Course of Study
Choice Based Credit System
T. Y. B. Tech. (Electrical Engineering)
(Effective from Academic Year 2016-17)

Department of Electrical Engineering,
SGGS Institute of Engineering and Technology, Vishnupuri,
Nanded-431606 (MS), India

(An autonomous institute established by Govt. of Maharashtra)

SGGS Institute of Engineering and Technology, Vishnupuri, Nanded

Department of Electrical Engineering

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STRUCTURE

Semester-V					
Course Code	**Name of the Course**	**Lectures**	**Tutorials**	**Practical**	**Credits**
EE301	Power System Analysis and Stability	4	-	2	5
EE303	Feedback Control System	3	1	2	5
EE305	Digital Signal Processing	3		2	4
EE307	Microprocessors Fundamental and Applications	3	-	2	4
EE309	Elective-II	3	-	-	3
EE311	Mini Project and Seminar-I			4	2
	Sub Total	**16**	**1**	**12**	**23**
Semester-VI					
Course Code	**Name of the Course**	**Lectures**	**Tutorials**	**Practical**	**Credits**
EE302	Microcontroller and Applications	3	-	2	4
EE304	Control System Design	4	-	2	5
EE306	Power Electronics	3	1	2	5
EE308	Electromagnetic Fields	3	1	-	4
EE310	Elective-III	3	-	-	3
EE312	Mini Project and Seminar-II	-	-	4	2
	Sub Total	**16**	**2**	**10**	**23**
	Total	**32**	**3**	**22**	**46**

Elective-II

EE309A-Power Plant Engineering

EE309B-Renewable Energy Technologies

EE309C-Electrical Installation and Design

Elective-III:

EE310A: Utilization of Energy and Management

EE310B: Electrical Machine Analysis

EE310C: Communication Engineering

OPEN ELECTIVES:
SEMESTER- V
EEO 301: Renewable Energy Technologies. **(L-3), (Pr-0)**
EEO 302: Power Plant Engineering. **(L-3), (Pr-0)**
EEO 303: Electrical Installation and Design (Skill) **(L-3), (Pr-0)**

SEMESTER -VI
EEO 304: Advances in Solar Energy **(L-3), (Pr-0**)

Attendance Criteria: Students have to maintain 75% attendance in all the registered courses in a semester to be eligible for appearing examinations.

SEMESTER-V

EE301 Power System Analysis and Stability			
Teaching Scheme :		**Examination Scheme:**	
Lectures	4 Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	4	Credits(P)	1

Prerequisites Courses:	
1	Power System Engineering , Electrical Machine-II
Course Objective:	
1	To understand the need of load flow and short circuit analysis
2	To impart knowledge of Load flow Analysis, Short circuit studies and power system stability
3	To develop skills for performing stability studies
4	To illustrate the automatic frequency and voltage control strategies for single and two area case and analyse the effects, knowing the necessity of generation control
Course Outcomes: Students' will be able to:	
1	Summarize the use of different load flow analysis method and assess the power system under symmetrical fault.
2	Understand symmetrical components of network and analyze the power system under unbalanced fault.
3	Evaluate the rotor angle, voltage stability and solve swing equation by various methods.
4	Develop and simulate power system in any available software for load flow analysis
5	Study and analyze stability of power system when subjected to electrical or mechanical disturbance
6	Produce report of load flow analysis and stability analysis of practical power system network in software.
Syllabus :	
Unit 1	**Network Representation and Power Flow Analysis: (06 Hours)** Loop Equations and Node Equations, Bus admittance and bus impedance matrix, network solution using matrix algebra. Load Flow Studies: Load flow problem Bus classification, Nodal admittance matrix, Network model formulation and development of load flow equations. Iterative methods of solution a) Gauss Sidel method b) Newton Raphson method c) Fast decoupled method.
Unit 2	**Symmetrical Fault Analysis and Components: (06 Hours)** Transient in RL series circuits, short circuit of synchronous machines, Short Circuit of a loaded synchronous machine, The bus impedance matrix in fault calculations, selection of circuit breaker, Symmetrical Components of Unsymmetrical phasors and power in terms of symmetrical components sequence impedances and sequence network of unloaded alternators and other power systems components network.

Unit 3	**Unsymmetrical Fault Analysis: (08Hours)** Unsymmetrical faults on unloaded alternator and three phase power system with a) line to ground b) line to line c) double line to ground d) one conductor open fault e) Two conductor open fault, Simplified models of synchronous machines for transient analysis.
Unit 4	**Power System Stability: (08 Hours)** Introduction to Power system stability problem, Rotor dynamics, m/c representation, Swing equation, power angle equation for two m/c system, Steady state stability and transient state stability, equal area criterion for stability and its application. Numerical solution of swing equation, factors affecting transient stability, methods for improving stability of Power system.
Unit 5	**Load Frequency Control: (06 Hours)** Objectives, tie line bias control, flat frequency control, supplementary control, Interconnected areas, two area three area systems, state variable model for single, two & three areas, cross coupling between control loops (AVR AGC) Applications of modern control theory. Application of artificial intelligence, AGC using Kalman methods.
Unit 6	**Automatic Generation Control: (06 Hours)** AGC, turbine generator models for real, reactive powers and frequency control, excitation systems, governor types and control, block schematics for alternator voltage regulator schemes and governors.
Text Books:	
1.	William Stevenson, "Elements of Power System Analysis", Tata McGraw-Hill (2001), 4th Edition.
2.	"Power System Analysis", I.J. Nagrath and D.P. Kothari, Tata McGraw Hill-Education (2007), 2nd Edition.
Reference Books:	
1	Hadi Sadat, "Power System Analysis", , Tata McGraw Hill Edition, Copy 1999.
2	O. I. Elgerd, "Electrical energy systems theory: An introduction" Tata McGraw Hill, edition 1999
3	A. R. Bergen and Vijay Vittal,"Power system analysis", (2nd edition), Pearson Education Asia, 2001
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Determination of sequence n/w of synchronous m/c.
2.	Determination of sequence n/w of Induction motor.
3.	Solution to load flow problem using GS, NR and FD method using software.
4.	Component analysis and component synthesis using various software tools.
5.	Fault analysis of various faults like LG, LLG and LL faults at least 3 sets of software experiments.
6.	Four problems on stability using Equal area criteria.
7.	Four problems on stability using swing curve plot.
Note: The above set of computational work is to be carried preferably using software like MATLAB, Scilab, MiPower, etc.	

Practical Examination:			
The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.			
EE303 Feedback Control System			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	1 Hrs/ Week		
Practical	2 Hrs/Week		
Credits (Th)	4	Credits(P)	1
Prerequisites Courses:			
1	Laplace Transform		
2	Fundamentals Circuit Theory		
Course Objective:			
1	Introduction to concepts of modelling of physical systems.		
2	Introduction to time domain and frequency domain modelling.		
3	Analyse the system response in time domain and frequency domain.		
4	Understand the state space concepts.		
5	Understand the concepts of stability and steady state errors.		
Course Outcomes: Students' will be able to:			
1	Analyse electromechanical systems by mathematical modelling.		
	Analyse the systems in transfer function, state space modelling		
2	Determine transient and steady state behaviour of systems using standard test signals.		
3	Analyse linear and non-linear systems for steady state errors, absolute stability and relative stability.		
4	Identify and design a control system satisfying requirements.		
5	Evaluate the performance of control systems in time domain and frequency domain.		
6	Apply state space analysis concept different system and will able to develope control strategies		
Syllabus :			
Unit 1	**Basic concept, Modelling and representation of control system and Components: (06 Hours)** Open and closed -loop systems. Laplace transform review, transfer function of electrical, mechanical, thermal, Hydraulic system with dead time elements, Electric circuit analog. Block diagram analysis and design of feedback systems, signal flow graph, mason's rule, signal flow graphs of state equation.		
Unit 2	**Time Domain Analysis: (07 Hours)** State space representation, converting transfer function to state space and state space to transfer function, time response, poles, zero and system response, response of first, second and general second order system, system response with additional poles additional zeros, Laplace transform solution of state equations. Time domain solution of state equations.		

