Course of Study

Choice Based Credit System

T. Y. B. Tech. (Electrical Engineering)

(Effective from Academic Year 2019-20 Only)

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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For Academic Year 2019-20 Only

STRUCTURE

Semester-V					
Course Code	**Name of the Course**	**Lectures**	**Tutorials**	**Practical**	**Credits**
EE301	Power System Engineering	3		2	4
EE303	Feedback Control System	3	1	2	5
EE305	Microprocessor and Microcontroller	3	1	2	5
EE307	Digital Signal Processing	3	-	2	4
EE309	Elective-II	3	-		3
EE311	Mini Project and Seminar-I			4	2
	Sub Total	**15**	**2**	**12**	**23**
Semester-VI					
Course Code	**Name of the Course**	**Lectures**	**Tutorials**	**Practical**	**Credits**
EE302	Power System Analysis and Stability	3	-	2	4
EE304	Electromagnetic Fields	3	1	-	4
EE306	Control System Design	3	-	2	4
EE308	Power Electronics	3	1	2	5
EE310	Elective-III	3	-	-	3
EE312	Mini Project and Seminar-II	-	-	4	2
	Sub Total	**15**	**1**	**10**	**22**
	Total	**30**	**3**	**22**	**45**

Elective-II
EE309A-Energy Audit and Conservation
EE309B-Renewable Energy Technologies
EE309C-Electrical Installation and Design
Elective-III:
EE310A: Power Plant Engineering
EE310B: Electrical Machine Analysis
EE310C: Utilization of Energy and Management

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

SEMESTER-V

EE301 Power System Engineering			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:	
1	Basic Electrical Engineering
Course Objective:	
	To introduce students to the basic structure and requirements of any electric power supply system
	To develop an understanding of components in a power system and to understand the basic principles involved in these components.
	To explore analysis and design principles for the complete power system
Course Outcomes: Students' will be able to:	
1	Represent and Model power system components
2	Understand use of software development tools to simulate and analyse the power system
3	Implement corrective measure for immediate as well as long term solution to the power system problems
4	Apply knowledge in evaluating performance of power system
Syllabus :	
Unit-1	**Introduction and Fundamentals of Power Systems:** Evolution of Power Systems and Present-Day Scenario, Structure of a power system, GRID formation, Concept of National GRID. Overview of conventional and non-conventional power generation. Analysis of simple three-phase circuits, Power Transfer in AC circuits, concept of real, reactive and complex power and their effects on power system operation.
Unit -2	**Electrical Design of Overhead Transmission Lines:** Resistance, Inductance: Definition, Inductance due to internal flux of two wire single phase line of composite conductor line, Concept of GMD, Inductance of three phase line with equal & unequal spacing, vertical spacing. Capacitance: Concept of electric field, Potential difference between two points in space, Effect of earth's surface on electric field, Computation of capacitance of single phase, three phase transmission lines with & without symmetrical spacing for solid & composite conductors. Concept of GMR and GMD, Skin effect, Proximity Effect, Ferranti effect.
Unit -3	**Transmission line modelling and performance:** Performance of Transmission Lines: Classification of lines such as short, medium, long lines Voltages and currents at sending end and receiving end of the lines, effect of load p.f. on regulation and efficiency, Determination of generalized ABCD constants in them, Circle Diagrams, numerical based on this concepts

