SECOND YEAR: ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION

(RC 2016-17)

SEMESTER - III

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 3.1	Applied Mathematics-III	3	1	--	3	100	25	--	--	--	**125**
EE 3.2	Electronic Devices and Circuit	3	1	2	3	100	25	--	25	--	**150**
EE 3.3	Electrical Machines-I	3	1	2	3	100	25	--	25	--	**150**
EE 3.4	Electrical Measurements and Measuring Instruments	3	1	2	3	100	25	25	--	--	**150**
EE 3.5	Economics and Management	3	--	--	3	100	25	--	--	--	**125**
EE 3.6	Analog and Digital Communications	3	--	2	3	100	25	--	--	25	**150**
TOTAL		**18**	**4**	**8**	**--**	**600**	**150**	**25**	**50**	**25**	**850**

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

SECOND YEAR: ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION

(RC 2016-17)

SEMESTER - IV

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 4.1	Numerical Techniques and Probability	3	1	2	3	100	25	--	--	--	**125**
EE 4.2	Electrical Machines-II	3	1	2	3	100	25	--	25	--	**150**
EE 4.3	Linear Integrated Circuits	3	1	2	3	100	25	--	25	--	**150**
EE 4.4	Digital Integrated Circuits	4	--	2	3	100	25	25	--	--	**150**
EE 4.5	Electrical Circuit Analysis and Synthesis	3	1	--	3	100	25	--	--	--	**125**
EE 4.6	Electrical Power	4	--	--	3	100	25	--	--	25	**150**
TOTAL		**20**	**4**	**8**	**--**	**600**	**150**	**25**	**50**	**25**	**850**

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

THIRD YEAR: ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION

(RC 2016-17)

SEMESTER - V

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.1	Electromagnetic Theory	3	--	--	3	100	25	--	--	--	**125**
EE 5.2	Microprocessor and Interfacing	3	1	2	3	100	25	--	25	--	**150**
EE 5.3	Power Electronics	3	1	2	3	100	25	--	25	--	**150**
EE 5.4	Control Engineering	3	1	2	3	100	25	25	--	--	**150**
EE 5.5	Renewable Energy	4	--	--	3	100	25	--	--	--	**125**
EE 5.6	Electrical Machines-III	3	1	2	3	100	25	--	--	25	**150**
TOTAL		**19**	**4**	**8**	**--**	**600**	**150**	**25**	**50**	**25**	**850**

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

THIRD YEAR: ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION

(RC 2016-17)

SEMESTER - VI

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.1	Power System Analysis	3	1	--	3	100	25	--	--	--	**125**
EE 6.2	Embedded Systems	3	1	2	3	100	25	--	25	--	**150**
EE 6.3	Electrical Drives and Control	4	--	2	3	100	25	--	25	--	**150**
EE 6.4	Electrical Machine Design	3	1	2	3	100	25	25	--	--	**150**
EE 6.5	Electronic Measurements and Virtual Instrumentation	3	1	--	3	100	25	--	--	--	**125**
EE 6.6	Digital Signal Processing	3	--	2	3	100	25	--	--	25	**150**
TOTAL		**19**	**4**	**8**	--	**600**	**150**	**25**	**50**	**25**	**850**

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

FINAL YEAR: ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION

(RC 2016-17)

SEMESTER - VII

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.1	Switchgear and Protection	3	1	--	3	100	25	--	--	--	**125**
EE 7.2	Advanced Drives and Control	4	--	2	3	100	25	--	--	--	**125**
EE 7.3	VLSI Circuit Design	3	1	2	3	100	25	--	25	--	**150**
EE 7.4	Elective - I	3	1	2	3	100	25	--	--	25	**150**
EE 7.5	Elective - II	3	1	2	3	100	25	--	--	25	**150**
EE 7.6	Project	--	--	4	3	--	--	--	--	25	**25**
TOTAL		**16**	**4**	**12**	**--**	**500**	**125**	**--**	**25**	**75**	**725**

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

List of Electives

Elective I		Elective II	
EE 7.4.1	Power System Planning and Reliability	EE 7.5.1	Fuzzy Logic and Neural Networks
EE 7.4.2	HVDC Transmission	EE 7.5.2	Data Communication & Networking
EE 7.4.3	Smart Grid	EE 7.5.3	Image Processing
EE 7.4.4	Operations Research	EE 7.5.4	Statistics and Probability
EE 7.4.5	Electrical Design Estimation and Costing	EE 7.5.5	Advanced Controllers

FINAL YEAR: ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION

(RC 2016-17)

SEMESTER - VIII

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.1	Flexible AC Transmission System	3	1	--	3	100	25	--	--	--	**125**
EE 8.2	PLC and its Applications	3	1	2	3	100	25	--	25	--	**150**
EE 8.3	Elective - III	3	1	2	3	100	25	--	--	25	**150**
EE 8.4	Elective - IV	3	1	2	3	100	25	--	--	25	**150**
EE 8.5	Project	--	--	8	3	--	--	75*	--	75	**150**
TOTAL		**12**	**4**	**14**	**--**	**400**	**100**	**75***	**25**	**125**	**725**

* **Term work in Project is separate Head of Passing**

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

List of Electives

Elective III		Elective IV	
EE 8.3.1	Illumination Engineering	EE 8.4.1	Digital System Design using HDL
EE 8.3.2	Energy Auditing	EE 8.4.2	Biomedical Instrumentation
EE 8.3.3	Micro Grid and Distributed Generation	EE 8.4.3	Wireless Sensor Network
EE 8.3.4	Power System Operation and Control	EE 8.4.4	Advanced Control Systems
EE 8.3.5	Power Quality	EE 8.4.5	Switch Mode Power Converters
EE 8.3.6	High Voltage Engineering	EE 8.4.6	Entrepreneurship Development

EE 5.1 ELECTROMAGNETIC THEORY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.1	Electromagnetic Theory	3	--	--	3	100	25	--	--	--	**125**

Course Objectives:

1. To provide an understanding of electric and magnetic fields.
2. To reveal the role of electric and magnetic field in electrical circuits, electrical machines and in performance of transmission lines.
3. To give a better understanding and develop appreciation of electrical engineering courses, through electric and magnetic field concepts.

Course Outcomes:

On completion of this course, the students will be able to apply the concepts of electric and magnetic field to the other subjects studied by them like Electric circuits, Electrical machines and Electric Power.

