plate – Pohlhausen solution, horizontal cylinder, horizontal plate, enclosed spaces. Effect of turbulence on convective heat transfer.	
Unit – 5	**Heat Exchangers**
Types of heat exchangers, LMTD approach – parallel, counter-flow, multi-pass and cross flow heat exchanger, NTU approach – parallel, counter flow, shell and tube, cross flow heat exchanger.	
Unit – 6	**Condensation and Boiling**
Dimensionless parameters, boiling modes, correlations, Forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation.	
Unit – 7	**Mass Transfer**
Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy	
Text Books	
Text Books: 1. S. P. Sukhatme, Heat Transfer, 4th Edition, University Press, 2005. 2. F. P. Incropera and D. P. Dewitt, Fundamentals of Heat and Mass Transfer, 5th Edition, John Wiley and Sons, 2004. 3. P. S. Ghoshdastidar, Heat Transfer, Oxford, 2004.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074160	FUNDAMENTALSOFNANO-ELECTRONICS	Theory	L	3	T	0	P	0	3
Pre-requisite	:Knowledge ofbasicanalogelectronicsdevicesand principles.								
Course Assessment Methods :	40 marks internal examination & 60 marks external examination								
Syllabus Version :	1								

Course Objectives :
To learn fundamentals of nano-electronics and nanotechnology. To learn application andrecent advancement in the field of nano-electronics and nanotechnology. To be aware with all Nano materialsandtheir characteristics.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1. Analyzedifferentnanostructuredmaterials
2. Characterizedifferentnanomaterialsusingcharacterizationtechnique
3. Applynano-electronicstechnologiestosolveengineeringproblems
4. Designnano-electronics systemusingquantumdots andquantumwires
5. Applymicroscopytoolsfornano-electronics

Unit – 1	**Nanostructurematerial**

Introduction to (i) Carbon Nano tubes(CNTs) - Single-walled Carbon Nanotubes(SWCNTs),Multi-walledCarbonNanotubes(MWCNTs),BNNanotubes,(ii)CarbonNanofibres(CNFs), (iii)Nanowires,(iv)Nanocomposites, (v)Nanocones(vi)Nanorods.	
Unit – 2	**Characterization ofnanomaterial**
CharacterizationTechniquesofNanomaterials:1)ScanningProbeMicroscopy:AtomicForceMicroscopy(AFM),ScanningTunnellingMicroscopy (STM) - Characterizationand sample preparation techniques. 2)ElectronMicroscopy-ScanningElectronMicroscopy(SEM),TransmissionElectronMicroscopy(TEM) - Characterization and samplepreparationtechniques.3)Thermo-physicalcharacterization:DifferentialScanningCalorimetry(DSC)andThermoGravimetricAnalysis(TGA).4)ElectricalCharacterization:Electricalconductivityand Dielectricpropertiesofmaterials.,Nanofilledresinforcastinsulator, capacitorsetc	
Unit – 3	Nanoelectronics technology
Introduction,fundamentalconcepts,technologicalevolution.BasicNanoelectronicTechnologies-Single ElectronDevices,QuantumMechanicalTunnelDevices,SpinNanoelectronics (Spintronics), MolecularNanoelectronics,QuantumComputing	
Unit – 4	Nanoelectronicssystem
QuantumDotsandQuantumWires(determinationofresistance,chargeconcentration,chargemobility), FabricationMethodsandTechniquesforNanoelectronics	
Unit – 5	Microscopy
Microscopy Tools for Nanoelectronics, Microelectro mechanical Systems (MEMS) andMicron optoelectromechanical Systems (MOEMS) Applications.	
Text Books	
1. S.Saito,A. Zettl-CarbonNanotubes:QuantumCylindersofGraphene 2. DanielMinoli-NanotechnologyApplicationstoTelecommunicationsandNetworking 3. Badih El-Kareh- Silicon Devices and Process Integration: Deep Submicron and Nano-ScaleTechnologies 4. Researchpapers/conferenceproceedings.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074180	Energy Efficient Building	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1
Course Objectives :	
Course Outcomes (COs): After completion of this course, the students shall be able to: 1. 2. 3. 4. 5.	