Unit -4	**Mechanical design of overhead transmission line:** Main components of overhead line, conductor materials, line supports, Insulators: Type of insulators, potential distribution over suspension insulator string, string efficiency, methods of improving string efficiency. Corona: Phenomenon of corona, factors affecting corona, advantages and disadvantages of corona, methods of reducing corona. Sag: Sag in overhead line, calculation of sag, Effects of wind & ice coating on transmission line.
Unit -5	**Distribution System:** Classification of distribution, AC and DC distribution system, overhead versus underground system, connection scheme of distribution system, Requirements of Distribution System, Design Consideration in Distribution Systems, Numerical Problems
Unit -6	**Underground Cables and Sub-Stations:** Underground cables: Construction of cables, insulating materials of cables, classification of cables, cables for 3-phase services, Insulation Resistance of Single-Core Cable, capacitance of single core cable, Dielectric Stress in single Core Cable, Grading of cables & Numerical. Sub-Stations: Classification of Substations, Comparisons between Outdoor and Indoor Sub-Station, Symbols for equipment in Substation Bus-Bar Arrangements in Substations, Key Diagram of Substations
Text Books:	
	1. V.K.Mehta, Rohit Mehta "Principles of POWER SYSTEM", Fourth Edition , S.Chand Publications, Latest Edition. 2. C.L. Wadhwa, "Electrical Power Systems", 6th Edition, New Age International, Latest Edition 3. D.P.Kothari, I.J.Nagrath, "Power System Engineering" 2nd Edition, McGraw Hill Education (India) Pvt. Ltd, Latest Edition 4. Stevenson W.D. "Power System Analysis", TMH, 4th Edition **5.** J.B. Gupta, "Electrical Power", SK Kataria & Sons.
Term Work:	
	The laboratory consists of minimum EIGHT experiments from following list. 1. Study of different equipment's used in power station. 2. Study of transmission line inductance. 3. Study of transmission line capacitance. 4. Study of different components of power system. (e.g. different types of line conductors, insulators, pole structure) 5. Study of regulation and transmission efficiency for short, medium and long transmission lines. 6. Study of ABCD parameters of short, medium and long transmission lines. 7. Study of circle diagram of transmission lines. 8. Study of corona effect for transmission lines. 9. Study of different effects of power system. (e.g. skin effect, Ferranti effect, proximity effect, surge impedance loading) 10. Study of different types of substations.

Independent Learning Experiences:
Online NPTEL video lectures: • Prof. A. K. Sinha, Department of Electrical Engineering, IIT Kharagpur. • https://swayam.gov.in
Note: The computational work is to be carried preferably by using software tools like **MATLAB, Mi-Power, Scilab.**

EE303 Feedback Control System

Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 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.
Course Outcomes: Students' will be able to:	
1	To exhibit the capability to represent the mathematical model of a system and to determine the response of different order systems for various standard inputs.
2	To demonstrate the ability to apply Laplace transform, transfer functions, modeling RLC circuit, block diagrams for simulation and control.
3	To specify control system performance in the frequency-domain and design compensators to achieve the desired performance.
4	To validate what they have learned theoretically in the field of control system engineering.
5	To gain some practical experience in control engineering which might become a future research point for them.
6	To construct and recognize the properties of root-locus for feedback control systems with a single variable parameter.
Syllabus :	
Unit 1	**Introduction to control systems** **(06 Hours)** Definition, history, elements of control systems, examples of control systems, open- loop (non-feedback) and closed loop (feedback) control systems, effect of feedback on overall gain, parameter variations, external disturbances or noise and control over system dynamics, regenerative feedback, linear versus nonlinear control systems, time- invariant versus time- varying systems, SISO and MIMO systems
Unit 2	**Mathematical modelling of dynamic systems** **(07 Hours)** Introduction, canonical form of feedback, control systems, transfers function and

	impulse response. differential equations and transfer functions of physical systems such as mechanical, electrical, electromechanical, thermal, pneumatic and liquid-level systems, analogous systems, force-voltage, force-current and torque- current analogies, loading effects in interconnected systems, systems with transportation lags, linearization of nonlinear mathematical models, block diagram representation of control system, rules and reduction techniques, signal flow graph: elements, definition, properties, masons gain formula, application of gain formula to block diagrams.
Unit 3	**Time- domain analysis of control systems(08 Hours)** Standard test signals, transient response, steady state error and error constants, dynamic error series, time response of first and second order systems and transient response specifications, effect of adding poles and zeros to transfer functions, dominant poles of transfer function, basic control actions and response of control systems, effects of integral and derivative control action on system performance, higher order systems.
Unit 4	**Stability of linear control systems(06 Hours)** Concept of stability, BIBO stability: condition, zero input and asymptotic stability, Hurwitz stability criterion, Routh-Hurwitz criterion in detail, relative stability analysis.
Unit 5	**The Root–Locus technique(06 Hours)** Introductions, basic properties of the root loci, general rules for constructing root loci, Root Locus analysis of control systems, Root Loci for systems with transport lag, Root-contour plots, Sensitivity of the roots of the characteristics equation.
Unit 6	**Frequency domain analysis (08 Hours)** Frequency response of closed loop systems, frequency domain specifications of the prototype second order system, correlation between time and frequency response, effect of adding a pole and a zero to the forward path transfer function, polar plots, Bode plots, phase and gain margin, stability analysis with Bode plot, log magnitude versus phase plots. Constant M and N circles, Nichols chart, gain adjustments, sensitivity analysis in frequency domain, Nyquist stability criterion: mathematical preliminaries, stability and relative stability analysis.
Unit 7	**Compensators** Introduction, different types of compensators (Electrical, Electronic and Mechanical type), their transfer functions.
Reference Books:	
1.	K. Ogata, “Modern Control Engineering”, Fourth Edition Pearson education India, 2002.
2.	B. C. Kuo, “Automatic control systems”, Seventh Edition, Prentice –Hall of India, 2000.
3.	Norman S. Nise, “Control systems Engineering”, Third Edition, John Wiley and Sons. Inc, Singapore, 2001.
4.	R. C. Dorf and R. H. Bishop, “Modern Control systems”, Eighth Edition, Addison Wesley, 1999.