UNIT - 1 (12 Hours)

Introduction: Introduction to vector fields, vector analysis and vector calculus.
Concepts of Gradient, divergence and curl and their engineering relevance.
Co-Ordinate systems - Cartesian, Cylindrical, spherical coordinate systems. Differential length, differential surface & differential volume in all coordinate systems. Inter conversion of vectors between coordinate systems. Line, surface and volume integral. Stroke's theorem, Divergence theorem.
Coulomb's law, concept of Electric Field, Electric field due to line, surface and volume charge density.
Electric Flux density, Gauss law and its application. Electrical potential, relation between field & potential, Electric Dipole.

UNIT - 2 (12 Hours)

Electrostatics: Maxwell's Equation for Electric field in integral and point form.
Laplace and Poisson equation, solution of Laplace and Poisson's equation in all coordinate systems.
Capacitance, Method of Images. Boundary conditions between E & D. Polarisation in dielectrics. Energy stored in electric field, energy density.

UNIT - 3 (12 Hours)

Magnetics: Concept of current density. Ohm's law in point form. Magnetic flux & Magnet flux density, Biot-Savart law & applications, magnetic intensity. Ampere's law and applications. Magnetic vector potential. Force and torque experienced by current carrying conductor in magnetic field.

UNIT - 4 (12 Hours)

Magnetic field of Solenoid. Inductance.
Electromagnet induction, Faradays laws and applications.
Maxwell's equation relating magnetic fields in integral and point form.
Displacement current. Fundamentals of Transverse electromagnetic wave, Poynting Vector.

Recommended Readings:

1. J. D. Kraus; Electromagnetic Field; McGraw Hill Publication.
2. S. P. Seth; Element of Electromagnetic Fields; Dhanpat Rai and Sons Publications.
3. W. H. Hayt ; Engineering Electromagnetics; McGraw Hill Publication.
4. Mathew Sadiku; Electromagnetic Engineering; 4TH Edition Oxford University Pres.
5. P. V. Gupta; Electromagnetic field; Dhanpat Rai.
6. W. H. Hayt; Problems & Solution in Electromagnetic; Tata McGraw Hill Publication.

EE 5.2 MICROPRCESSOR AND INTERFACING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.2	Microprocessor and Interfacing	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

1. To familiarize with basic architecture of general microcomputer.
2. To understand the assembly language program of 8086 to be familiar with programming using procedure, Interrupts.
3. To understand the interfacing diagram with memory and additional peripherals.
4. Study the salient features of 80286, 80386 and Pentium processor.

Course Outcomes:

On completion of this course, the students will have a thorough understanding of Architecture of a processor, Instruction sets, Programming in Assembly language.

UNIT - 1 (12 Hours)

Introduction to Microprocessor: Evolution of microprocessor, Introduction to Mainframe, Mini computers, Microcomputers. Block diagram of a typical microcomputer system. CPU, Address bus, Data Bus, Control bus of an 8 bit processor (8085). Basic instruction sets of 8085.

8086 Architecture: Internal block diagram, pin diagram, bus interface unit, execution unit, general purpose registers, flag register, segment registers, instruction pointer, stack pointer, index registers. Concept of physical and effective address. Merits of pipelining, segmentation. Timing diagrams for read and write instructions. Modes of operation – Minimum and Maximum modes.

Assembly Language Programming– Concept of machine language, assembly language high level language, instruction types – data transfer arithmetic, logic, input/output, branching and looping, string instructions. Addressing modes.

UNIT - 2 (12 Hours)

Counters and Delays: Software delay, counters, implementing standard program structures in 8086 Assembly Language: Simple Sequence programs, Jumps, Conditional Jumps, If –Then, If-Then-Else and Multiple If-Then-Else programs, While-do programs, Repeat-Until, Assembler Directives of 8086.

Procedure: CALL and RET instructions along with their formats, functioning of stack with respect to CALL and RET instructions, reentrant and recursive procedures. Macro defining and calling a macro, passing parameters to macros. Procedures versus macro.

Interrupts: 8086 interrupts, interrupt types, software interrupts, hardware interrupts, interrupt priority. 8259 Priority interrupt controller Block diagram, Interfacing to 8086, Initialization Command Words (ICW's), Operational Command Words (OCW's).

UNIT - 3 (12 Hours)

Interfacing: Memory and I/O organization, Memory mapped I/O and I/O mapped I/O, I/O data transfer schemes simple I/O vs. handshake I/O, synchronous vs. asynchronous data transfer, interrupt driven transfer, DMA transfer.

Programmable Peripheral Interfaces: 8255 PPI – Block diagram, various registers, control and status word formats, various modes in detail, interfacing with 8086 and Programming in various modes, Interfacing ADC and DAC with 8086: Necessity, typical interfacing circuit and programming.

8254 Programmable Timer/Counter Interface: Block diagram, Interface connections to 8086, various registers, control word format, modes of operation and applications.

UNIT - 4 (12 Hours)

DMA Controller: Advantages of DMA, 8257 DMA controller - Block diagram, various registers, working - modes of operation (Master and slave mode).

Communciaction: Serial Communication: Serial / Parallel communication concepts, RS232C/RS 485 standard, Baud rate, synchronous and asynchronous formats, USART 8251 - Block diagram, Interface connection, operation and applications.

Keyboard/Display Interface: Various arrangements of keyboards and displays, various scanning and encoding/decoding schemes, necessity of 8279 programmable keyboard/display interface controller, block diagram, working and interfacing 8279 with 8086. Salient features of advanced processor and comparison it with 8086.

Recommended Readings:

1. Douglas V. Hall; Microprocessors and Interfacing; TMH.
2. John F. Uffenbeck; The 8086/8088 family design, programming and interfacing; (PHI).
3. Liu and Gibson; Microprocessor Systems: The 8086/8088 family architecture programming and design; PHI.
4. Barry B. Brey; Intel Microprocessors Architecture and Programming; PHI.
5. M. Rafiquazzaman; Microprocessor and Microcomputer based system; PHI.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Program in 8086 to study various addressing modes.
2. Program in 8086 to find sum and average of n numbers.
3. Program in 8086 to find even and odd number.
4. Program in 8086 to Block transfer and Block exchange operation with/without String Instruction.
5. Program in 8086 ALP to find the square of a number using procedure.
6. Program in 8086 implement bubble sort.
7. Program in 8086 check for a palindrome.
8. Program in 8086 to scan a character in a given string.
9. Program in 8086 to find GCD of two numbers.
10. Interfacing DAC card with 8086 to generate waveforms.
11. Interfacing ADC card with 8086.
12. Interfacing Led's, SWITCHES to 8086 with the help of 8255.
13. Program in 8086 to display character/message using appropriate delay.
14. Study experiments on 8257,8251,8279.