Unit – 1	**Introduction**

Climate and shelter ,Historic buildings, Modern architecture , Examples from different climate zones, Thermal comfort ,Solar geometry and shading, Heating and cooling loads, Sustainable sites and landscaping , enhancing ecosystems, building envelop, selection of green materials - products and practices Energy estimates and site planning, Integrative Modelling methods and building simulation.

Unit – 2	**Principles of Energy conscious building design**

Principles of Energy conscious building design, Energy conservation in buildings, Day lighting, Water heating and photovoltaic systems, Advances in thermal insulation, Heat gain/loss through building components, Solar architecture. Energy Efficient Landscape Design, Modification of microclimate through landscape elements for energy conservation

Unit – 3	**Passive Solar Heating**

Illustrative passive buildings, Passive solar heating, Direct gain, Thermal storage wall, Sunspace, Convective air loop, Passive cooling, Ventilation, Radiation, Evaporation and Dehumidification, Mass effect, Design guidelines. Cooling and heating concepts, Passive concepts appropriate for the various climatic zones in, India. Classification of building materials based on energy intensity.

Unit – 4	**Energy Conservation in Building**

Site protection planning - health and safety planning – construction and demolition waste management - reducing the footprint of construction operations – maximizing the value of building commissioning in HVAC System, Computer packages for thermal design of buildings and performance prediction, Monitoring and instrumentation of passive buildings, Control systems for energy efficient buildings, Integration of emerging technologies – Intelligent building design principles.lighting and non mechanical Systems – costs and benefits relevance to LEED / IGBC standards

Unit – 5	**Economics of Energy Efficient Buildings**

B **Energy Storage**usiness case for high-performance **energy efficient** buildings, the economics of **energy efficient** buildings, benefits, managing initial costs – cost barrier in project management – long- term environment benefits. Energy Management of Buildings and Energy Audit of Buildings. Energy management matrix monitoring and targeting, Energy survey and Energy Audit of buildings. Calculation of energy inputs in buildings. Energy Audit reports of buildings. Energy rating of buildings.

Text Books

1. J.A. Clarke, Energy Simulation in Building Design (2e) Butterworth 2001.
2. J.K. Nayak and J.A. Prajapati Hadbook on Energy Consious Buildings, Solar Energy Control MNES, 2006.
3. Energy Conservation Building Codes 2006; Bereau of Energy Efficiency.
4. J.R. Williams, Passive Solar Heating, Ann Arbar Science, 1983.
5. Green building guidelines: Meeting the demand for low-energy, resource-efficient homes. Washington, D.C.: Sustainable Buildings Industry Council, 2004.

Reference Books:

1. Jerry Yudelson, Green building A to Z, Understanding the buildings, 2008.5.
2. R.W. Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. McFarland and W.O.
3. Wray, Passive Solar Design Hanbook, Vol.3, Report of U.S. Department of Energy (DOE/CS-0127/3), 1982.
4. M.S. Sodha, N.K., Bansal, P.K. Bansal, A.Kumar and M.A.S. Malik. Solar Passive Building, Science and Design, Pergamon Press, 1986. J.L. Threlkeld, Thermal Environmental Engineering, Prentice Hall, 1970

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN074200	Waste to Energy	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

Course Outcomes (COs): After completion of this course, the students shall be able to:
1.
2.
3.
4.
5.

Unit – 1	**Solid waste**

Definitions - Sources, Types, Compositions, Properties of Solid Waste - Municipal Solid Waste - Physical, Chemical and Biological Property - Collection - Transfer Stations – Waste Minimization and Recycling of Municipal Waste.

Unit – 2	**Waste Treatment**

Size Reduction - Aerobic Composting - Incineration - Furnace Type & Design, Medical / Pharmaceutical Waste Incineration - Environmental Impacts - Measures of Mitigate Environmental Effects due to Incineration

Unit – 3	**Hazardous Waste Management**

Definition & Identification of Hazardous Waste - Sources and Nature of Hazardous Waste - Impact on Environment - Hazardous Waste Control - Minimization and Recycling - Assessment of Hazardous Waste Sites - Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure.