5.	I. J. Nagrath and M. Gopal, “Control systems Engineering”, Third Edition, New age International Publishers, India, 2001.
Term Work: It will consist of at least eight experiments/assignments/programs from the following list:	
1.	Determination of transfer function of an armature controlled d. c. motor.
2.	Determination of transfer functions of D. C. generator.
3.	Effect of feedback on D. C. generator.
4.	Transient response of second order system.
5.	Study of D. C. positional servo system.
6.	Study of A. C. servo voltage stabilizer.
7.	Study the performance of an open and closed loop control system using electronic amplifiers using OPAMPs.
8.	Study the performance of a second order system (Use any OPAMP based electronic system such as an active second order Butterworth filter).
9.	Study the performance of any first order and second order system
Experiments based on software (programs)	
1.	Introduction to MATLAB, MATLAB’s simulink and control systems toolbox (with some examples) or any other control system related software package.
2.	Compare and plot the unit-step responses of the unity-feedback closed loop systems with the given forward path transfer function. Assume zero initial conditions. Use any computer simulation program.
3.	Study of effect of damping factor on system performance by obtaining unit step response and unit impulse response for a prototype standard second order system. Consider five different values for x = 0.1, 0.3, 0.5, 0.7 and 1.0. Also study the effect of varying undammed natural frequency by taking three different values. Comment on the simulations obtained.
4.	Write a program that will compute the step response characteristics of a second order system i.e. Percent overshoot, rise time, peak time and settling time. Generalize it for accepting different values of undammed natural frequency and damping factor.
5.	Study and plot the unit step responses of addition of a pole and a zero to the forward path transfer function for a unity feedback system. Plot the responses for four different values of poles and zeros. Comment on the simulations obtained.
6.	Study and plot the unit step responses of addition of a pole and a zero to the closed loop transfer function. Plot the responses for four different values of poles and zeros. Comment on the simulations obtained.
7.	Program for compensator design using Bode plot.
8.	Program for compensator design using Root Locus analysis.
9.	Plot and comment on various properties of any three systems (problems) using • Routh-Hurwitz criterion • Root locus technique • Bode plots

	• Nyquist plots Use any software package.

EE305 Microprocessor and Microcontroller			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs./ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	1 Hrs/Week		
Practical	2 Hrs./Week		
Credits (Th)	4	Credits(P)	1

Prerequisites Courses:	
1	Analog and Digital Circuits
Course Objective:	
1	To teach the students to familiarize with microprocessor and microcontroller architecture and functioning.
2	To train the students to program the microprocessor and microcontrollers for any application.
Course Outcomes: Students' will be able to:	
1.	To describe basics of 8085, 8051 and its instruction set.
2.	To understand historical development of microcontrollers and to know different 8, 16, 32 bit microcontrollers.
3.	To solve assembly language programs based on the instruction set of 8085 and 8051.
4.	To get insight of 8051 based hardware system and so to study ADC, keyboard etc.
5.	To execute assembly language programs based on the instruction set of 8051
6.	To develop 8085, 8051 based instrumentation system.
Syllabus :	
Unit 1	**Introduction to 8085**
	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, instruction set timing diagrams, a minimum configuration for 8085, interrupt structure of 8085, internal interrupt circuit, hardware and software interrupts.
Unit 2	**Interfacing memories to 8085**
	Interfacing memories EPROM and RAM with 8085 with exhaustive and partial decoding techniques.
Unit 3	**Peripheral devices used in 8085 systems**
	Following structure programmable peripheral devices are to be studied in details as regards block diagram, software for their interfacing with 8085: 8255, 8253, 8279, ADC.
Unit 4	**Introduction to microcontrollers**
	8051 Architecture, pin out diagram, 8051 oscillator and clock, Program counter and Data pointer, A and B CPU registers, flags and PSW, internal memory, stack and stack pointer, SFRS, internal ROM, I/P and O/P ports.