EE 5.3 POWER ELECTRONICS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.3	Power Electronics	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

1. State the principle of working of thyristors and underline their effects on power system.
2. Describe the switching characteristics of power MOSFET, SCR, and other power electronics devices.
3. Illustrate the firing and commutation concepts of SCRs.
4. Analyze AC-AC, AC-DC,DC-DC,DC-AC converters working with different loads connected and Evaluate the performance parameters.

Course Outcomes:

The students are expected to learn different types of switching devices, their control, performance characteristics and applications. They also learn about the principle of commutation of SCRs, the working principles of AC-AC, AC-DC, DC-DC and DC-AC converters and to analyze the working of various types of converter circuits with different types of loads connected across them.

UNIT - 1 (12 Hours)

Power Semiconductor Devices: Applications of power electronics. Thyristors: working, characteristics, two transistor model, firing circuits using op-amps and digital IC'S, commutation.
Power MOSFET: switching characteristics, power IGBT: switching characteristics, power diodes, power transistors, SCRs, DIAC, TRIAC, GTO.

AC Voltage Controllers: Introduction, principle of operation of single phase voltage controllers for R, R-L & R-L-E loads and its applications.

UNIT - 2 (12 Hours)

Phase Controlled Rectifiers: Principles of single phase half controlled and fully controlled converter with R, RL and RLE load, input side harmonics and power factor, Principles of three - phase fully - controlled converter operation with RLE load, Effect of load and source inductances, General idea of gating circuits, single phase and three phase dual converters.

UNIT - 3 (12 Hours)

DC - DC Converters: Introduction, Basic principles of step - down and step - up operation, chopper classification, study of Buck, Boost and Buck- Boost regulators, limitations of single- stage conversion.
Switch mode power supply: Introduction to forward and flyback converters - principle of operation and analysis.

UNIT - 4 (12 Hours)

Inverters: Introduction, principle of operation, performance parameters, single phase series, parallel and bridge inverters with R, RL and RLC loads, three phase bridge inverters - 120 and 180 degrees mode of operation.
Cycloconverters: Principle of operation of single-phase cycloconverters, relevant waveforms, circulating current mode of operation, advantages and disadvantages.

Recommended Readings:

1. M. H. Rashid; Power Electronics - Circuits, Devices and Applications; PHI.
2. P. S. Bimbhra; Power Electronics; Khanna Publishers, New Delhi.
3. Mohan Undeland Robin; Power Electronics - Converters, Applications and Design; John Wiley & Sons.
4. L. Umanand; Power Electronics; Wiley India Pvt Ltd.
5. P. C. Sen; Power Electronics; Tata McGraw - Hill Publishing Company Ltd.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. SCR characteristics.
2. Power MOSFET and IGBT characteristics.
3. Commutation circuits (class A, B, C).
4. Single phase half controlled converter.
5. Single phase Full controlled converter.
6. AC voltage converter using TRIAC.
7. Single phase cycloconverter.
8. Parallel bridge inverter.
9. Series inverter.
10. DC Chopper.
11. DC-DC buck boost converter.
12. Simulation of single phase fully controlled converter with R-L-E load.
13. Simulation of single phase voltage source inverter with R and RL load.
14. Single phase Dual converter.

EE 5.4 CONTROL ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.4	Control Engineering	3	1	2	3	100	25	25	--	--	**150**

Course Objectives:

1. To familiarize with the basic elements of control systems, their characteristics and the controllers.
2. To understand the input output relation and analyze the system in time and frequency domain.
3. To understand the stability analysis of the control systems in frequency and time domain.
4. To design a compensator in time and frequency domain.

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Course Outcomes:

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

1. Understand the open loop and closed loop systems and various servo components.
2. Understand the Time response of linear first order and linear second order systems, time domain performance and steady state errors.
3. Understand the Stability of linear feedback systems.
4. Analyze frequency Response methods.
5. Compensate a system in time and frequency domain.

UNIT - 1 (12 Hours)

Control Systems: Basic definition and elements of open loop and closed loop control systems. Types of feedback control systems, linear time variant and time invariant systems, non-linear systems, adaptive control systems.
Servo Systems Components: Servo amplifiers, controllers (PI/PD/PID), DC servomotors, armature control and field control, AC servomotor, Synchros, Stepper motors. Mathematical models of systems. Differential equations of physical systems - electrical and mechanical systems.

UNIT -2 (12 Hours)

Transfer Function: Overview of Laplace Transforms, Transfer functions of linear systems. Block diagram reduction techniques, Signal flow graphs, Mason's gain formula.
Time response: Linear first order and linear second order systems. Time domain performance specifications, steady state error of feedback control systems, error constants and error series.

UNIT -3 (12 Hours)

Time domain Response: Stability of linear feedback systems, concept of stability, Routh-Hurwitz stability criterion. Root locus concept, Root locus methods and rules for construction of Root loci.
Frequency Domain response: Frequency Response, Bode plots, Polar plots.

UNIT -4 (12 Hours)

Frequency Domain response: Nyquist stability criterion, relative stability, gain margin, phase margin, M and N circles, Nichols chart.
Design: Preliminary design considerations, lead compensation, lag compensation, lag-lead compensation. Compensator design in time and frequency domain.

Recommended Readings:

1. K. Ogata; Modern Control Engineering; PHI Publication
2. I. J. Nagath and M. Copal; Control Systems Engineering; New Age Publisher.
3. M. Gopal; Control Systems; TMH Publication.
4. B. C. Kuo; Automatic Control System; PHI.
5. Norman Nise; Control System Engineering; Wiley Edition.

List of experiments

(At least 8 experiments should be conducted from the list of experiments.)

1. Speed Torque characteristics of AC servomotor.
2. Characteristics of DC servomotor.
3. Study of stepper motor.
4. Characteristics of Synchro transmitter, transmitter-receiver and error detector.
5. DC motor transfer function.
6. Effect of PD, PI and PID controller on second order system.
7. Determination of DC motor gain constants.
8. Transfer function of DC servomotor.
9. Study of control system components.
   Simulations on MATLAB/Scilab.
10. Modelling a DC servomotor with armature and field control.
11. Time domain response for various Wn and ξ of a second order system.
12. Time domain specification of a second order system.
13. Plotting Root locus of a given transfer function.
14. Plotting Bode plot of a given transfer function.
15. Plotting Nyquist plot of a given transfer function.
16. Plotting phase magnitude plot of a given transfer function.
17. Design of Lead, Lag and Lead-Lag compensation circuit for a given transfer function. Analyze step response by simulation.