Unit 3	**Stability and Steady State Error: (08 Hours)** Concept of stability for linear systems, Absolute and relative stability, Routh and Hurwitz criterion for stability and stability in state space, steady state error for unity feedback systems & disturbances non unity feedback systems, static error constants, and system type, steady state error specifications, sensitivity, steady state error for systems in state space.
Unit 4	**Root Locus Techniques: (06 Hours)** Definition of root locus, Rules for plotting root loci, Root contour, stability analysis using root locus. Effect of addition of poles and zeros. Transient response design via gain adjustment, Root locus for positive feedback system, pole sensitivity.
Unit 5	**Frequency Domain Analysis: (08 Hours)** Frequency domain specification, Correlation between time and Frequency domain specifications, Bode plot, gain and phase margin, Effect of gain variation and addition of poles and zeros on Bode plot, Determination of transfer function from Bode plot, Concept of stability for linear systems, Absolute and relative stability, Routh stability criterion and its application in special cases. Nyquist stability criterion and stability margin, Polar plots.
Unit 6	**State Space Concept: (06 Hours)** Concept of state and state variable, state equations of linear time-invariant and continuous data system. Matrix representation of state equation, Conversion of state variable model to transfer function, Canonical form, companion form, Jordan Canonical form, Solution of state equations. Concept of controllability and observability, Eigen values and stability.
Text Books:	
1.	Norman S. Nise, "Control System Engineering", John Wiley and sons, 2004, 4th Edition.
2.	I.J. Nagrath and M. Gopal "Control System Engineering", Wiley Eastern Ltd. (3rd Edition), 2000.
Reference Books:	
1.	Franklin Powel, "Feedback Control Dynamic System", , Pearson Education, 2002, 5th Edition.
2.	Dorf and Bishop, Adison Wesley Longm "Modern Control System", an, 1998, 8th Edition.
3.	"Modern Control Engineering Eastern Economy", K. Ogata, Prentice Hall of India Pvt Ltd. 2002, 4th Edition.
4.	M. Gopal , "Control System- Principles and Design", (2nd Edition).2002
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Stability Analysis of First, Second and Higher order system using MATLAB
2.	Plotting Bode and Nyquist plot using MATLAB
3.	Plotting of root locus using MATLAB
4.	Calculation of state transition matrix, state X (t), Eigen values using MATLAB
5.	To evaluate the effect of pole and zero location upon the time response of first and second order systems using MATLAB.

6.	To evaluate the effect of additional poles and zeros upon the time response of second order system
7.	To convert the given state space equation into diagonal form using MATLAB and to determine stability of a system using MATLAB
8.	To verify the effect of open loop poles and zeros upon the shape of the root locus, and to design a system by varying gain with the help of root locus in MATLAB.

Note: The computational work is to be carried preferably by using software tools like MATLAB, Scilab.

Practical Examination:

The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.

E305 Digital Signal Processing

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory:	
Tutorials	--	Mid Term:30 Marks	
Practical	2 Hrs/Week	End Sem. Exam :70 Marks	
Credits (Th)	4	Credits(P)	1

Prerequisites Courses:

1	Signals and Systems

Course Objective:

1	To elaborate Sampling theorem, classification of discrete signals and systems
2	To analyze DT signals with Z transform, inverse Z transform and DTFT
3	To describe Frequency response of LTI system
4	To introduce Digital filters and analyze the response
5	To demonstrate DSP Applications in electrical engineering

Course Outcomes: Students' will be able to:

1	Sample and reconstruct any analog signal
2	Find frequency response of LTI system
3	Find Fourier Transform of discrete signals
4	Design of IIR & FIR filter
5	Implementation of IIR and FIR filter
6	Develop DSP Algorithm for various application

Syllabus :

Unit 1	**Discrete time signals and systems in the time domain: (8 Hours)** Introduction to signal and signal processing, classification of signals, signal processing operations, examples and applications, Discrete time signals, typical sequences and sequence representation, the sampling process, Discrete time systems, Time domain characterization of LTI discrete time systems, Finite dimensional LTI Discrete time systems, correlation of signals, Random signals.
Unit 2	**Discrete Time signals in Transform domain: (08 Hours)** Discrete time Fourier transform, Discrete Fourier Transform, Relationship between the DTFT and the DFT and their inverses, Discrete Fourier Transform properties, Computation of the DFT of real sequences, Linear convolution using the DFT, The Z-transform, ROC of the rational Z-transform, Inverse Z-transform-transform properties, Transform domain representation of random signals.

Unit 3	**LTI Discrete time systems in Transform Domain: (6 Hours)** Finite dimensional Discrete time systems, the frequency response, the transfer function, types of transfer functions, Simple digital filters, All pass Transfer function, Minimum phase and maximum phase transfer functions, Complementary transfer functions, Inverse systems, Systems identification, Digital two pairs.
Unit 4	**Digital Filter Structures: (6 Hours)** Block diagram representation, equivalent structures, Basic FIR structures, BasicIIR structures, All pass filters, IIR tapped cascaded lattice structures, FIR cascaded lattice structures
Unit 5	**Digital Filter design: (6 Hours)** IIR filter design – Bilinear transformation, Impulse invariant transformation, Low pass IIR digital filters, Spectral transformations, FIR filter design using windowing techniques, Frequency sampling technique, and Computer aided design.
Unit 6	**DSP Algorithm Implementation: (6 Hours)** Computation of DFT, FFT algorithms, Decimation in time, Decimation in frequency and Different algorithms of FFT such as DIT and DIF where input and output is in order, radix-n algorithms and Applications of DSP.
Text Book:	
1.	E. C. Ifeachor, B. W. Jarvis, Digital Signal Processing- A Practical Approach, Second Edition, Pearson Education, New Delhi, 2002.
2.	S. K. Mitra, Digital signal processing- A computer based approach, Tata McGraw Hill, 2002
3.	A.V. Oppenheim, R, W, Schafer, Discrete time signal processing, Prentice-Hall ofIndia, 2001.
4.	J. G. Proakis, D. G. Manolakis, Digital signal processing –Principles, algorithms and applications, Prentice Hall of India, 2002.
5.	R. G. Lyons, "Understanding Digital Signal Processing", Pearson Education New Delhi, 1999.
Reference Book:	
1.	
2.	
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Digital signal generation
2.	Simple operations on signals
3.	Linear Convolution
4.	Discrete time Fourier transform
5.	Discrete Fourier Transform - Direct computation, DIT algorithm, DIF algorithm
6.	FIR filter design and software realization by windowing and Frequency sampling
7.	IIR Filter Design and software realization of Butterworth and Chebyshev approx.
8.	Any other experiments decided by the Course Coordinator.
Note: The computational work is to be carried preferably by using software tools like MATLAB, Scilab.	

Practical Examination:
The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.

EE307 Microprocessor Fundamentals and Applications			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs./ Week	Theory:	
Tutorials	--	Mid Term:30 Marks	
Practical	2 Hrs./Week	End Sem. Exam :70 Marks	
Credits (Th)	4	Credits(P)	1

Prerequisites Courses:	
1	Analog and Digital Circuits
Course Objective:	
1	Understand the basic architecture of 8085 microprocessor.
2	Write assembly language programs to develop microprocessor based Design.
3	Write interrupt service routines for all interrupt types
4	Interface memory and I/O devices to 8085 using peripheral devices
5	Write microcontroller programs and interface devices
Course Outcomes: Students' will be able to:	
1	Identify microprocessor based systems.
2	Summarize architecture and operation of 8085 processor
3	Explain and summarize architecture and operation of 8086 processor
4	Develop assembly language programs.
5	Interface various I/O devices with microprocessor.
6	Design microprocessor based systems.
Syllabus :	
Unit 1	Introduction to 8085: **(08 Hours)** Architecture and operation, pin out diagram, Assembly language programming for 8085 microprocessor instruction classification, instruction set study in details, addressing modes, writing assembly language programs, stacks subroutines, floating point routines.
Unit 2	Instruction set timing diagrams, a minimum configuration for 8085.Interfacing memories EPROM and RAM with 8085 with exhaustive and partial decoding techniques. **(06 Hours)**
Unit 3	Interrupt structure of 8085, internal interrupt circuit and hardware and software interrupts, serial data transfer. Following structure programmable peripheral devices are to be studied in details as regards block diagram, software for their interfacing with 8085: 8255, 8253,8279, 8251. **(08 Hours)**
Unit 4	Bus interfacing standards- RS 232, IEEE 488. Interfacing application: Interfacing seven segment displays keyboard, A to D and D to A converter. **(06 Hours)**
Unit 5	Microprocessor based data acquisition and control system: Temperature control system, Flow control system etc. Introduction to 8086, 80486, and Pentium processors. **(08 Hours)**

Unit 6	Introduction to 8086 : **(06 Hours)** Architecture and operation, pin out diagram, Assembly language programming for 8086 microprocessor instruction classification, instruction set study in details
Text/ Reference Book:	
1.	R. S. Gaonkar "Microprocessor Architecture, Programming and application with 8085/8085A", Fourth Edition, Willey Eastern Ltd.
Reference Books:	
1.	K. L. Short "Microprocessor and programming logic", Second Edition, Prentice-Hall India Pvt. Ltd.
2.	U. V. Kulkarni and T. R. Sontakke "The 8085A Basics: Programming and Interfacing", Sadusudha Prakashan, Nanded
3.	Intel Mcs, "8085 user's manual" Intel Corporation
4.	B. Ram "Fundamentals of microprocessor and Microcomputer", Dhanpat Rai publishing company Ltd.(2011).
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Interfacing 7-segment displays with 8255.
2.	Interfacing Keyboard matrix with 8255.
3.	Interfacing DAC
4.	Interfacing ADC
5.	Programming for 8253.
6.	Software implementation of ADC
7.	Observing timing diagram on CRO.
8.	Study of interrupts.
9.	Programming for speed and direction control of DC motor.
10.	Programming for speed and direction control of stepper motor.
11.	Assembly language programme based on lookup table concept
12.	Study of hexadecimal, modulo-9, BCD counters
13.	Assembly language programme for real time clock
Note: The computational work is to be carried preferably by using software tools likeMATLAB, Scilab.	
Practical Examination:	
The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.	