Unit 5	**Programming 8051**
	Assembly language programming for 8051 microcontroller, instruction classification, instruction set Arithmetic and Logical operations, jump and call instructions etc., writing assembly language programming based on instruction set, stacks and subroutines.
Unit 6	**Timers in 8051**
	Interrupts of 8051, counters and timers, timer modes, timer/counter programming.
Unit 7	**Interfacing peripherals to 8051**
	8051 microcontroller interfacing with: keyboard and display, A/D and D/A chips.
Unit 8	**Design of 8051 based systems**
	Design of dedicated systems using 8051 for temperature indication OR/AND control, flow indication, OR/AND control, stepper motor control, embedded control systems, Smart transmitters.
Unit 9	**Serial data transmission**
	Introduction to serial data transmission methods.
Text/ Reference Book:	
1.	K. L. Short, "Microprocessor and programming logic", Second Edition, Prentice- Hall India Pvt. Ltd.
2.	R. S. Gaonkar, "Microprocessor Architecture, Programming and application with 8085/8085A", Fourth Edition, Willey Eastern Ltd.
3.	B. Ram, "Fundamentals of microprocessor and Microcomputer", Dhanpat Rai and Sons, Eighth Edition, New Delhi.
4.	Ayala K. J., "8051 Microcontroller: Architecture, Programming and applications" Second Edition, Penram international.
5.	Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, "The Microcontroller and Embedded Systems", Second Edition, Pearson, 2012.
Reference Books:	
1.	B. Ram, "Advanced Microprocessor and Interfacing" Tata McGraw-Hill Publishing Company Ltd., First Edition, New Delhi.
2.	Ajit Pal, "Microprocessor Principles and Applications", Tata Mc-Graw Hill, First Edition New Delhi.
3.	U. V. Kulkarni and T. R. Sontakke, "The 8085A Basics: Programming and Interfacing", Sadusudha Prakashan, First Edition, Nanded.
4.	Intel Mcs, "8085 users manual", Intel Corporation.
5.	Myke Predko, "Programming and customizing the 8051 Microcontroller", Tata McGraw-Hill, First Edition, New Delhi.
6.	N.G. Palan, "8031 Microcontroller – Architecture, Programming and Hardware Design", Technova publishing House.
Term Work: It will consist of a record of at least eight of the following experiments based on the Prescribed syllabus.	
1.	Study of Dyralog 8085 kit.
2.	Writing simple programs based on 8085 Instruction set.
3.	Write a program to find largest number from a series of numbers.
4.	Write a program to transfer a block of data.
5.	Write a program for arranging numbers in ascending / descending order.
6.	To study interfacing of 8255 with LEDs, 7-Segment display.

7.	To study interfacing of 8255 with Keyboard, ADC.
8.	To study 8051 Simulator.
9.	To write simple programs using 8051 simulator like- a. Finding largest/smallest number. b. arranging numbers in ascending / descending order. c. Arithmetic of 16-bit numbers.
10.	Interfacing of stepper motor with microcontroller.
11.	Mini project based on 8051.
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.	

EE307 Digital Signal Processing

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	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	**Introduction (8 Hours)** Discrete time signals and systems, time domain characterization of discrete time LTI systems, sampling theorem, benefits and limitations of processing signal digitally. Correlation of signals. The Z-transform: inverse Z-transform and Z-transform properties for one-sided and two-sided z-transforms. Discrete Time Fourier Transform (DTFT) and its properties.
Unit 2	**LTI Discrete Time Systems in transform domain (6 Hours)** The frequency response, the transfer function, types of transfer functions,