5.5 RENEWABLE ENERGY SYSTEMS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.5	Renewable Energy Systems	4	--	--	3	100	25	--	--	--	**125**

Course Objectives:

1. To understand types and applications of various forms of renewable energy and its environmental impacts.
2. To identify the new methodologies / technologies for effective utilization of renewable energy sources.
3. To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications.
4. To do analysis of the environmental and cost economics of using renewable energy sources compared to fossil fuels.

Course Outcomes:

On completion of this course, the students will be able to understand different forms of Renewable Energy sources. They will be able to do environmental, economic assessment of the resources used. Course will be useful to design the renewable energy systems for power generation and other energy uses for domestic and industrial applications

UNIT - 1 (16 Hours)

Introduction: World energy use, reserves of energy resources, environmental aspects of energy utilization, concepts of non conventional energy sources, criteria for assessing the potential of NCES, renewable energy scenario in India and around the world, potentials, achievements / applications, classification of NCES, solar, wind, geothermal, biomass, ocean, tidal, wave energy sources, comparison of these energy sources, economics of renewable energy systems, comparative analysis of renewable and non renewable energy sources, limitations of renewable energy systems.

UNIT - 2 (16 Hours)

Solar Energy: Energy available from sun, solar radiation data, solar radiation on tilted surface, instruments for measuring solar radiation, solar energy conversion into heat, flat plate and concentrating collectors, principle of natural and forced convection, orientation and thermal analysis of solar collectors.

PhotoVoltaics: P-N junctions. solar cells, PV systems, calculation of energy through photovoltaic power generation. Standalone and grid connected solar PV systems.
Photovoltaic applications: Battery charger, domestic lighting, street lighting, water pumping and power generation schemes.

UNIT - 3 (16 Hours)

Wind Energy: Energy available from wind, general formula, lift and drag. Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed estimation, Betz limit. Horizontal axis and vertical axis rotors, aerodynamics of wind turbine rotor, determination of torque coefficient, site selection, wind resource assessment.
Wind Turbine Generators: Induction, synchronous machines, constant V & F and variable V & F generations, reactive power compensation, integration of wind energy converters into grid, working principle of wind power plant.

UNIT - 4 (16 Hours)

Other Types of Energy resources: Fuel cell :- Principle of working, various types , construction and applications.
Mini and Microhydel Power (MHP) Generation: Classification of hydel plants, concept of micro hydel, merits. MHP plants: Components, design and layout, turbines, efficiency, integrated energy systems and their cost benefit analysis. Principles of ocean and tidal energy conversion. Biomass resources and their classification, biomass conversion processes, thermo chemical conversion, direct combustion, gasification, pyrolysis and liquefaction.

Recommended Readings:

1. G. D. Rai; Non Conventional Energy Sources; Khanna Publishers.
2. J. W. Twidell and A. Weir; Renewable Energy Sources; Taylor & Francis, CRC press.
3. S. P. Sukhatme; Solar energy; Tata McGraw Hill Publishing Company Ltd, PHI Learning Private Limited.
4. Chetan Singh Solanki; Solar Photovoltaics Fundamentals, Technologies and Applications; Prentice hall India ltd.
5. D. P. Kothari & K. C. Singhal; Renewable energy sources and emerging technologies; Prentice hall India ltd.

EE 5.6 ELECTRICAL MACHINES -III

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 5.6	Electrical Machines -III	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

5. To introduce concepts of various types of synchronous and special electrical machines, do mathematical analysis and understand application of these machines.
6. To study the working principles of synchronous machines as generator and motor , determination of their no load/load characteristics, testing, starting and analyzing methods of speed control of motors, performance characteristics.
7. To familiarize the constructional details, the principle of operation, prediction of performance, the methods of testing the Synchronous and other machines.
8. To impart Industry oriented learning.

Course Outcomes:

On completion of this course, the students will know the working principle, performance characteristics, mathematical analysis, control and application of different synchronous and special machines. They will have an ability to design and conduct experiments as well as identify, formulate and solve machine related problems.

UNIT - 1 (12 Hours)

Synchronous Generators: Construction, types, EMF and torque equation. Basic synchronous machine model, Circuit model of synchronous machine. Space and time phasor diagrams for generator operation under no load and load conditions. Synchronous impedance, determination of synchronous reactance using OCC and SCC. Armature reaction and leakage reactance, nature of armature reaction in synchronous generators and motors. EMF, MMF and Potier method for determining voltage regulation. Operating characteristics of generators, variable excitation with constant load, Power angle diagram, Different methods of synchronization with bus.

UNIT - 2 (12 Hours)

Synchronous Motors: Construction, starting methods of synchronous motor, use of damper bars, power input and power developed equations, complete phasor diagrams under various power factors and expression of power, circle diagram, O-curves and V-curves and their implications. Effect of excitation variation. Stability of synchronous motor, swing equation, hunting and equal area criteria, synchronous condenser. Difference between Induction and Synchronous motor, applications of synchronous motors.

UNIT - 3 (12 Hours)

Salient Pole Synchronous Machine & Linear Transformation: Blondel's two reaction theory, direct axis and quadrature axis synchronous reactance. Phasor diagrams under different power factor conditions and expression for power for generator and motor modes, reluctance power and phasor diagram with zero excitation for generator and motor modes, slip test to estimate direct axis and quadrature axis synchronous reactances, qualitative analysis of sudden short circuit phenomenon of synchronous generator.

Linear Transformation of Machines: Transformation from rotational axis to stationary axis, Park transformation, Clarke transformation. .

UNIT - 4 (12 Hours)

Single Phase AC & Special machines: Construction, performance, characteristics and applications of single phase synchronous motors, hysteresis motor, reluctance motor and universal motor.

Constructional Features, EMF, Torque Equation and Torque Speed Characteristics of Special Machines : PMDC motor, switched reluctance motor, permanent magnet synchronous motor, BLDC motor..