ELECTIVES -II

EE309A Power Plant Engineering			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA
Prerequisites Courses:			
1	Power System Engineering,		
2	Electrical machines		
Course Objective:			
1	To develop fundamental understanding about various energy sources		
2	To provide knowledge about working of steam power plant, Hydro power plant , nuclear power plant and diesel power plant		
3	To teach Economics of combined working power plants		
Course Outcomes: **Students will be able to :**			
1	Classify different sources of energy and analyse economics of power plant		
2	Explain the working of various power plant		
3	Reproduce Economics of combined working power plants		
4	Understand mechanical and chemical aspect related to power plant engineering		
5	Analyse different components of power plants		
6	Understand tariffs related to power plants		
Syllabus :			
Unit 1	**Sources of Energy and Economics of Power Plant (06 Hours)** Sources of energy , Fuels ,Types of fuels, Solid fuels, Liquid fuels, Gaseous fuels, Calorific value of fuels, Types of coal, Coal selection, Requirements of fuel ,HydelPotential energy, Nuclear energy – Comparison of Sources of power – Non conventional sources of energy Solar energy, Wind energy, Tidal power and Bio gas. Types of loads. Economic load sharing, Economics in plant selection, Economic of power generation , Choice of power station , Energy rates		
Unit 2	**Steam Power Plant (08 Hours)** Thermal Station: Introduction, selection of sites, Layout of Steam power Plant, Fuel and ash handling, Combustion for burning coal, Mechanical stackers, Pulverizes, Electrostatic Precipitators, Draughts-Different types, Surface condensers - Types of cooling towers, Steam turbines, Steam engines: Advantages of steam turbines over steam engines, Boilers: Types of boilers, Principles of steam power plant design, Factors affecting steam plant design ,Thermal power plants environmental control, simple numerical examples.		
Unit 3	**Hydro Electric Power Plant (06 Hours)** Lay out of Hydroelectric power plant: Elements of Hydroelectric power plan, Classification of Hydroelectric power plant, Advantages of Hydroelectric power plant, Mini and Micro hydro power plants, Types of Dams, Pen stock, Draft tube, Surge tank, Hydraulic turbines, Classifications, Turbine governing, Cavitation's, Safety measures in Hydro power stations, Control room functions, Switch gear,		

	Site selection, Comparison of Hydroelectric power plant and steam power plant.
Unit 4	**Nuclear Power Plant (08 Hours)** Review of atomic physics (atomic number, mass number, isotopes, atomic mass, unit rate of radioactivity, mass equivalent number, binding energy and mass defects), Nuclear power plant layout, Elements of Nuclear power plant, Types of reactors ,Pressurized water reactor, Boiling water reactor, Waste disposal and safety, Advantages of Nuclear power plant, Comparison of Nuclear power plant and steam power plant, Site selection and Commissioning procedures, simple numerical, India's nuclear power program.
Unit 5	**Diesel Engine & Gas Turbine Power Plant (06 Hours)** Types of diesel engine power plants, Layout and components, Diesel engine power plant auxiliaries, Engine starting methods, Advantages of Diesel engine power plant, Application of Diesel engine power plant , Site selection. Gas turbine power plant ,Classification, Elements of simple gas turbine power plant, Layout, Open and Closed cycles, Reheating, Regeneration and Inter cooling – Combined cycles - Applications and advantages of Gas turbine plant, simple numerical examples.
Unit 6	**Combined working of power plants: (06 Hours)** Economics of combined working power plants, base load and peak load stations, pumped storage plants, inter- connections of power stations. Tariff: Fixed cost, running cost and their interrelation for all types of conventional power plants, depreciable cost, different types of tariffs, numerical example based on above, effect of deregulation on pricing.
Text Books:	
1.	P.K. Nag, "Power Plant Engineering", Third Edition, Tata McGraw – Hill, 2007
2.	G.R. Nagpal "Power Plant Engineering", Khanna Publishers.
Reference Books:	
1.	Arora S.C and Domkundwar ,"A Course in Power plant Engineering's, Dhanpat Rai, 2001.
2.	El-Wakil M.M, "Power Plant Technology", Tata McGraw-Hill
3.	Rai G.D, "Introduction to Power Plant Technology", Khanna Publishers.

EE309B Renewable Energy Technologies			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA
Prerequisites Courses:			
1	Engineering Physics , Environmental Science, Engineering Chemistry		
Course Objective:			
1	To develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.		
2	To provide knowledge about development of Wind Power plant and various		

	operational as well as performance parameter/characteristics
3	To explain the contribution of Biomass Energy System in power generation
4	To teach Integration and Economics of Renewable Energy System.
Course Outcomes: Students' will be able to:	
1	Explain theory of sources like solar, wind and also experiments of same
2	Analyze operating conditions like stand alone and grid connected of renewable sources
3	Reproduce different Storage Systems, concept of Integration and Economics of Renewable Energy System
4	Summarizing forthcoming renewable technologies
5	Design the solar tracking system for roof top application
6	Simulate and implement solar charge controller in practical applications
Syllabus :	
Unit 1	**Introduction to Renewable Energy Sources: (06 Hours)** Energy sources: classification of energy sources, introduction to renewable energy, Renewable energy trends, and key factors affecting renewable energy supply, advantages and disadvantages of RES and their uses, national and international policies on RES
Unit 2	**Solar Energy: (08 Hours)** Solar Photovoltaic : Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Maximum Power Point Tracking (MPPT) algorithms. solar thermal conversion: basics, solar concentrator and tracking system, flat plate collectors-liquid and air type, theory of flat plate collectors, selective coatings, advanced collectors: ETC, solar Pond
Unit 3	**Wind Energy: : (08 Hours)** Power available in wind, wind turbine power & torque characteristics, types of rotors, characteristics of wind rotor, local effects, wind shear, turbulence & acceleration effects, measurement of wind, wind speed statistics, energy estimation of wind regimes, capacity factor, aerodynamics of wind turbines, airfoil, lift & drag characteristics, power coefficient & tip speed ratio characteristics, electrical generator machines in wind energy systems.
Unit 4	**Biomass Energy: : (06 Hours)** Overview of biomass as energy source, biomass as a fuel, physicochemical and thermal characteristics of biomass as fuel, biochemical conversion of biomass for energy production, liquid biofuel, energy plantation- overview on energy plantation, basis of selecting the plants for energy plantation, waste land utilization through energy plantation
Unit 5	**Forthcoming renewable technologies: (06 Hours)** Geothermal Energy Generation, ocean-thermal energy generation, tidal energy generation, magneto hydro dynamic power generation- working, layout, different components, advantages, limitations.
Unit 6	**Storage Technologies: (06 Hours)** Introduction, need for storage for RES, basic thermodynamic and electrochemical Principles, classification, traditional energy storage system- battery, fuel cell,

	principle of operation, types, applications for power generation.
Text Books:	
1.	Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
2.	Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19-926178-4).
Reference Books:	
1.	S. P. Sukhatme, J. K. Nayak Solar Energy- Principles of Thermal Collection and Storage (3rd edition), Tata McGraw-Hill Publication.
2.	Paul Gipe Wind Power, Renewable Energy for Home, Farm, and Business.
3.	Mullic and G.N.Tiwari, "Renewable Energy Applications", Pearson Publications.
4.	Website : powermin.nic.in, www.mnre.gov.in

EE309 C Electrical Installation and Design

Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA

Prerequisites Courses:	
1	Electrical Measurement, Electrical machines
2	Power System
Course Objective:	
1	Study of essentials of electrical installation.
2	Study of wiring system and their estimation.
3	To study various aspects of illumination.
4	To study estimation and costing of H.T and L.T conductors for installation.
5	All Indian Electricity Rules.
Course Outcomes: Students' will be able to:	
1	Design the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD
2	Substation arrangement studies
3	Find out specifications of cables, insulators for various voltage ratings.
4	Acquainted with different methods of measuring resistances.
5	Start his/her own consultancy and business opportunities in electrical installation
6	Design and representing the electrical systems with standard symbols and drawings, SLD
Syllabus :	
Unit 1	**Electrical Drawing:** **(06 Hours)** Principles, Symbols, Single Line Diagrams (SLD), Introduction to common Electrical Components, such as contactor, switches, relays, timers, cables, lugs, connectors, MCCB, ELCB, panel meters etc. Different Tools Used: Screwdriver, Pliers of various types, wrench, and blowlamp, Precaution for using tools