	All pass transfer function, minimum-phase and maximum-phase transfer functions, inverse systems.
Unit 3	**Discrete Fourier Transform** **(6 Hours)** Discrete Fourier Transform (DFT) and its properties. Computation of DFT (FFT algorithms), Decimation-In-Time (DIT), Decimation-In-Frequency (DIF) and radix-n algorithms of FFT.
Unit 4	**Digital Filter Structures:** **(6 Hours)** Digital filter structures: block diagram representation, equivalent structures, basic FIR structures, basic IIR structures, All pass filters, IIR tapped cascaded lattice structures, FIR cascaded lattice structures.
Unit 5	**Digital filter design IIR filter design** **(6 Hours)** Bilinear transformation, impulse invariant transformation, Lowpass IIR digital filters, spectral transformations, FIR filter design using windowing techniques, frequency sampling technique, and computer aided design.
Unit 6	**Digital Signal Processor** **(8 Hours)** Harvard architecture and modified Harvard architecture. Introduction to fixed point and floating point DSP processors, architectural features, computational units, bus architecture and memory architecture, data addressing, address generation unit, pipelining, on-chip peripherals.
Text Book/Reference 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.
Term Work: Term work shall consist of at least six to eight assignment/tutorials/practical based on above syllabus. Some of the experiments may be from the following list. Students are supposed to write the programs (at least eight) on general-purpose computer using any development environment (C/C++/Matlab) or on any DSP processor and development environment.	
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 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 Energy Audit and Conservation			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical			
Credits (Th)	3	Credits(P)	NA

Prerequisites Courses:	
1	Generation, transmission and distribution of Electric Power Switchgear and Protection
Course Objective:	
1	To explain the current energy scenario and need of energy conservation.
2	To demonstrate the advantages of energy audit.
3	To demonstrate importance of energy management.
4	To identify importance of energy efficiency in electrical utility.
Course Outcomes: Students' will be able to:	
1	To implement conservation of energy techniques in electrical system.
2	Evaluate the technical economic feasibility of the energy audit technique.
3	To understand various kinds of tariffs in electrical utility.
4	Explain captive power generation.
5	Apply financial management in electrical conservation.
6	Analyse captive power generation and co-generation.
Syllabus :	
Unit 1	**Energy scenario:(06 Hours)** Energy scenario: Introduction, energy problems, energy use trends in developing countries, prospects of changes in energy supply, strategies for sustainable development, finite fossil reserve, Energy and environment, Need for renewable and energy efficiency, Energy conservation principles, Energy conservation in industries, generation, transmission and distribution, household, commercial sectors, transport, agriculture.
Unit 2	**Energy Audit: (06 Hours)** Energy flow diagram, strategy of energy audit, comparison with standards, considerations in implementing energy with conservations programmes, instruments for energy audit, energy audit of illumination system, energy audit of electrical system, energy audit of heating ventilation and air conditioning systems, energy audit of compressed air system, energy audit of building, distribution and utilization system, economic analysis. Energy conservation Act 2003.
Unit 3	**Energy Management and Integrated Resource Planning:(06 Hours)** Definition and Objectives of Energy management, Energy management strategy, Key elements, Responsibilities and duties of Energy Manager, Energy efficiency Programs, Energy Monitoring System, Importance of SCADA, Analysis techniques, Cumulative sum of differences (CUSUM).
Unit 4	**Energy efficiency in electrical utility: (06 Hours)** Electrical billing, power factor management, distribution and transformer losses,

	losses due to unbalance and due to harmonics, Demand Side Management, Demand-Response, Role of tariff in DSM and in Energy management, TOU tariff, Power factor tariff, Energy conservation in lighting system, HVAC system, Electrical Motors, Pump and pumping System.
Unit 5	**Financial Analysis and Management: (06 Hours)** Investment need, Financial analysis techniques, Calculation of Simple Pay-back period, return on investment, cash flows, risk and sensitivity analysis, Time value of money, Net Present value, Breakeven analysis, Cost optimization, Cost and Price of Energy services, Cost of Energy generated through Distributed Generation.
Unit 6	**Captive Power Generation**:**(06 Hours)** Types of captive power plants, financing of captive power plants, captive power plants in India, energy banking, energy wheeling, Carbon credits Cogeneration-Cogeneration technologies, industries suitable for cogeneration, allocation of costs. Sale of electricity to utility, impact of pricing of cogeneration, electric power plant reject heat, agricultural uses of waste heat, Potential of cogeneration in India.

Text/ Reference Books:

1. B. R. Gupta, "Generation of Electrical Energy" S.Chand Publication.
2. S. Rao & Dr. B. B. Parulekar, "Energy Technology: Non-conventional,Renewable and Conventional" Khanna Publishers.
3. Frank Kreith and George Burmeister, "Energy Management &Conservation", Amazon Publishers.
4. Beggs and Clive, "Energy Management Supply and Conservation", Wall Mart Publishers
5. K.Bhattacharya, MHJ Bollen, J .E.Dalder, "Operation of Restructured Power System", Kluwer Academic Publications.
6.S. C. Tripathy, "Utilization of Electrical Energy", Tata Mc Graw Hill.
7. Energy Conservation Act 2001.
8. Bureau of Energy Efficiency India web-site http://www.bee-india.com.