Recommended Readings:

1) I. J. Nagrath & D. P. Kothari; Electrical Machines; Tata McGraw Hill.
2) P. S. Bimbhra; Electrical Machinery; Khanna Publishers.
3) J. B. Gupta; Theory & Performance of Electrical Machine; Kataria & Sons
4) M. G. Say; Theory, Performance & Design of A.C. Machines; CBS Publishers.
5) Langsdorf A. S.; Theory of A.C. Machinery; Tata McGraw Hill
6) A. E. Fitggerald, C. Kingsley Jr. and Umans; Electric Machinery; McGraw Hill, International Student Edition.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. OC and SC test on three phase alternator
2. Load test on three phase alternator
3. Slip test on three phase alternator
4. Parallel operation of three phase alternator
5. Slip test on three phase alternator
6. Zero power factor characteristic of three phase alternator
7. Performance characteristics of synchronous motor.
8. To determine V curves of synchronous motor
9. Load test on universal motor
10. Performance characteristics of PMDC/ BLDC motor

EE 6.1 POWER SYSTEM ANALYSIS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.1	Power System Analysis	3	1	--	3	100	25	--	--	--	**125**

Course Objectives:

1. To model the power system under steady state operating condition.
2. To model and analyze the system under faulted condition.
3. To apply numerical methods to solve the power flow problem.
4. To develop conceptual understanding of the economic operation of power system.
5. To model and analyze the transient and dynamic behavior of power system when subjected to disturbances.

Course Outcomes:

On completion of this course, the students will be able to model and analyze the power system under steady state and transient conditions. They will be able to solve the power flow problems and economic scheduling problems. They will be able to do fault analysis.

UNIT - 1 (12 Hours)

Basic components of power system, their models, Single line diagram, impedance diagram, reactance diagram, Per unit system, equivalence of per unit impedance of transformer on LT and HT side, change of base.
Symmetrical components, resolution of symmetrical components, Sequence networks, Determination of zero sequence network of transformers, Formation of sequence networks of power system, sequence voltages of Generator.

UNIT - 2 (12 Hours)

Fault analysis – Faults on power system, Analysis of symmetrical balanced three phase fault, short circuit MVA, computation of short circuit capacity and fault currents.
Current limiting reactors – functions, selection and location in power system.
Representation of unsymmetrical faults – Single line to ground fault, line to line fault and double line to ground fault. Their analysis using sequence networks.
Control of voltage profile. Introduction to reactive power control.

UNIT - 3 (12 Hours)

Load flow analysis – Neccessity of load flow studies, Classification of Buses, Formation of Y_{BUS} by singular transformation.
Static load flow equations, Gauss-Seidal method – with PV bus present and absent, Q-limit check for voltage controlled buses. Newton Raphson method – with PV bus present and absent, Q-limit check for voltage controlled buses.
Economic Load Dispatch – Neglecting losses and Generator limits, Neglecting losses and including generator limits. Transmission loss coefficients, penalty factor.

UNIT - 4 (12 Hours)

Power system stability analysis – Importance of stability studies, Classification of Power system stability- steady state stability, transient stability and Dynamic stability.
Maximum steady state power transfer, Power angle equation, Power angle curve, Methods of improving steady state stability.
Rotor dynamics, constants of rotor, swing equation, swing curve, synchronizing power coefficients.
Equal area criterion, Critical clearing angle, Multimachine stability.
Factors affecting transient stability and methods for its improvement.

Recommended Readings:

1. I. J. Nagrath and D. P. Kothari; Modern Power System Analysis; Tata McGraw Hill.
2. Hadi Sadaat; Power System Analysis; Tata McGraw Hill.
3. Stevenson W.D. Jr and Grainger; Elements of Power System Analysis; Tata McGraw Hill.
4. C. L. Wadhwa; Electrical Power Systems; New Age International.
5. B M Weedy; Electrical Power Systems; John Wiley and Sons.
6. M. A. Pai; Computer Techniques in power system; Tata McGraw Hill.
7. B R Gupta; Electrical Power System; S. Chand and Company Ltd.
8. P Kundur; Power System Stability and Control; Tata McGraw Hill.

EE 6.2 EMBEDDED SYSTEMS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.2	Embedded Systems	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

1. To familiarize the students with 8051 and ARM 7 microcontroller architecture, Programming, interfacing and applications.
2. To introduce the concepts of Real Time Operating Systems
3. To introduce the concepts of PLCs.
4. To equip students with skills for designing embedded based control systems

Course outcomes:

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

1. Understand the concept of Embedded System and real time operating systems.
2. Familiarize with the architecture of 8051 microcontroller, its interfacing and applications.
3. Understand detailed architecture of ARM7 microcontroller, its instruction set, operating modes and interfacing
4. Apply the interfacing concepts to designing embedded system based control for projects.
5. Understand RTOS and scheduling techniques.
6. Understand the PLC architecture and programming.

UNIT - 1 (12 Hours)

Introduction to embedded systems:
Definition and Characteristics of Embedded systems, Overview of processors and hardware units in an embedded system, Software elements, Concept of Real time Systems, Challenges in Embedded System Design.

Embedded System Architecture:
Instruction Set Architecture: CISC and RISC instruction set architecture, Harvard and Princeton architecture.

Architecture of 8051:
Functional block diagram, Hardware description -Register structure, Memory organization, SFR memory map, Addressing modes, Boolean processing, 8051 Instruction set, simple programs, I/O port configuration, Serial port configuration and programming.

UNIT - 2 (12 Hours)

8051 Microcontroller:
Timers/Counters configurations and programming, Interrupts structure and interrupt based Programming
Interfacing and applications of 8051 micro controller:
Keypad interfacing, LED interfacing, Seven segment interfacing, LCD interfacing, ADC and DAC interfacing, Stepper motor interfacing, Relays and sensors interfacing, Automobile turn indicator, Small dc motor control, AC power control. Software simulations: Writing assembly language and C programs.

UNIT - 3 (12 Hours)

ARM 7 Architecture:
Detailed architecture, Block diagram, various registers, operating modes.
ARM Instruction set:
Data processing instructions, branching instructions, arithmetic and logical instructions, data transfer instructions, coprocessor data operations Addressing modes, simple programs.
ARM micro controller Interfacing:
LED interfacing, Seven segment interfacing, LCD interfacing and DAC interfacing.