Unit 2	**Wiring System**: **(06 Hours)** Selection of types of wiring, Methods of wiring (Cleat, Casing capping, Metal sheathed and Conduit) Calculation and Estimation of power rating of different AC and DC machines. Electrical system design for a typical midsize housing complex, mechanical workshop, auditorium and IT industry, Estimation for a light and fan system, Process of tendering and Construction and Design of MCC and PCC for a typical industry
Unit 3	Complete arrangement of substation (Single and double bus bar), key diagrams for typical substations. Various type's pole structure, Insulators, cables and their types. Review of Insulated Wires: Types: Rubber covered taped and compounded or VIR, Lead alloy sheathed, Tough rubber sheathed, Weather proof, Flexible wire splicing, Termination (Twist splicing, Married joint, Tap joint, Pig tail joint) **(06 Hours)**
Unit 4	**Illumination:** Radiant Energy, Terms and Definitions, Laws of Illumination, Polar Curves, Photometry, Methods of Lighting calculations, Consideration points for planning a lighting installation ,Design consideration of good lighting scheme, Luminous Efficacy, Electrical Lamps, Design of Interior and Exterior Lighting Systems, Illumination Levels for Various Purposes, Light Fittings, Factory Lighting, Flood Lighting, Street Lighting, Energy ,Conservation in Lighting **(06 Hours)**
Unit 5	**Measurement of earth resistance & Testing**: **(08 Hours)** Measurement of Earth Resistance ,Two Point Methods, Three Point method, Fall of potential method, Direct measurement of Earth resistance, Testing of Installations, **Estimating & Conductor size calculations for internal wiring H.T & L.T Overhead Lines and Underground cables:** Estimating, Price catalogue, Schedule of rates & Estimating data, Determination of conductor size, Current carrying capacity, Voltage drop, Minimum permissible size, Conductor size calculation for internal domestic wiring, Underground cable, Overhead lines with A.C.S.R
Unit 6	Estimates for L.T Distributors & Street Light Feeders, Estimates for 11 kV Feeders, All Indian Electricity Rules like 1956,2003,2005 , National Tariff Policies **(06 Hours)**
Text Books:	
1.	K.B. Raina & S.K. Bhattacharaya – Electrical Design Estimating & Costing, New age international publishers (1991), 1st Edition.
2.	S. L. Uppal and G.C. Garg – Electrical Wiring, Estimation & Costing, Khanna Publication (2008).
Reference Books:	
1.	J. B. Gupta, "Utilization of Electric Power and Electric Traction", 2002,S. K. Kataria and Sons.
2.	Pratab H., "Art and Science of Utilization of Electrical Energy", Second Edition, Dhanpat Rai and Sons, New Delhi.
3.	Surjeet Singh, "Electrical Estimating and Costing" Dhanpat Rai and Company (P) Ltd, Reprint 2008.

EE311 Mini project and Seminar-I

Credit (2)

The project work is intended to develop skill of electrical hardware assembly, electronics PCB design and assembly for small gadgets amongst the students. This skill may become useful during their final year project.

The students should undertake an electrical/electronic based hardware project and they have to submit report on the same. The project should include design and development of a small gadget useful in day-to-day life, in consultation with the faculty advisor.

SEMESTER-VI

EE302 Microcontroller and Applications			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs./ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:	
1	Analog and Digital Circuits
2	Microprocessor fundamentals and Applications
Course Objective:	
1	Understand the basic architecture of microcontroller based systems
2	Study the assembly and c language programs
3	Study of various timers, counters and interrupts in Microcontrollers
4	Interface various circuits with 8051 and PIC microcontroller
Course Outcomes: Students' will be able to:	
1	Identify Various Microcontroller based circuits.
2	To write microcontroller programs in assembly and C-languages.
3	Develop various interfacing circuits using timers and interrupts.
4	Design microcontroller based systems
5	Interface various hardware to 8051
6	Simulate and design PIC Application

Syllabus :	
Unit 1	**Architecture of 8051: (06 Hours)** Difference between Microprocessor and Microcontrollers, Harvard and Von-Neumann architectures, Advantage of microcontrollers, Overview of 8051family, 8051 features, internal architecture, Pin out and pin functions, internal data memory, banks, registers, user memory, stack. SFR area, PSW, Code memory space, (Internal/External), External Data memory space Ports and port structure, clock circuit.
Unit 2	**Instruction Set and Programming: (06 Hours)** Instruction set, Data movement instructions, Addressing modes, Jump/Loop/call instructions, Arithmetic instructions, signed/unsigned arithmetic in 8051, Logic Instructions, Bit oriented instructions, I/O Programming using Boolean Instructions, Assembler directives, Assembly programming of 8051 using IDE. Introduction to C programming for 8051, data types, using pointers, Development tools for 8051 programs.
Unit 3	**Interrupts, Timers and Serial Communication for 8051: (08 Hours)** Interrupt structure of 8051, writing ISR, interrupt blocking conditions, interrupt priorities, Programming for external interrupt. Timers in 8051, Timer block diagram and function, Timer modes 0, 1, 2 and their Applications, Programming timer interrupts. Serial communication modes in 8051, RS232 signals of PC, Port expansion using serial communication, Multiprocessor Communication mode.

Unit 4	**Interfacing with 8051: (08 Hours)** Interfacing external memory (RAM/ROM) to 8051, Display interfacing, Thumbwheel interfacing, (Static/Multiplexed), LCD interfacing, Keyboard interfacing, Interfacing of ADC and DAC to 8051, Stepper motor, Relay interfacing, RTC interfacing, Case studies of temperature controller, Mains frequency meter, Batch counter.
Unit 5	**PIC Microcontroller: (06 Hours)** PIC Architecture Block diagram, Programming Techniques, Assembler Directives, C-programming using PIC, register operations, Special features, Configuration registers in PIC
Unit 6	**PIC Application: (06 Hours)** Counters/ Timers in PIC, Interrupt structure , Programming of timers and interrupts ,Capture and Compare Module, PIC Motor Control Application
Text Books:	
1.	Muhammad Mazidi, Janice Mazidi and RolinMcKinlay, 'The 8051 Microcontroller and Embedded systems using Assembly and C', Pearson Education.
2.	Mazidi, RolinMcKinlay and Danny Causey, 'PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education
Reference Books:	
1.	"8051 Architecture, Programming and Applications", Kenneth Ayala, West publishing company.
2.	Embedded System - Raj Kamal, 2nd Ed.,TATA McGraw Hill, 2009.
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Assembly programming to illustrate various instructions. (Minimum 6 programs).
2.	Block transfer, addition, multiplication, division, string operation, finding maximum,
3.	Minimum, nested delay routine etc, programming using internal and external data memory.
4.	Introduction to Keil IDE, Using Keil IDE to assemble a readymade program, Hex file format, down loading into 8051 and running the program. Assembly of basic 8051 using C, (Sample programs minimum 2).
5.	Study of timers and interrupts.
6.	Study of serial communication modes.
7.	Study of multiprocessor modes.
8.	Interfacing with 8051 – (any 6 programs from the following list): a. Multiplexed LED display interfacing. b. LCD Interfacing. c. Keyboard interfacing. d. ADC interfacing. e. Thumbwheel interfacing. f. DAC interfacing. g. Batch counter. h. Design of Temperature Indicator and Controller i. Design of Mains frequency Meter.

Practical Examination:
The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.