Term Work:

At least eight experiments based on the curriculum from the following list should be performed

1. Computing efficiency of DC motor/Induction Motor/Transformer.
2. Draw the energy flow diagram for an industry/shop floor division.
3. Study of various energy efficient equipment like LED lighting devices, Energy Efficient motors, Electronics ballast etc.
4. Study of Variable frequency drive based IM speed control for energy conservation.
5. Industry visit with an aim of

(i) Studying various energy management systems prevailing in a particular industry/Organization

(ii) Identifying the various energy conservation methods useful in a particular industry

6. Studying the various energy conservation methods useful in power generation, transmission and distribution

7. Study of APFC panel or Estimating the requirement of capacitance for power factor improvement.

08. Evaluating the energy conservation opportunity through various methods like simple

payback period IRR and NPV.

09. Determine depreciation cost of a given energy conservation project/equipment.

10. Study of various measuring instruments used for energy audit: Lux meter, Power analyzer, flue gas analyzer.

11. Identifying the energy conservation opportunities in a lab, department or institute.

Note:

There is no examination for this subject but students have to submit audit report on above topics mentioned in the term work.

EE309B Renewable Energy Technologies

Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 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 Continuous Evaluation : 20 Marks End Sem. Exam :50 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 Ruleslike 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, DhanpatRai 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 Power System Analysis and Stability			
Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs/Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:	
1	Power System-I
2	Electrical machines
Course Objective:	
	To understand the need of load flow and short circuit analysis
	To impart knowledge of Load flow Analysis, Short circuit studies and power system stability
	To develop skills for performing stability studies
	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 :**	
	Summarize the use of different load flow analysis method and assess the power system under symmetrical fault.
	Understand symmetrical components of network and analyze the power system under unbalanced fault.
	Evaluate the rotor angle, voltage stability and solve swing equation by various methods.
	Develop and simulate power system in any available software for load flow analysis
	Study and analyze stability of power system when subjected to electrical or mechanical disturbance
	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, per unit system, single line diagram. 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.
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.	
	Determination of sequence n/w of synchronous m/c.
	Determination of sequence n/w of Induction motor.
	Solution to load flow problem using GS, NR and FD method using software.
	Component analysis and component synthesis using various software tools.
	Fault analysis of various faults like LG, LLG and LL faults at least 3 sets of software experiments.
	Four problems on stability using Equal area criteria.
	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.	

<table>
<tr><td colspan="4">EE304 Electromagnetic Fields</td></tr>
<tr><td colspan="2">Teaching Scheme :</td><td colspan="2">Examination Scheme:</td></tr>
<tr><td>Lectures</td><td>3Hrs/ Week</td><td colspan="2" rowspan="3">Theory: Mid Term:30 Marks
Continuous Evaluation : 20 Marks
End Sem. Exam :50 Marks</td></tr>
<tr><td>Tutorials</td><td>--</td></tr>
<tr><td>Practical</td><td>--</td></tr>
<tr><td>Credits (Th)</td><td>3</td><td>Credits(P)</td><td>NA</td></tr>
<tr><td colspan="4">Prerequisites Courses:</td></tr>
<tr><td>1</td><td colspan="3">Vector Algebra</td></tr>
<tr><td colspan="4">Course Objective:</td></tr>
<tr><td></td><td colspan="3">Understanding of basic concepts of Vectors.</td></tr>
<tr><td></td><td colspan="3">Understanding of basic concepts of Electrostatic fields and Electromagnetic fields.</td></tr>
<tr><td></td><td colspan="3">Study of Magnetic Forces Materials and Devices</td></tr>
<tr><td></td><td colspan="3">Study of Magneto Static Fields</td></tr>
<tr><td></td><td colspan="3">Study of Maxwell’s Equations</td></tr>
<tr><td colspan="4">Course Outcomes: Students’ will be able to:</td></tr>
<tr><td></td><td colspan="3">Understand the applications of vector algebra</td></tr>
<tr><td></td><td colspan="3">Learn basic theory of electric and magnetic fields</td></tr>
<tr><td></td><td colspan="3">Evaluate the Electrostatic boundary value conditions and problems</td></tr>
<tr><td></td><td colspan="3">Analyse various aspects of magneto static fields</td></tr>
<tr><td></td><td colspan="3">Understand magnetic forces materials and devices.</td></tr>
<tr><td></td><td colspan="3">Apply Maxwell’s equations.</td></tr>
<tr><td colspan="4">Syllabus :</td></tr>
<tr><td>Unit 1</td><td colspan="3">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.</td></tr>
<tr><td>Unit 2</td><td colspan="3">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.</td></tr>
<tr><td>Unit 3</td><td colspan="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.</td></tr>
<tr><td>Unit 4</td><td colspan="3">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.</td></tr>
<tr><td>Unit 5</td><td colspan="3">Magnetic Forces Materials and Devices: (08 Hours)
Introduction, Forces due to Magnetic Fields, Magnetic Torque and Moment,</td></tr>
</table>