UNIT - 4 (12 Hours)

RTOS Concepts:
Introduction, Necessity, scheduling in real time operating systems, Priority Inversion and Deadlock in RTOS.
Communicating between Tasks:
Intertask communication and synchronization, Messages and message queues, Semaphores, Intertask communication via messages and semaphores

Recommended Readings:

1) Mazidi; The 8051 Microcontroller and embedded systems using assembly and C; PHI.
2) Hackworth; Programmable Logic Controller; Pearson Edition.
3) Raj Kamal; Embedded Systems, Architecture, Programming and Design; Tata Mc. Graw Hill
4) David Seal; ARM Architecture Reference Manual; Second Edition; Addison-Wesley.
5) Predko; Programming and customizing 8051 Microcontroller; Tata McGraw Hill.
6) Ayala; 8051 Microcontroller Architecture and Programming; Penram International Publisher.
7) http://www.freertos.org/tutorial/
8) NPTEL course materials

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Introduction to UMPS, Keil and Flash Magic
2. Alternate glowing of LEDs
3. Traffic light control
4. Timer programming
5. Interrupt programming
6. Serial programming
7. Seven segment display interfacing to 8051
8. LCD interfacing to 8051
9. Stepper motor interfacing to 8051
10. DAC interfacing to 8051
11. ADC Interfacing to 8051
12. DC motor interfacing to 8051
13. Sensor interfacing to 8051
14. Study of arithmetic & logic instructions for ARM
15. Flashing LEDs using ARM controller
16. LCD interfacing to ARM
17. Seven segment display interfacing to ARM
18. DAC interfacing to ARM
19. Scheduling Tasks using RTOS
20. PLC ladder programming to implement a logic function
21. Simulation of various flip-flops using PLC ladder
22. Simulation of washing machine control using PLC ladder.

EE 6.3 ELECTRICAL DRIVES AND CONTROL

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.3	Electrical Drives and Control	4	--	2	3	100	25	--	25	--	**150**

Course Objectives:

5. Illustrate the steady state operation and transient dynamics of a motor load system
6. Analyze the operation of the converter, chopper fed DC drive
7. Familiarize with the starters and controllers for DC and AC motors
8. Understand the applications of electrical drives

Course Outcomes:

The students will be able to understand the basic concepts of electrical drives, control of DC and AC drives. They will also be able to learn motor starters and controllers using various relays and also study the industrial applications

UNIT - 1 (16 Hours)

General concept of Electric drives: Classification of electric drives, Advantages of electric drives, components of electric drives, choice of electric drives, Selection of motor power rating, Thermal model of motor for heating and cooling, calculation of motor rating for various types of duty cycles. Dynamics of Electric drives, fundamental torque equation, speed torque equation of DC and AC motors, speed torque conventions, multiquadrant operations, Components of load torques, load equalisation.

Types of braking: Dynamic braking, counter current braking, Regenerative Braking of DC and AC motors. Classification of control schemes, manual control, semiautomatic control, automatic control.

UNIT - 2 (16 Hours)

Control of DC Drives: Basic parameters, operating modes, motoring modes, Braking modes, schemes for DC motor speed control, buck boost control, single phase, three phase fully controlled, half controlled DC drives, dual converter control,chopper controlled DC motor drives

Control of AC Motor Drives: Basic parameters, speed control of induction motor drives, pole changing Induction motor drives, stator frequency variation. Speed control of slip ring induction motors, stator voltage variation, rotor resistance variation, slip power recovery, eddy current drives, variable voltage variable frequency control. Speed control of Synchronous motor, input frequency variation, starting of large synchronous motor.

UNIT - 3 (16 Hours)

Motor starters and controllers: DC motor starters, starters using voltage sensing relays, current sensing relays, time delay relays, starters using frequency relays.
DOL starters with provision for speed reversal, Autotransformer starters, Rotor resistance starters, Master controller for wound rotor Induction motors, starting, plugging and speed reversal, starters for two speed pole changing induction motor. Starters for two winding two speed pole changing induction motor with provision for speed reversal (constant Torque), starter for single winding two speed pole changing Induction motor with provision for speed reversal, constant horsepower.

UNIT - 4 (16 Hours)

Industrial applications: Layout of electric drives, Application of Synchronous motor, Induction motor (squirrel cage/ wound rotor), DC motor for electric drives, Suitable electric drives for Rolling mills, Textile mills, Lathe Machines, Drilling Machines, Milling machines.
Electric traction: Tractive effort, requirements of Electric traction, suitability of different types of motors, coefficient of Adhesion, supply systems, train movement, speed control, traction in metro systems

Recommended Readings:

1) Gopal K Dubey; Fundamentals of Electric Drives; Narosa publishing House.
2) Nisit K De, Prashanta K Sen; Electric Drives; PHI publication.
3) S.K.Pillai; A First course on Electrical Drives ;New Age International publishers
4) Mohammed A EL-Sharakawi; Electric Drives; Vikas Publishing house
5) V Subramanayam; Electric Drives-Concepts and applications; Tata McGraw Hill publication
6) Alexander Fransua and others; Electric Machines and Drive system; Technical Press, London
7) R. Krishnan; Electric motor drives-Modelling Analysis and Control; PHI India

List of experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. To determine constants of DC shunt motor.
2. Determination of moment of inertia.
3. Dynamic braking of synchronous motor.
4. Dynamic braking of three phase squirrel cage induction motor.
5. Dynamic braking of DC shunt motor.
6. Counter current braking of DC shunt motor.
7. Capacitor braking of three phase induction motor.
8. Dynamic braking of single phase motor(shaded pole and capacitor motor).
9. Counter current braking of three phase squirrel cage induction motor.
10. Ward Leonard method of speed control.
11. Speed control of universal motor using single phase half controlled bridge rectifier.

EE 6.4 ELECTRICAL MACHINE DESIGN

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.4	Electrical Machine Design	3	1	2	3	100	25	25	--	--	**150**

Course Objectives:

6. To study MMF calculation and thermal rating of various electrical machines.
7. To design core, yoke, windings and cooling systems of transformers.
8. To design stator and rotor of induction machines.
9. To design stator and rotor of synchronous machines.
10. To design armature and field systems for D.C. machines.
11. To optimize the design using computers.

Course Outcomes:

On completion of this course, the students will be able to calculate the MMF and thermal ratings of various electrical machines. They will be able to design the stator and rotor of Induction and Synchronous machines. They will also be able to design the core, yoke, windings and cooling system for transformers and also armature and field system for DC machines.

UNIT - 1 (12 Hours)

Principles of Electrical Machine design: Considerations for the design of Electrical machines, limitations, Different types of materials and insulators used in electrical machines.

Various configurations of slotting, MMF calculation for teeth, Real and Apparent flux densities, Leakage reactance of transformers.

Temperature rise calculations, Rating of machines, Determination of motor rating, Cooling of rotating electrical machines, Quantity of cooling medium employed.

UNIT - 2 (12 Hours)

Design of Transformers: Output equations for Single phase and three phase transformers, Ratio of iron loss to copper loss, Design of the core, Choice Flux density and Current density, Types of Windings, estimation of number of turns and conductor cross sectional area of Primary and secondary windings.