EE304 Control System Design			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory:	
Tutorials	1 Hrs./ Week	Mid Term:30 Marks	
Practical	2 Hrs./Week	End Sem. Exam :70 Marks	
Credits (Th)	4	Credits(P)	1

Prerequisites Courses:	
1	Feedback control system
Course Objective:	
1	Provide the knowledge of various nonlinearities observed in real world.
2	Design a control system using lead – lag compensator, P, PI and PID controllers.
3	Design a control system using state space technique.
4	Provide the knowledge of absolute and relative stability.
5	Illustrate the stability and performance of compensated system response.
Course Outcomes: Students' will be able to:	
1	Understand the concepts of compensation and tuning of comptrollers.
2	Understand the various nonlinearities and their behaviour observed in real world.
3	Analyse the nonlinear system with describing function method and phase plane method.
4	Analyse the response and stability of system with different controllers.
5	Understand the concepts of discrete control systems.
6	Evaluate the performance of compensated and uncompensated systems in time and frequency domain.
Syllabus :	
Unit 1	**Non-linear control systems: (08 Hours)** Different types of non-linearity, Peculiarities of non-linear systems, Definition of describing function. (D.F.) derivation on D.F.'s for various non-linearity.D.F. analysis of non-linear control systems, Limit cycles, Merit and limitations of D.F. analysis. Phase plane method, Singular points, Construction of phase-plane plots for non -linear systems by isoclines method.
Unit 2	**PID controllers: (06 Hours)** Introduction to Proportional (P), Integral (I) & Derivative (D)controller, individual effect on overall system performance, P-PI & PID control and effect on overall system performance, Numerical examples.
Unit 3	**Compensator Design using Root Locus: (06 Hours)** Review of root locus concept, cascade lead compensation, cascade lag compensation, cascade lag -lead compensation, minor loop feedback compensation, compensation for plants with dominant complex poles, root locus of system with dead time, sensitivity of root locus.
Unit 4	**System Stability and Performance in Frequency Domain: (08 Hours)** Review of Nyquist criterion, stability margins, stability margins on Bode plots,

	stability analysis with dead time, frequency response measurement, co–relation between time and frequency domain specification, M circles, Nichol's chart, sensitivity in frequency domain Compensator Design using Bode Plot: Introduction, Reshaping Bode plot, cascade lead compensation, cascade lag compensation, cascade lag -lead compensation, Robust control system.
Unit 5	**State space analysis & design: (06 Hours)** Digitalisation of system matrices having distinct & repeated Eigen values, Vander monde &modified Vander monde matrix. Definition of controllability & observability, effect of pole zero cancellation on the controllability & Observability of the system, pole placement design through state feedback.
Unit 6	**Discrete Data Control System: (06 Hours)** Methods of representation, Z-transform, Inverse Z-transforms, Pulse transfer function of closed loop system, Response between sampling instants, Concept of stability of discrete time systems, Stability by Jury's test.
Unit 7	**Hardware Implementation: (06 Hours)** Introduction, passive electric network, operational amplifier usage, tunable PID controllers, Ziegler-Nichols method for controller tuning.
Text Books:	
1.	Norman Nise, "Control system Engineering", 3rd edition, 2000, John Wiley
2.	I.J. Nagrath and M. Gopal, "Control system engineering", Wiley Eastern Ltd, 3rd edition, 2000
3.	M. Gopal,"Digital Control Engineering", Wiley Eastern, 1988.
Reference Books:	
1.	Benjamin C. Kuo, "Automatic Control system", Prentice Hall of India Pvt Ltd.
2.	John J. D'Azzo, C. H. Houpis, Linear control system analysis and design (conventional and modern), McGraw Hill International Fourth edition.
3.	Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India Pvt Ltd.
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Design of lead, lag compensator in Root locus Domain.
2.	Design of lag-lead compensator in Root locus Domain.
3.	Design of P, PI, PD controller.
4.	Design of PID controller.
5.	Design of lead, lag compensator in frequency Domain.
6.	Design of lag-lead compensator in frequency Domain.
7.	Design of controller in state space Domain.
8.	Design of observer in state space Domain
Note: The above set of computational work is to be carried preferably using software like MATLAB, Scilab, MiPower, etc.	
Tutorials: One hour per week is to be utilized to ensure that the students have properly learnt the topics covered in the lectures. This shall include assignments, quiz, test etc. The teacher may add any other academic activity to this so as to evaluate the student for his/her in-semester performance.	
Practical Examination:	
The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.	

EE306 Power Electronics			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs./ Week	Theory:	
Tutorials	1 Hrs./ Week	Mid Term:30 Marks	
Practical	2 Hrs./Week	End Sem. Exam :70 Marks	
Credits (Th)	4	Credits(P)	1

Prerequisites Courses:	
1	Analog and Digital Circuits, Basics of circuit theory
Course Objective:	
1	Study different power electronic devices
2	Understand different types of converters such as rectifier, inverter, chopper
3	Design different types of converters such as rectifier, inverter, and chopper
4	Simulate different types of converters such as rectifier, inverter, and chopper
Course Outcomes: Students' will be able to:	
1	Understanding of different types Power Semiconductor Switches and their characteristics.
2	Analytical study of different types of Power Converter systems.
3	Solve the numerical problems on semiconductor switches, rectifier, converter, inverter, choppers and cycloconverter, circuits.
4	Simulate DC-DC converters
5	Simulate and Design DC-AC Inverters
6	Apply PWM technique
Syllabus :	
Unit 1	**Power Semiconductor Switches: (06 Hours)** Characteristics of ideal switch. Characteristics, Rating, protection and cooling of power semiconductor devices such as power diodes, transistor, MOSFET, IGBT and GTO, Study of the driver circuits for thyristor, GTO and IGBT, Introduction to smart power modules, Comparative study of MOSFET, thyristor, GTO, BJT and IGBT.
Unit 2	**Rectifiers: (06 Hours)** Single phase half wave and single phase full wave diode bridge. Three phase half wave and three phase full wave diode bridge, Transformer power rating for above configurations.
Unit 3	**Phase Controlled AC to DC Converters: (08 Hours)** Classification of converters Single phase half controlled and fully controlled thyristor converters, Three pulse and six pulse controlled converters operation of converter with freewheeling diode. Effect of source inductance on the performance of the converter, overlap – angle. Performance factors for the converter such as displacement factor, distortion factor, total harmonic distortion, ripple factor and transformer utilization factor. Introduction to 12 pulse converter, ingle phase and three phase dual converter, firing scheme for 1 phase and three phase converter, Brief introduction to commutation methods
Unit 4	**DC to DC Converters: (06 Hours)** Control of DC to DC converters, step down (buck) converter, Analysis of buck converter with RLE load step up converter, buck – boost converter, full DC to DC

	converter, concept of multiphase choppers.
Unit 5	**Switch Mode DC – AC Inverters: (08 Hours)** Basic concepts of switch mode inverters single phase inverter, three phase six step inverter, 120 mode of conduction 180 mode of conduction, three phase PWM Inverter, sinusoidal PWM and selective harmonics elimination methods of PWM. Effect of blanking time on output voltage in PWM inverters, Introduction to three level inverters.
Unit 6	**Cycloconverters: (06 Hours)** Single phase to single phase and three phase to single phase cyclo-converter circulating, non-circulating currents mode operation. Three phase to three phase cyclo-converter, Introduction to matrix converters.
Text Books:	
1.	M.H. Rashid "Power Electronics, Circuits, Devices and Applications", Pearson Education Inc., 3rd Edition.
2.	P. S. Bhimra "Power Electronics", , Khanna Publishers (2010).
Reference Books:	
1.	Mohan, Undeland & Robins "Power Electronics, Converter Applications and Design", , John Wiley and sons (Asia) Pvt. Ltd.
2.	"G. K. Dubey and Others Thyristorised Power Controller", Wiley Eastern Ltd.
3.	B.K. Bose, "Modern Power Electronics and A.C. Drives", Prentice Hall of India Pvt. Ltd. Publication.
4.	B.W.Williams, "Power Electronics", John Willey
Term Work: It will consist of a record of the following experiments based on the prescribed syllabus.	
1.	Voltage and current relationship in 3 phase full wave diode bridge rectifier and study of input current harmonic spectrum.
2.	Study of firing circuit of single phase full wave half controlled converter and load side performance evaluation.
3.	Study of firing circuit of single phase full wave full controlled converter, continuous and discontinuous modes of operation.
4.	Firing circuit scheme for 3-phase full wave half controlled converter and load side performance evaluation of the converter.
5.	Study of 6 pulse full controlled converter with R and RL load and evaluate the load side performance.
6.	Study of triac based single phase AC voltage controller.
7.	Study of Class B commutation method for Thyristor (Morgan's circuit).
8.	Study of Class D commutation method for Thyristor (Jone's circuit).
9.	Study of MOSFET based for step up chopper.
10.	Control circuit study of single phase PWM Inverter.
Note: The above set of computational work is to be carried preferably using software like MATLAB, Scilab, MiPower, etc.	
Tutorials: One hour per week is to be utilized to ensure that the students have properly learnt the topics covered in the lectures. This shall include assignments, quiz, test etc. The teacher may add any other academic activity to this so as to evaluate the student for his/her in-semester performance.	
Practical Examination:	

The examination will be of three hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.