	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.	AshutoshPramanik "Electromagnetic Theory and Applications", , PHI Ltd 2nd Edition

EE306 Control System Design

Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	2 Hrs./Week		
Credits (Th)	3	Credits(P)	1

Prerequisites Courses:	
1	Feedback control system
Course Objective:	
1	Modeling of Physical systems using state space technique.
2	Analysis and Design of control system using state space technique.
3	Provide the knowledge of various nonlinearities observed in real world.
4	Design a control system using lead – lag compensator, P, PI and PID controllers.
5	Provide the knowledge of absolute and relative stability.
Course Outcomes: Students' will be able to:	
1	Understand the concepts of state space modelling, analysis and design.
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 and Lyapunov theory.
4	Analyse the response and stability of system with different controllers.
5	Evaluate the performance of compensated and uncompensated systems in time and frequency domain.
Syllabus :	
Unit 1	**State Space Concept: (10 Hours)** State variable method: Modeling and Analysis Concept of state, state variable, and state model, state space representation using physical, phase and canonical

	variables and their block diagram representation, state model and transfer function, diagonalization, solution of state equation, state transition matrix its properties and computation.
Unit 2	**State Space Analysis and Design: (06 Hours)** Concept of Controllability and Observability and their test criterion, Design pole placement design using state feedback, full order state observer design.
Unit 3	**Non-linear control systems: (04 Hours)** Behavior of nonlinear systems, common physical nonlinearities, Concept of describing function method, phase plane method, singular points, stability of nonlinear system.
Unit 4	**Fundamentals of Lyapunov Theory: (06 Hours)** Equilibrium points, concept of stability, linearization and local stability, Lyapunov's Direct method: positive definite functions and Lyapunov functions, equilibrium point theorems, System Analysis based on Lyapunov's Direct Method: Lyapunov analysis of LTI systems, Krasovski's method, Variable gradient method.
Unit 5	**PID controllers: (06 Hours)** Introduction to Proportional (P), Integral (I) & Derivative (D) controller, individual effect on overall system performance, P, PI, PD & PID control and effect on overall system performance, Numerical examples.
Unit 6	**Compensator Design using Root Locus and Bode Plot: (08 Hours)** Review of root locus concept, lead compensation, lag compensation, cascade lag-lead compensation, compensation for plants with dominant complex poles. Compensator Design using Bode Plot: Reshaping Bode plot, lead compensation, lag compensation, cascade lag-lead compensation.
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.	J. E. Slotine and W. Li, "Applied Nonlinear Control", Prentice Hall International, 1991.
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.	Introduction to Matlab.
2.	Solution of Ordinary differential equation using Matlab.
3.	Modeling of Physical Systems using Matlab.
4.	Modeling of Physical Systems using Simulink.
5.	Conversion of given transfer function to State Space forms and vice versa.
6.	Determine Controllability and Observability of a system.
7.	Design and tuning PID controller using MATLAB/Simulink.
8.	Design of controller in state space Domain.

9.	Design of observer in state space Domain.
10.	Design of Lead / Lag Compensator using Root Locus.
11.	Design of Lead / Lag Compensator using Bode 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 two hours duration and will consist of an experiment based on term-work and followed by an oral based on above syllabus.	