Unit – 4	**Hazardous Waste Management**

Definition & Identification of Hazardous Waste - Sources and Nature of Hazardous Waste - Impact on Environment - Hazardous Waste Control - Minimization and Recycling - Assessment of Hazardous Waste Sites - Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure

Unit – 5	**Energy Generation from Waste**

Types - Biochemical Conversion - Sources of Energy Generation - Industrial Waste, Agro Residues - Anaerobic Digestion - Biogas Production - Types of Biogas Plant Thermochemical Conversion - Sources of Energy Generation - Gasification - Types of Gasifiers - Briquetting - Industrial Applications of Gasifiers - Utilization and Advantages of Briquetting - Environment Benefits of Biochemical and Thermochemical Conversion

Text Books

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier, Applied Science, London, 1985
2. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Printice Hall, 2000
3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987
5. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC New Delhi, 1983.

Reference Books:

SEMESTER IX

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN075030	MACHINE LEARNING	Theory	L	3	T	0	P	0	3

Pre-requisite	Knowledge of any programming language
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To introduce the student with the broad outlines of machine learning.
2. To familiarize students with various techniques of machine learning used to classify, categorize and interpret data.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Explain the application of machine learning, the general step wise process to machinelearning and different methods of learning
2. Categorize the data based on gain using decision tree.
3. Explain the use of instance based learning, linear regression, logistic regression and support
4. Analyse artificial neural network model and its advance version as deep learning
5. Distinguish between different types of clustering techniques

Unit – 1	**Introduction, Typesof learning**

Overview: Foundations, Scope, Problems, Approaches of AI, Applications, Types of learning and types of error, k-fold validation

Unit – 2	**Intelligent Agents, Decision tree**

Hypothesis, bias, features, Decision tree, Calculation of gain, entropy, Classification of data based on decision tree, Prunning-pre-prunning, post prunning

Unit – 3	**Linearand logistic learning, support vector machines**

Regression model, regression line, single and multiple variable, error, LMS algorithm.Logistic regression & Support vector machinesSigmoidal function used. Types of function, support vectors, functional margin, geometrical margin,optimization function

Unit – 4	**Neural network and Deep learning**

Analogy between biological and artificial neural network, structure, Mc culloch and pitts model, Perceptron model, Use of neural network to solve different logic gates Backpropagation algorithm, implementation, deep learning structure.

Unit – 5	**Knearest neighbour and Clustering technique**

KNN, voronoi diagram, lazy algorithm, learning algorithm. Different Clustering techniques

Text Books

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN075050	REAL TIME EMBEDDED SYSTEMS	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :
This course explores the processes of real time embedded systems to provide the basic foundation in embedded system.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To understand the concept of embedded system, microcontroller, different components of microcontroller and their interactions.
2. Get familiarized with programming environment to develop embedded solutions. **CO3** Understand the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices.
3. Evaluate the implications of design choices on real time system implementation
4. Apply real-time methodology to multiprocessor and distributed systems

Unit – 1	**Introduction of Embedded Stystems**

General features of Embedded System, basic components, processors technologies, I.C. technologies, software tools.

Unit – 2	**Concept of Memory and communication protocol**

SRAM, DRAM, memory hierarchy and cache, cache mapping, writing, advanced RAM. Power & display devices, Basic networking, communication & protocol concept, parallel & serial communication buses, inter communication and networking.

Unit – 3	**Operating system**

Device Drivers, Multiple processes, Task, Threads, Introduction to Operating System, Time-sharing systems, Real time Systems.

Unit – 4	**Real-Time Operating Systems**

System structure, Kernel, management & scheduling.

Unit – 5	**Embedded system designing**

Typical embedded system designing, software programming and system testing, Selected application case studies from areas such as PowerElectronics System.

Text Books

1. Raj kamal- Embedded Systems – Tata McGraw-Hill,2004
2. F. Vahid, T. Givargis- Embedded System Design-John Wiley &Sons,Inc. 2002
3. Goldsmith Sylvia, —A Practical Guide to Real-Time Systems Development‖, Prentice Hall.