EE308 Electromagnetic Fields			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	1 Hrs./Week		
Practical	--		
Credits (Th)	4	Credits(P)	NA
Prerequisites Courses:			
1	Vector Algebra		
Course Objective:			
1	Understanding of basic concepts of Vectors.		
2	Understanding of basic concepts of Electrostatic fields and Electromagnetic fields.		
3	Study of Magnetic Forces Materials and Devices		
4	Study of Magneto Static Fields		
5	Study of Maxwell's Equations		
Course Outcomes: Students' will be able to:			
1	Understand the applications of vector algebra		
2	Learn basic theory of electric and magnetic fields		
3	Evaluate the Electrostatic boundary value conditions and problems		
4	Analyse various aspects of magneto static fields		
5	Understand magnetic forces materials and devices.		
6	Apply Maxwell's equations.		
Syllabus :			
Unit 1	**Vector analysis:** **(06 Hours)** Vector Algebra, Rectangular Coordinate System, Vector Component, Vector Field, Dot Product, Cross Product, Circular and Cylindrical Coordinate System, Vector Calculus, Del Operator, Gradient of Scalar, Divergence of Vector and Divergence Theorem, Curl of a Vector and Stroke's Theorem, Lapalcian of a Scalar, Classification of Vector Fields.		
Unit 2	**Electrostatic Fields and Electric Fields:** **(08 Hours)** Gauss's Law- Maxwell's Equation, Electric Potential, Relationship between E and V-Maxwell's Equation, Electric Dipole and Flux Lines, Energy Density in Electrostatic Fields, Properties of Materials, Convection and Conduction Current, Conductors, Polarization in Dielectrics, Dielectric Constant and Strength, Linear , Isotropic and Homogenous Dielectrics, Continuity Equation and Relaxation Time, Boundary Conditions.		
Unit 3	**Electrostatic Boundary-Value Problems:** **(06 Hours)** Introduction, Poisson's and Laplace's Equations, Uniqueness Theorem, General Procedures for Solving Poisson's and Laplace's Equations, Resistance and Capacitance, Method of Images.		
Unit 4	**Magneto Static Fields:** **(06 Hours)** Biot- Savart's Law, Ampere's Circuital Law-Maxwell's Equation, Application of Ampere's Law, Magnetic Flux Density-Maxwell's Equation, Maxwell's Equation		

	for Static Fields, Magnetic Scalar and Vector Potentials.
Unit 5	**Magnetic Forces Materials and Devices: (08 Hours)** Introduction, Forces due to Magnetic Fields, Magnetic Torque and Moment, Magnetic Dipole, Magnetization in Materials, Classification of Magnetic Materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits, Force on Magnetic Materials
Unit 6	**Maxwell's Equations: (06 Hours)** Introduction, Faraday's Law, Transformer and Motional Electromotive Forces, Displacement Current, Maxwell's Equations in Final Forms,Time-Varying Potentials, Time Harmonic Fields.
Text Books:	
1.	William H. Hayt, Jr John A Buck, "Electromagnetic Engineering", , Tata McGraw Hill, 6th Edition.
2.	Shevgaonkar R. K. , "Electromagnetic Waves", Tata McGraw Hill, 1st Edition.
Reference Books:	
1.	M. Sadiku, "Elements of Electromagnetics", oxford university press (2010), 4th Edition.
2.	Paul, Clayton, "Introduction to Electromagnetic Fields", , Tata McGraw Hill (2007), 3rd Edition.
3.	Ashutosh Pramanik "Electromagnetic Theory and Applications", , PHI Ltd 2nd Edition
Tutorials: One hour per week is to be utilized to ensure that the students have properly learnt the topics covered in the lectures. This shall include assignments, quiz, test etc. The teacher may add any other academic activity to this so as to evaluate the student for his/her in-semester performance.	

ELECTIVES -III

EE310 A Utilization of Energy Management			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA
Prerequisites Courses:			
1	Basic Electrical Engineering		
2	Electrical Machines		
Course Objective:			
1	To give an overview of various areas of application of Electrical Energy.		
2	To introduce the concept of Energy Audit, Energy Management and Energy Conservation.		
3	Study of Speed-time curves and mechanics of train movement.		
4	Study of various methods of Control of traction motors.		
5	Study of various electrical motors and DG start up assessment.		
Course Outcomes: Students' will be able to:			
1	Understand selection of electrical motors according to load		
2	Understand basic principles of electric heating and welding		
3	Evaluate speed time curves for traction		
4	Understanding and planning of Energy Audit		
5	Analysis of DG system start up process		
6	Do Energy Audit of commercial organization		
Syllabus :			
Unit 1	**Industrial application of Electrical Motors: (06 Hours)** Selection of motor for particular application, heating and cooling curves, load equalization, capitalization of losses.		
Unit 2	**Heating and Welding: (06 Hours)** Classification, design of resistance ovens, dielectric heating, arc furnaces, electric welding and its control		
Unit 3	**Speed-time curves and mechanics of train movement: (06 Hours)** Introduction to electric traction, traction systems, track electrification systems, ST curves, mechanics of train movement, coefficient of adhesion, specific energy consumption.		
Unit 4	**Control of traction motors: (08 Hours)** Series-parallel control, drum controller, multiple unit control, regenerative braking, systems of current collection and train lighting, negative booster, traction sub-station.		
Unit 5	**General aspects of Energy Audit and Energy Management (EAM):(06 Hours)** Energy scenario, basics of energy and its various forms EM&A, Energy monitoring and targeting, and electrical systems.		

Unit 6	**Efficiency and performance assessment: (06 Hours)** Electrical motors, lighting system, DG set system, energy efficient technologies in electrical systems, application of non-conventional and renewable energy resources
Text Books:	
1.	J. B. Gupta "Utilization of Electrical Power and Electric Traction", , 8th edition 2006
2.	H. Partab "Art and Science of Utilization of Electrical Energy", , 2nd Edition, 2005.
3.	"Bureau of Energy Efficiency, Energy manager training" – ebook1- Chapter 1,2,3,8; ebook3- Chapter 1,2,8,9,10; ebook4- Chapter 5,10,12
Reference Book:	
1.	Soni, Gupta &Bhatnagar -"A course in Electrical Power"
2.	S. C. Tripathy, "Utilization of Electrical Energy", Tata Mc Graw Hill
Term Work:	
1.	Visit to a local industry for the study of electrical energy utilization. A comprehensive report to be submitted.
2.	Prepare the energy audit report for the industry visited.
3.	Prepare a model of renewable energy source and submit a report on the same.

EE310 B Electrical Machine Analysis

Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA

Prerequisites Courses:	
1	Electromagnetism
2	Electrical Machines
Course Objective:	
1	Introduction to basic concepts of magnetically coupled circuits
2	Study of various principles of electromechanical energy conversion
3	To understand the concept of space vector on d-axis and q-axis variables
4	Study of Clarke and Park's Transformations
5	Study of various models of induction and synchronous machines
Course Outcomes: Students' will be able to:	
1	Understand the limitations of conventional models of electrical machines
2	Determine the torque produced in electrical machines using the concept of co energy
3	Determine the performance of machines using reference frame theory
4	Select strategies to control the torque for a given application
5	Apply Clarke and Park's Transformations for analysis of synchronous machines
6	Evaluate the performance of induction machine

Syllabus:	
Unit 1	**Magnetically coupled circuits:** (**06 Hours)** Review of basic concepts, magnetizing inductance, Modelling linear and nonlinear magnetic circuits.
Unit 2	**Electromechanical energy conversion:** (**08 Hours)** Principles of energy flow, concept of field energy and co-energy, Derivation of torque expression for various machines using the principles of energy flow and the principle of co energy, Inductance matrices of induction and synchronous machines
Unit 3	**Theory of DC machines :** (**08 Hours)** Review of the DC machine, mathematical model of commutator, State-space model of a DC machine, reduced order model & transfer function of the DC machine, Reference Frame Theory-Concept of space vector, components of space vector, direct and quadrature axis variables.
Unit 4	**Transformation: :** (**06 Hours)** Types of transformation, condition for power invariance, zero-sequence component, Expression for power with various types of transformation, Transformations between reference frames, Clarke and Park's Transformations, Variables observed from various frames, Simulation studies
Unit 5	**Theory of symmetrical Induction Machines:** (**06 Hours)** Voltage and torque in machine variables, Derivation of dq0 model for a symmetrical induction machine, Voltage and torque equation in arbitrary reference frame variables, Analysis of steady state operation, State-space model of induction machine in'd-q' variables, Simulation studies
Unit 6	**Theory of synchronous machines:** (**06 Hours)** Equations in arbitrary reference frame, Park's transformation, Derivation of dq0 model for a salient pole synchronous machine with damper windings, Torque expression of a salient pole synchronous machine with damper windings and identification of various components
Text Books:	
1.	E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery, TMH, 5th Ed
2.	A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, Delhi
3.	Say.M.G. "Performance & Design of Alternating Current Machine" (English Language Book Society), CBS Publisher (2002)
Reference Books:	
1.	Rik De Doncker, Duco W. J. Pulle, André Veltman: Advanced Electrical Drives: Analysis, Modeling, Control Springer, 2011.
2.	Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff: "Analysis of Electric Machinery & Drive systems"-IEEE Press, 2002
3.	K.M. Vishnu Murthy, B.S. "Computer Aided Design of Electrical Machines" Publications, 2008
4.	Rama Krishnan: Electric motor drives: Modeling, analysis, and control, Prentice Hall, 2001.