Design of insulation, Window dimensions, No-load current calculations, Temperature rise of transformers, Transformer oil as a cooling medium, Design of tank and cooling tubes (round and rectangular).

UNIT - 3 (12 Hours)

Design of Induction motor : Output Equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring induction motor, estimation of No load current.
Design of synchronous machine : Output equation, Choice of specific loadings, short circuit ratio, Length of air gap, Number of stator slots, methods of eliminating harmonics, Field design for salient poles.

UNIT - 4 (12 Hours)

Design of DC Machine: Output equation, choice of specific loadings, Constraints in the design of DC machines.
Armature Design, Design of the Field system, Tentative design of Field winding, Design of commutator and brushes, design of yoke and poles- main and inter poles.
Computer Aided Design of Electrical Machines: Design optimization using computers.

Recommended Readings:

1. A. K. Sawhney; Course in Electrical Machine design; Dhanpat Rai and Sons Publication.
2. V. N. Mittle; Design of Electrical Machines; 4th Edition, Dhanpat Rai and Sons Publication.
3. M. G. Say; Performance And Design Of AC Machines; CBS Publishers and Distributors Pvt. Ltd.
4. M. V. Deshpande; Design and Testing of electrical Machines; Wheeler Publications.
5. R. K. Agarwal; Principles of electrical machine Design; Esskay publication.
6. Ramamurthy M; Computer aided design of Electrical equipment; East West Press.
7. A. Shanmugasundarm, G.Gangadharan, R.Palani; Design Data Handbook; Wiley Eastern Ltd.
8. S. K. Sen; Principles of electrical machine design with computer programs; Oxford and IBH publishing co. 1987
9. A. E. Clayton, Hencock; Performance and design of DC machines; CBS Publisher and Distributors Pvt. Ltd.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Design and assembly of single phase low rating transformer.
2. Design of core stamping layout using Qcad.
3. Design of 1 phase and 3 phase core type transformer layout using Qcad.
4. Design of 1 phase and 3 phase shell type transformer layout using Qcad.
5. Design of transformer core section layout using Qcad.

6. Design of transformer cooling arrangement for air cooled transformer layout using Qcad.
7. Design of transformer cooling arrangement for oil cooled transformer layout using Qcad.
8. Design of transformer winding layout using Qcad.
9. Design of 3 phase induction motor.
10. Drawing of 3 phase induction motor-stator mush winding, using Qcad.
11. Drawing of 3 phase squirrel cage induction motor rotor, using Qcad.

EE 6.5 ELECTRONIC MEASUREMENTS & VIRTUAL INSTRUMENTATION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.5	Electronics Measurements &Virtual Instrumentation	3	1	-	3	100	25	-	-	-	**125**

Course Objective:

1. To understand and study working of analog and digital instruments.
2. To study working principle of digital storage oscilloscopes, frequency meters and phase meter.
3. To study operation of special measuring instrument such as Q-meter, signal generator and different signal analyzers and emphasize on transducers.
4. To understand the basics of virtual instrumentation and its programming.

Course Outcomes:

On completion of this course, the students will know the working principle, performance characteristics of various Electronic Instruments. They will have an ability to select appropriate transducers for measurement. They will able to develop virtual instruments of any specific application.

UNIT – 1 (12 Hours)

Electronic Analog Voltmeter: Electronic DC Voltmeter, Electronic AC voltmeter, balanced bridge, peak responsive and RMS responsive voltmeters, logarithmic voltmeters, differential voltmeters. Electronic millimeters, considerations in choosing an analog voltmeter. Vector impedance meter, vector voltmeter, PH meter.

Digital Instruments: Operating principles of DVM using successive approximation, Microprocessor based DMM with Auto ranging and self diagnostic features, V/F conversion and Integrating, principles. Digital method for frequency, phase, time and period measurements.

UNIT – 2 (12 Hours)

Cathode Ray Oscilloscope: General purpose CRO, advanced types, block diagram of digital storage Oscilloscope. Use of CRO for voltage, current, frequency and phase measurement. circular time base ,velocity and intensity, modulation. Dual trace and double beam CRO.

Frequency Meters: Introduction, elements of counting and digital display, elements of analog frequency meter. Time-base and associated circuits. Electronic counter as frequency, time period and time interval measuring device, universal counter-timer.

Heterodyne principle. Analog phase meter (phase detector as phase meter), analog phase meter using Flip-flops. Digital phase meter.

UNIT – 3 (12 Hours)

Q-Meters: Basic concept, measurement methods, direct connection, series and parallel connection, sources of error in measurement of Q. Signal Generators: AF and RF Oscillators and signal generators. Laboratory type pulse and square wave generators, standard signal generators. Function generators.

Signal Analysis: Wave Analyzers, Harmonic distortion analyzers, spectrum analyzers.

Transducers: Principles, classification, Guidelines for selection, Requirements, Types and Application of Transducers, Resistance, Capacitance, inductance Transducers, Potentiometer, Strain gauges, LVDT, Piezo Electric transducers, Resistance Thermometers, Thermocouples, Thermistors, Photosensitive Device, Capacitive transducer, Hall Effect transducers.

UNIT – 4 (12 Hours)

Virtual Instrumentation: Virtual instrumentation, Definition, flexibility – Block diagram and architecture of virtual instruments ,Virtual instruments versus traditional instruments. Review of software in virtual instrumentation , VI programming techniques , VI , sub VI, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, string and file input / output.

Signal Conditioning and acquisition: Signal conditioning, signal transmission methods; Data loggers, PC based data acquisition systems, Interfacing and bus standards. Data Acquisition Card: DAQ cards for VI applications ,Requirements , DAQ modules with serial communication , Simulation of Various application using Labview..

Recommended Readings:

1) Kalsi H.S; Electronic Instrumentation ;TMH
2) W. D. Cooper; Electronic Instrumentation and measurement technique; PHI
3) Gary Johnson; LAB VIEW Graphical Programming, , second edition; McGraw Hill
4) A.D. Helfrick, Cooper; Modern Electronic Instrumentation and measurement; PHI
5) A. P. Malvino; Electronic Instrumentation Fundamental;TMH
6) Robert Bishop; LABVIEW Express; PHI

EE 6.6 DIGITAL SIGNAL PROCESSING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 6.6	Digital Signal Processing	3	-	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To familiarize the students with signals and systems, their properties and apply them to signal processing.
2. Analyze the analog and discrete signals using various transformations.
3. To design and implement IIR and FIR filters .