Reference Books:

1. David Simon, —An Embedded Software Primer,‖ Addison Wesley, 1999
2. Philip A.Laplante, —Real Time System Design and Analysis‖, IEEE CS Press

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN075070	ELECTRICAL MACHINE DESIGN	Theory	L	3	T	0	P	0	3

Pre-requisite	: Fundamental of Machines
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To learn the principal laws of machine design.
2. To learn the concept of DC machine design.
3. To learn the concept of AC machine design.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Knowledge on laws of machine design
2. Knowledge on magnetic circuit design
3. Design concept of rotating machine
4. Knowledge of design process
5. Design concept of insulation

Unit – 1	**Laws in Machine Design**

Principal Laws and Methods in Electrical Machine Design - Electromagnetic Principles, Windings of Electrical Machines- Basic Principles, Salient- Pole Windings, Slot Windings.

Unit – 2	**Design of Magnetic circuit.**

Design of Magnetic Circuits- Air Gap, Core Length, Magnetic Materials of a Rotating Machine. Design of Transformers, DC machines

Unit – 3	**Introduction to design of rotating machines**

Main Dimensions of a Rotating Machine- Mechanical, Electrical and Magnetic Loadability, Air Gap

Unit – 4	**Design of rotating machines**

Design Process and Properties of Rotating Electrical Machines- Asynchronous Motor,Synchronous

Unit – 5	**Insulation design**

Machine. Insulation of Electrical Machines - Dimensioning of an Insulation.Thermal Design aspects.

Text Books

1. Design of Rotating Electrical Machines, Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, John Wiley & Sons, Ltd.
2. A Course in Electrical Machine Design, A.K.Sawhney, Dhanpat Rai.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN075090	ADVANCED MICROPROCESSOR AND EMBEDDED SYSTEMS	Theory	L	3	T	0	P	0	3

Pre-requisite	: Basics of computer knowledge.
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To teach the basic of 8086 microprocessor architecture.
2. To provide knowledge of family of higher x86 family of processors.
3. To describe the basics of advanced microprocessor ARM and embedded systems.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Understand the basic architecture and family of processors
2. Understand the ARM processors and its utilization in embedded systems

Unit – 1	

Internal architecture of 8086 CPU, Registers & Memory organization, 8086 basic system concepts, signals, instruction queue, MIN mode and MAX mode, Instruction sets, Addressing modes, assembly directives, assembly language program developmenttools & simple assembly programming, DOS function calls.

Unit – 2	

8086 Interrupt: types of interrupts, Interrupt vector table. Macro, Basics of interfacing, Overview of DRAM and SRAM. Introduction to higher bit processors, 80286, 80386,80486, Pentium Raspberry Pi UNIT-II Basic

Unit – 3	

Embedded system, overview of main components and software tools in designing of an embedded system

Unit – 4	

Introduction, Instructions and preliminaries of ARM processor, ARM Interrupt processing, Digital Signal Processors. Memory Organization, Virtual Memory and Memory Management Unit, Power Aware architecture. Introduction of different type of CPU buses

Unit – 5	

Fundamentals of Embedded Operating Systems, Scheduling Policies, Resource Management, Networked Embedded System. VHDL: Introduction, Programming with different type of dataflow modeling

Text Books

1. Advanced Microprocessor and peripherals, architecture, programming and interfacing, Ajoy Kumar Ray & Kishor M. Bhurchandi, Tata McGraw Hill Publishing Company limited.
2. Douglas V. Hall, "Microprocessors and Interfacing - Programming and Hardware", Tata McGraw-Hill Publishing Company Ltd., New Delhi, India
3. Raj kamal- Embedded Systems – Tata McGraw-Hill, 2004

Reference Books:

1. F. Vahid, T. Givargis- Embedded System Design-John Wiley &Sons,Inc. 2002
2. VHDL Programming by example, Douglas L. Perry- McGraw-Hill

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN075110	PROCESS CONTROL & INSTRUMENTATION	Theory	L	3	T	0	P	0	3

Pre-requisite	:NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To provide an understanding of process.
2. To learn about the basic elements or building blocks of feed forward and feedback control system.
3. To be able to analyze, design and evaluate PID controller.
4. To provide knowledge about different final control elements

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Learn the basic principles & importance of process control in industrial process plants
2. Apply the use of block diagrams & the mathematical basis for the design of control systems
3. Learn the basics design and tune process (PID) controllers
4. Construct the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants
5. Learn the basic of final control elements

Unit – 1	**The basic process control loop**

Different blocks in it, how is it different from _servo' Loop.
Process modelling, process equations – their limitations - general approach.
Effect of disturbances and variation in set point in process control.
Offset - why does it appear, analysis, how is it eliminated.
Process Reaction Curves, Controllability – using: deviation reduction factors, Gain Bandwidth product, State controllability, Self-regulation.