EE310 C Communication Engineering			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA
Prerequisites Courses:			
1	Analog and Digital Circuits		
Course Objective:			
1	Introduction to Communication Engineering		
2	Study of modulation, demodulation and sampling concepts		
3	Study of basics of Analog and Digital communication		
4	Power line carrier communication systems studies.		
Course Outcomes: Students' will be able to:			
1	Understand basics of Communication engineering, Analog and Digital Communication		
2	Analysis of Modulation, Demodulation and sampling techniques		
3	Evaluate Digital Modulation Techniques, Coding and Quantizing		
4	Simulate Power line carrier communication systems studies		
5	Design mathematical models for communication channels		
6	Understand coding for different modulation and demodulation techniques		
Syllabus:			
Unit 1	**Introduction to Communication Engineering: (06 Hours)** Introduction to Communication Engineering, Transmitter and receivers, Communication Channel, Brief Review of Signals and Systems, Introduction to The Hilbert Transform, Analytic Representation of Band pass Signals – Hilbert Transform		
Unit 2	**Introduction to Analog Communication: (06 Hours)** Fundamentals of Analog Signal transmission**,** Analog Modulation of Carriers, Amplitude Modulation, Single Sideband Modulation		
Unit 3	**Modulation, Demodulation And Sampling: (06 Hours)** Angle Modulation, Generation of FM Signals, FM Generation and Detection, Demodulation of Angle Modulated Signals, Feedback Demodulators - Phase Locked Loop, Frequency Compressive Feedback Demodulator, Performance of AM Systems in Noise, Signal-to-noise ratio, Noise in AM and Angle Modulation Systems, Noise in Phase and Frequency Modulation Systems, Noise in Angle Modulation, Pulse Modulation Schemes - PWM and PPM, Delta Modulation, introduction to sampling theorem		
Unit 4	**Introduction to Digital Communication : (06 Hours)** Introduction to Digital Communication, elements of digital communication system, communication channels and their characteristics, mathematical models for communication channels, Sampling, Quantization, PCM and Delta Modulation, Probability and Random Processes, Channels and their Models		

Unit 5	**Digital Modulation Techniques, Coding and Quantizing: (08 Hours)** Digital Modulation Techniques, Digital modulation formats, Amplitude shift keying, frequency shift keying, phase shift keying, DPSK, QPSK, Minimum shift keying Equalizers, coding for analog sources-optimum quantization, rate distortion function, scalar quantization, vector quantization, Coding techniques for analog sources. Temporal waveform coding, spectral waveform coding, model based source coding. Source Coding, Channel Coding, Fundamentals of OFDM, Quantization,
Unit 6	**Multiplexing of Signals and power line carrier communication systems: (06 Hours)** Frequency-Division Multiplexing (FDM), Time-Division Multiplexing (TDM), Statistical Time-division Multiplexing, Orthogonal Frequency Division Multiplexing, power line carrier communication, PLC modulation
Text Books:	
1.	J. G. Proakis, Digital Communication, Fourth Edition, McGraw Hill
2.	Simon Haykin, Digital Communication, John Wiley & Sons Pvt. Ltd.
3.	K.S. Shanmugam, Digital and Analog Communication Systems, Wiley Int. Pub.
Reference Books:	
1.	Taub H. and Schilling D.L., "Prnciples of Communication Systems", Tata McGraw Hill, 2001.
2.	Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3.	Haykin S., "Communications Systems", 4th Ed., John Wiley and Sons, 2001.
4.	B. P. Lathi, Modern Analog and Digital Communication Systems, Prism Sounders

EE312 Mini project and Seminar-II

Credit (2)

The project work is intended to develop skill of electrical hardware assembly, electronics PCB design and assembly for small gadgets amongst the students. This skill may become useful during their final year project.

The students should undertake an electrical/electronic based hardware project and they have to submit report on the same. The project should include design and development of a small gadget useful in day-to-day life, in consultation with the faculty advisor.

OPEN ELECTIVES:

SEMESTER- V

EEO 301 Renewable Energy Technologies			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA

Prerequisites Courses:	
1	Engineering Physics , Environmental Science, Engineering Chemistry
Course Objectives:	
1	To develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.
2	To provide knowledge about development of Wind Power plant and various operational as well as performance parameter/characteristics
3	To explain the contribution of Biomass Energy System in power generation
4	To teach Integration and Economics of Renewable Energy System.
Course Outcomes: Students' will be able to:	
1	Explain theory of sources like solar, wind and also experiments of same
2	Analyze operating conditions like stand alone and grid connected of renewable sources
3	Reproduce different Storage Systems, concept of Integration and Economics of Renewable Energy System
4	Summarizing forthcoming renewable technologies
5	Design the solar tracking system
6	Simulate and implement solar charge controller in practical applications
Syllabus :	
Unit 1	**Introduction to Renewable Energy Sources: (06 Hrs)** Energy sources: classification of energy sources, introduction to renewable energy, Renewable energy trends, and key factors affecting renewable energy supply, advantages and disadvantages of RES and their uses.
Unit 2	**Solar Energy: (08 Hours)** Solar Photovoltaic: Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Maximum Power Point Tracking (MPPT) algorithms. solar thermal conversion: basics, solar concentrator and tracking system, flat plate collectors-liquid and air type, theory of flat plate collectors, selective coatings, advanced collectors: ETC, solar Pond
Unit 3	**Wind Energy: : (08 Hrs)** Power available in wind, wind turbine power & torque characteristics, types of rotors, characteristics of wind rotor, local effects, wind shear, turbulence & acceleration effects, measurement of wind, wind speed statistics, energy estimation of wind regimes, capacity factor, aerodynamics of wind turbines, air foil, lift & drag characteristics, power coefficient & tip speed ratio characteristics, electrical generator machines in wind energy systems.

Unit 4	**Biomass Energy: : (06 Hrs)** Overview of biomass as energy source, biomass as a fuel, physicochemical and thermal characteristics of biomass as fuel, biochemical conversion of biomass for energy production, liquid biofuel, energy plantation- overview on energy plantation, basis of selecting the plants for energy plantation, waste land utilization through energy plantation
Unit 5	**Forthcoming renewable technologies: (06 Hrs)** Geothermal Energy Generation, ocean-thermal energy generation, tidal energy generation, magneto hydro dynamic power generation- working, layout, different components, advantages, limitations
Unit 6	**Storage Technologies: (06 Hrs)** Introduction, need for storage for RES, basic thermodynamic and electrochemical Principles, classification, traditional energy storage system- battery, fuel cell, principle of operation, types, applications for power generation.
Text/ Reference Book:	
1.	Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
2.	Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19-926178-4).
Reference Books:	
1.	S. P. Sukhatme, J. K. Nayak Solar Energy- Principles of Thermal Collection and Storage (3rd edition), Tata McGraw-Hill Publication.
2.	Paul Gipe Wind Power, Renewable Energy for Home, Farm, and Business.
3.	Mullic and G.N.Tiwari, "Renewable Energy Applications", Pearson Publications.
4.	Website : powermin.nic.in, www.mnre.gov.in

EEO 302 Power Plant Engineering			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA
Prerequisites Courses:			
1	Power System Engineering,		
2	Electrical machines		
Course Objectives: Students' will be able to:			
1	To develop fundamental understanding about various energy sources		
2	To provide knowledge about working of steam power plant, Hydro power plant , nuclear power plant and diesel power plant		
3	To teach Economics of combined working power plants		
Course Outcomes:			
1	Reproduce Economics of combined working power plants		
2	Classify different sources of energy and analyse economics of power plant		
3	Explain the working of various power plant		