EE308 Power Electronics

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs./ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	1 Hrs/Week		
Practical	2 Hrs./Week		
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	To extend simple power electronic converters to realize rectifiers and inverters.
3	To develop and quantify common performance objectives for power electronic circuits such as efficiency, power factor, etc.
4	To analyze and design DC/DC converter (chopper) circuits.
5	To analyze and evaluate the operation of cycloconverters and voltage controllers.
6	To outline operating principles of application of power electronic circuits as motor drives, UPS systems, etc.
Course Outcomes: Students' will be able to:	
1	To understand the basic principle, characteristics and applications of power electronic and switching devices.
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	**Introduction(06 Hours)** Modern power semiconductor devices and their characteristics, gate drive specifications, ratings, applications, turn ON and turn OFF methods, design of gate triggering circuits using UJT and thyristor protection circuits.
Unit 2	**Phase controlled rectifiers (06 Hours)** Single phase rectifiers: Half wave, center tapped, bridge (half controlled and fully controlled) with R and RL load. Three phase rectifiers: half wave, bridge with R and RL load effect of source inductance, dual converters, power factor improvement methods.
Unit 3	**DC chopper (08 Hours)**

	Basic chopper, continuous and discontinuous current conduction, TRC, CLC methods, classification of choppers, step-up chopper, switching mode regulators.
Unit 4	**AC voltage controller & cycloconverters (06 Hours)** AC voltage controller: types of ac voltage controllers, single-phase and three phase ac voltage controllers with R and RL load, transformer tap changers, single phase to single phase cycloconverters, three phase to single phase cycloconverters, three phase to three phase cycloconverterswith circulating and non-circulating mode.
Unit 5	**Inverters (08 Hours)** Single phase inverters: series, parallel and bridge configurations with R load, PWM inverters. Three phase inverters: 120° and 180° conduction with R and load RL, voltage control and harmonics reduction.
Unit 6	**Application in power electronics (06 Hours)** UPS and SMPS, basic characteristics of DC motors, operating modes, DC motor control using different rectifiers, induction motor drives, performance characteristics, stator voltage control, rotor voltage control, frequency control, voltage and frequency control.
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.	V. R. Moorthi, Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press, 2006.
3.	"G. K. Dubey and Others Thyristorised Power Controller", Wiley Eastern Ltd.
4.	B.K. Bose, "Modern Power Electronics and A.C. Drives", Prentice Hall of India Pvt. Ltd. Publication.
5.	B.W.Williams, "Power Electronics", John Willey
6.	G. De, Principles of Thyristorised Converters, Oxford and IBH Publications.

Term Work:

It will consist of a record of at least six to eight experiments based on the following list.

1. UJT Relaxation oscillator.
2. SCR characteristics.
3. Triac characteristics.
4. Power control using SCR.
5. Power control using Triac.
6. Single phase controlled Rectifiers.
7. Single phase half controlled Rectifiers.
8. Single phase fully controlled Rectifiers.
9. Single phase inverter using transistor/ MOSFET/IGBT.
10. Basic step-down chopper.
11. Basic step-up chopper.
12. Study of D.C. motor control using controlled rectifiers.
13. Study of D.C. motor control using choppers.
14. Study of A.C. motor control using 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.

ELECTIVES -III

EE310A Power Plant Engineering

Teaching Scheme :		**Examination Scheme:**	
Lectures	3 Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 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 Book:	
1.	Arora S.C and Domkundwar ,"A Course in Power plant Engineering's, DhanpatRai, 2001.
2.	El-Wakil M.M, "Power Plant Technology", Tata McGraw-Hill
3.	Rai G.D, "Introduction to Power Plant Technology", Khanna Publishers.

EE310B Electrical Machine Analysis

Teaching Scheme :		**Examination Scheme:**
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks

Tutorials	--	Continuous Evaluation : 20 Marks	
Practical	--	End Sem. Exam :50 Marks	
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", DhanpatRai and Sons, Delhi
3.	Say.M.G. "Performance & Design of Alternating Current Machine" (English LanguageBook 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.

EE310C Utilization of Energy and Management

Teaching Scheme :		**Examination Scheme:**	
Lectures	3Hrs/ Week	Theory: Mid Term:30 Marks Continuous Evaluation : 20 Marks End Sem. Exam :50 Marks	
Tutorials	--		
Practical	--		
Credits (Th)	3	Credits(P)	NA

Prerequisites Courses:	
1	Power System Engineering, Electrical Machine
Course Objective:	
1	To give an overview of various areas of application of Electrical Energy.
2	Study of Speed-time curves and mechanics of train movement.
3	Study of various methods of Control of traction motors.
4	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 Books:	
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.

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.