Unit – 2	**Schemes and analysis**

On-off control, Time proportional control, PI and PID Control – Ziegler – Nichols method, Cohen - Coon method and 3-C.Method of parameter adjustment

Unit – 3	**Electric Drives**

Energy Saving with adjustable Speed Drives, AC and DC Adjustable Speed Drives, Stepper motor Drives, Servo Drives.

Unit – 4	**Final Control Element**:

Types of Actuators and Control valves, Safety and solenoid valves, Pneumatic Actuators.
Electrical Actuators, Valvecharacteristics, Cv values, Valve sizing, Valve selection, cavitation, linearization, positioners

Unit – 5	**P-I and I-P converters**

Elements of a digital control loop. Development of a control algorithm, direct digital control.
Control of a specific plant like: Drum Level Control.

Text Books

1. D. Patranabis, Principles of Process Control, TMH, New Delhi, 2nd Ed.
2. D. P. Eckman, Automatic Process control, John Wiley, New York
3. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia

4. P. Harriott, Process control, Mc Graw Hill, New York.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
EEN075130	DIGITAL SYSTEM DESIGN	Theory	L	3	T	0	P	0	3

Pre-requisite	: NILL
Course Assessment Methods :	40 marks internal examination & 60 marks external examination
Syllabus Version :	1

Course Objectives :

1. To impart the basic knowledge about the analog and digital circuits.
2. To understand the designing procedure of various asynchronous and synchronous digital system.
3. To know about various ADC and DAC.
4. To understand basics of computer aided deigning

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. Ability to identify basic requirements for a design application and propose a cost effective solution.
2. The ability to identify and prevent various hazards and timing problems in a digital design.
3. To develop skill to build, and troubleshoot digital circuits
4. Explain basic concept of VLSI technology
5. Establish the transformations of analog techniques in the digital world

Unit – 1	**Review of Sequential sequential finite state machines**

Concept of memory, general model of Sequential machine and classifications, output decoder, design of counters and registers, code sequence detectors. Sequential code generators.

Unit – 2	**Analysis and Design of Asynchronous sequential Finite state Machines**

Need for Asynchronous circuits, Analysis, Cycles and Races, Hazards, Analysis and Design *of* Asynchronous sequential Finite state Machines.

Unit – 3	**Introduction to system controller design and Linked state machines**

System controller state specification (MDS diagram), timing and frequency considerations, synchronizing systems, state assignments, implementation using ROM, PAL, PLA, Concept of linked state machines.

Unit – 4	**Introduction to VLSI**

Benefits of integration, criteria for evaluatingimplementation styles,introductionto computer-aided- design.

Unit – 5	**Introduction to Modern Digital System Implementation options, Interfacing Units and Methods of A/D conversions**

Mask Programmable gate array, cell based integrated circuits, Sampling, aliasing effect, antialiasing filters, sample and hold circuits, DACs, resistive ladder networks, (Weighted R, R-2R Networks), characteristics of DACs, simultaneous conversion, counter method, continuous A/D dual slope A/D successive approximation technique, characteri.stics of ADCs, Data acquisition systems

Text Books
1. Malvino and Leach- Digital Principles and Applications- MGH. 1986. 2. Thomas L. Floyd – Digital Fundamentals, 10th Edition, Pearson
Reference Books:
1. S. Salivahanan& S. Arivazhagan – Degital Circuits and Design, 4th Edition, Vikas Publishing House (P) Ltd. 2. A. Anand Kumar – Fundamental of Digital Circuits (Ed.4)-PHI, 2016.

Signature of the Head of Department with seal