4	Understand mechanical and chemical aspect related to power plant engineering
5	Analyse different components of power plants
6	Understand tariffs related to power plants
Syllabus :	
Unit 1	**Sources of Energy and Economics of Power Plant (06 Hours)** Sources of energy , Fuels ,Types of fuels, Solid fuels, Liquid fuels, Gaseous fuels, Calorific value of fuels, Types of coal, Coal selection, Requirements of fuel ,Hydel Potential energy, Nuclear energy – Comparison of Sources of power – Non conventional sources of energy Solar energy, Wind energy, Tidal power and Bio gas. Types of loads. Economic load sharing, Economics in plant selection, Economic of power generation , Choice of power station , Energy rates
Unit 2	**Steam Power Plant (08 Hours)** Thermal Station: Introduction, selection of sites, Layout of Steam power Plant, Fuel and ash handling, Combustion for burning coal, Mechanical stackers, Pulverizes, Electrostatic Precipitators, Draughts-Different types, Surface condensers - Types of cooling towers, Steam turbines, Steam engines: Advantages of steam turbines over steam engines, Boilers: Types of boilers, Principles of steam power plant design, Factors affecting steam plant design ,Thermal power plants environmental control, simple numerical examples.
Unit 3	**Hydro Electric Power Plant (06 Hours)** Lay out of Hydroelectric power plant: Elements of Hydroelectric power plan, Classification of Hydroelectric power plant, Advantages of Hydroelectric power plant, Mini and Micro hydro power plants, Types of Dams, Pen stock, Draft tube, Surge tank, Hydraulic turbines, Classifications, Turbine governing, Cavitations, Safety measures in Hydro power stations, Control room functions, Switch gear, Site selection, Comparison of Hydroelectric power plant and steam power plant.,
Unit 4	**Nuclear Power Plant (08 Hours)** Review of atomic physics (atomic number, mass number, isotopes, atomic mass, unit rate of radioactivity, mass equivalent number, binding energy and mass defects), Nuclear power plant layout, Elements of Nuclear power plant, Types of reactors ,Pressurized water reactor, Boiling water reactor, Waste disposal and safety, Advantages of Nuclear power plant, Comparison of Nuclear power plant and steam power plant, Site selection and Commissioning procedures, simple numerical, India's nuclear power program.
Unit 5	**Diesel Engine & Gas Turbine Power Plant (06 Hours)** Types of diesel engine power plants, Layout and components, Diesel engine power plant auxiliaries, Engine starting methods, Advantages of Diesel engine power plant, Application of Diesel engine power plant, Site selection. Gas turbine power plant ,Classification, Elements of simple gas turbine power plant, Layout, Open and Closed cycles,Reheating, Regeneration and Inter cooling – Combined cycles - Applications and advantages of Gas turbine plant, simple numerical examples.
Unit 6	**Combined working of power plants: (06 Hours)** Economics of combined working power plants, base load and peak load stations, pumped storage plants, inter- connections of power stations. Tariff: Fixed cost, running cost and their interrelation for all types of conventional power plants,

	depreciable cost, different types of tariffs, numerical example based on above, effect of deregulation on pricing.
Text Books :	
1.	P.K. Nag, "Power Plant Engineering", Third Edition, Tata McGraw – Hill, 2007
2.	G.R. Nagpal "Power Plant Engineering", Khanna Publishers.
Reference Books:	
1.	Arora S.C and Domkundwar ,"A Course in Power plant Engineering's, Dhanpat Rai, 2001.
2.	El-Wakil M.M, "Power Plant Technology", Tata McGraw-Hill
3.	Rai G.D, "Introduction to Power Plant Technology", Khanna Publishers.

EEO303 Electrical Installation and Design

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA

Prerequisites Courses:	
1	Electrical Measurement, Electrical machines
2	Power System
Course Objectives:	
1	Study of essentials of electrical installation.
2	Study of wiring system and their estimation.
3	To study various aspects of illumination.
4	To study estimation and costing of H.T and L.T conductors for installation.
5	All Indian Electricity Rules.
Course Outcomes:Students' will be able to:	
1	Design the electrical wiring systems for residential, commercial requirement
2	Substation arrangement studies
3	Find out specifications of cables, insulators for various voltage ratings.
4	Acquainted with different methods of measuring resistances.
5	Start his/her own consultancy and business opportunities in electrical installation
6	Design and representing the electrical systems with standard symbols and drawings, SLD
Syllabus :	
Unit 1	**Electrical Drawing:** **(06 Hrs)** Principles, Symbols, Single Line Diagrams (SLD), Introduction to common Electrical Components, such as contactor, switches, relays, timers, cables, lugs, connectors,MCCB, ELCB, panel meters etc. Different Tools Used: Screwdriver, Pliers of various types, wrench, and blowlamp, Precaution for using tools
Unit 2	**Wiring System**: **(06 Hrs)** Selection of types of wiring, Methods of wiring (Cleat, Casing capping, Metal sheathed and Conduit) Calculation and Estimation of power rating of different AC and DC machines. Electrical system design for a typical midsize housing complex,

	mechanical workshop, auditorium and IT industry, Estimation for a light and fan system, Process of tendering and Construction and Design of MCC and PCC for a typical industry
Unit 3	Complete arrangement of substation (Single and double bus bar), key diagrams for typical substations. Various type's pole structure, Insulators, cables and their types. Review of Insulated Wires: Types: Rubber covered taped and compounded or VIR, Lead alloy sheathed, Tough rubber sheathed, Weather proof, Flexible wire splicing, Termination (Twist splicing, Married joint, Tap joint, Pig tail joint) **(06 Hrs)**
Unit 4	**Illumination:** Radiant Energy, Terms and Definitions, Laws of Illumination, Polar Curves, Photometry, Methods of Lighting calculations, Consideration points for planning a lighting installation ,Design consideration of good lighting scheme, Luminous Efficacy, Electrical Lamps, Design of Interior and Exterior Lighting Systems, Illumination Levels for Various Purposes, Light Fittings, Factory Lighting, Flood Lighting, Street Lighting, Energy ,Conservation in Lighting
Unit 5	**Measurement of earth resistance & Testing**: **(06 Hrs)** Measurement of Earth Resistance ,Two Point Methods, Three Point method, Fall of potential method, Direct measurement of Earth resistance, Testing of Installations, **Estimating & Conductor size calculations for internal wiring H.T & L.T Overhead Lines and Underground cables:** Estimating, Price catalogue, Schedule of rates & Estimating data, Determination of conductor size, Current carrying capacity, Voltage drop, Minimum permissible size, Conductor size calculation for internal domestic wiring, Underground cable, Overhead lines with A.C.S.R
Unit 6	Estimates for L.T Distributors & Street Light Feeders, Estimates for 11 kV Feeders, All Indian Electricity Rules like 1956,2003,2005, National Tariff Policies **(06 Hrs)**
Text Books:	
1.	K.B. Raina & S.K. Bhattacharaya – Electrical Design Estimating & Costing, New age international publishers (1991), 1st Edition.
2.	S. L. Uppal and G.C. Garg – Electrical Wiring, Estimation & Costing, Khanna Publication (2008).
Reference Books:	
1.	J. B. Gupta, "Utilization of Electric Power and Electric Traction", 2002,S. K. Kataria and Sons.
2.	Pratab H., "Art and Science of Utilization of Electrical Energy", Second Edition, Dhanpat Rai and Sons, New Delhi.
3.	Surjeet Singh, "Electrical Estimating and Costing" Dhanpat Rai and Company (P) Ltd, Reprint 2008.

SEMESTER- VI

EEO304 Advances in Solar Energy			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks End Sem. Exam :70 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA
Prerequisites Courses:			
1	Power Electronics		
Course Objective:			
1	To create awareness about the importance of renewable technology for sustainable future.		
2	Impart the knowledge of solar power generation		
3	Study of Solar Photovoltaic Energy Conversion & Utilization		
4	To acquaint students with possible storage systems in renewable generation		
5	Introduce recent trends in renewable energy system to students		
Course Outcomes: Students' will be able to:			
1	Understand the various renewable energy sources.		
2	Understand the equivalent circuit of PV cell and its modelling		
3	Explore business opportunities in Solar Technologies		
	Describe energy storage systems		
4	Understand the smart grid, recent trends in renewable system &		
5	Summarize standards for grid integration through Case study of solar power plants		
6	Design suitable power controller for the grid-connected PV system		
Syllabus :			
Unit 1	**Introduction to Renewable Energy Sources** Global and Indian scenario of RES, need for alternative energy sources, advantages & disadvantages of RES, classification of RES & comparison, key factors affecting RES		
Unit 2	**Solar Energy** Solar thermal power generation, solar photovoltaic power generation, basics of PV cell, materials used for PV cell, efficiency of PV cell, equivalent electrical circuit, open circuit voltage and short circuit current, I-V & P-V curves, effects of different electrical parameters on I-V & P-V curves, measurement of solar insolation, solar concentrator, flat plate & concentrating collectors.		
Unit 3	**Solar Photovoltaic Energy Conversion & Utilization** Configuration of PV power generation system- off-grid system & grid-connected PV system, single stage & two stage converters for power transfer, single phase & three phase inverters for PV, control of grid connected PV system.		
Unit 4	**Storage Technologies** Introduction, need for storage for RES, traditional energy storage system- battery, fuel cell, principle of operation, types of fuel cell.		

Unit 5	**Emerging Trends in Renewable Energy** Introduction to SG, SG in Indian context, architecture of SG, advantages &disadvantages, key challenges for SG, SG technologies, AMI, PMU, WAMS, standards & codes for grid integration of DG system
Unit 6	Case study of Off –Grid and On-Grid Solar Plants
Text Books:	
1.	Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
2.	Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19-926178-4).
3.	Mullic and G.N.Tiwari, "Renewable Energy Applications", Pearson Publications.
Reference Books:	
1.	S. P. Sukhatme, J. K. Nayak Solar Energy- Principles of Thermal Collection and Storage (3rd edition), Tata McGraw-Hill Publication.
2.	Paul Gipe Wind Power, Renewable Energy for Home, Farm, and Business.