Course Outcomes:

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

1. Understand the basics of Signals and systems
2. Understand the properties of Linear time invariant systems
3. Analyse signals using State Variable Techniques, Fourier transforms, Z-transforms
4. Design and implement IIR and FIR filters
5. Evaluate the DFT and FFT of a sequence

UNIT - 1 (12 Hours)

Signals and systems: Continuous time and discrete time signals, transformation of signals, types of signals, unit impulse and unit step functions, Examples of systems, interconnection of systems, linear time invariant systems, properties, convolution, correlation.Causal LTI systems described by differential and difference equations.
Discrete time signals: A/D conversion, sampling, impulse train sampling model, data reconstruction, quantizing and encoding.

UNIT - 2 (12 Hours)

State variable analysis: State equations, representation, state equations for electrical network, state model from transfer function, derivation of transfer function from state model, similarity transformation, state transition matrix, solution of non-homogeneous state equations.
Fourier transforms: Fourier integral, Fourier transform, properties of Fourier transform, Fourier transform of power and energy signals.Solution of system characterized by linear constant coefficient differential equation.

UNIT - 3 (12 Hours)

Z transforms: Definitions, Properties of Z-Transforms, Inverse Z-transforms by partial fraction, power series and inversion integral methods, difference equations.
Filters: Structures for FIR and IIR systems- Direct, parallel and cascade. Design of FIR filters-Magnitude and phase response of high pass,low pass, band pass and band reject filters. Design of linear phase FIR filters using frequency sampling, windowing. Design of IIR filters-IIR filter design using bilinear transformation. Design of low pass Butterworth filter

UNIT - 4 (12 Hours)

Discrete Fourier Transform(DFT): DFT as a linear transformation, relationship of DFT to other transforms, properties of DFT, linear filtering methods based on DFT
Fast Fourier Transform (FFT): Decimation in time , decimation in frequency FFT: radix 2 and mixed radix algorithms, applications of FFT in linear filtering and correlation.

Recommended Readings:

1. Oppenheim and Willskay, Hamid Nawab; Signals and Systems; Prentice Hall of India
2. Simon Haykin and Barry Van Veen; Signals and system; John Weily and Sons
3. John G Proakis, Dimitris Manolakis; Digital Signal Processing; Prentice Hall of India
4. Vinay K.Ingle, John G.Proakis; Digital Signal Processing-A MATLAB based approach
5. Linder; Introduction to signals and system; McGraw Hill
6. Nagrath,Sharan, Rajan and Kumar; Signals and system; McGraw Hill
7. S Salivahanan ,A Vallavaraj, C Gnanapriya; Digital Signal Processing;McGraw Hill
8. Sanjeet Mitra ;Digital signal processing using MATLAB; TMH, 2001

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

Software experiments on MATLAB/SCILAB

1. Representation of basic signals
2. Transformation on signals
3. Discrete convolution
4. Discrete correlation

5. Verification of Sampling theorem
6. Solving a given difference equation
7. Computation of N point DFT of a given sequence and to plot its magnitude and phase spectrum
8. Design and implementation of analog and discrete IIR Butterworth filter to meet the given specifications
9. FIR filter design using windowing techniques
10. State space representation
11. Computing inverse Z-transform of a rational function
12. Simulation of function generator and CRO using LABVIEW
13. Simulation Temperature recording using LABVIEW
14. Simulation of Washing Machine control using LABVIEW
15. File handling using LABVIEW

Hardware Experiments on DSP processor

16. Linear Convolution of two sequences
17. Circular Convolution of two sequences
18. Computation of N-Point DFT of a Sequence
19. Impulse Response of First Order and Second Order System
20. Filter Design
21. FFT implementation

EE 7.1 SWITCHGEAR AND PROTECTION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.1	Switchgear and Protection	3	1	--	3	100	25	--	--	--	**125**

Course Objectives:

9. To understand the concept of protective relaying.
10. To study the different protection systems for alternator, transformer and motor
11. To familiarize with the protection of transmission lines and bus bars and protection against lightning
12. To study the difference between fuses and circuit breakers and its working.

Course Outcomes:

The students will be able to understand the basic concepts of protective relaying. They will also be able to learn different protection for alternator, transformer, motor, transmission lines ,bus bars and protection against lightning.

UNIT - 1 (12 Hours)

Protective Relays: Fundamental requirements of protective relaying, Basic relays - Electromagnetic,Induction type over current relays, IDMT relays.
Directional relays, Distance or Impedance relay, relay setting and operating time. Salient features ofNumerical relays, Numerical protection.
Static and Digital relaying: Overview of static relay, block diagram, operating principle, merits and demerits of static relay, introduction and block diagram of numerical relay, sampling theorem, anti-Aliasing filter, block diagram of PMU.

UNIT - 2 (12 Hours)

Differential protection of alternator: Earth fault protection, restricted earth fault protection, stator sensitive earth fault protection, leakage to frame protection, protection against unbalanced loads.
Protection of transformers: Differential protection, over current and earth fault protection, restricted earth fault protection, gas actuated devices used for protection, thermal protection, over fluxing protection.
Protection of motors: Protection of 3 phase motors against over current, protection against singlephasing and phase reversals, rotor protection against rotor faults.

UNIT - 3 (12 Hours)

Protection of transmission lines and bus bars: Time graded protection, current graded protection, distance protection, plain impedance protection, directional impedance relay, reactance relay, mhorelay, carrier assisted distance protection, carrier current protection.

Realization of distance relays (impedance, reactance and mho relay) using numerical relaying algorithm (flowchart, block diagram), Introduction to Wide Area Measurement (WAM) system.

Protection against lightning: causes of over voltages, mechanism of lightning, insulation coordination, types of lightning arrestors, surge absorbers, neutral earthing, types of neutral earthing, isolator earthing switch.

UNIT - 4 (12 Hours)

Fuses: Desirable characteristics of a fuse element, types of fuses and their constructional features, difference between fuse and circuit breakers. Selection of fuses.

Theory of circuit breakers: Fundamental of fault clearing, switching phenomena in circuit breakers, arc formation and arc extinction in circuit breakers, rating of circuit breakers.

Types of circuit breakers: Construction and principle of arc extinction in air break circuit breakers, air blast circuit breakers, minimum oil circuit breakers, SF6 gas circuit breakers, vacuum circuit breakers. Difference between MCB and MCCB, switch fuse unit and fuse switch unit.

Recommended Readings:

1. Sunil S. Rao; Switchgear and Protection; Khanna Publisher
2. Paithankar YG & Bhide SP; Fundamentals of Power System Protection; PHI.
3. S. Badriram; Power system Protection; TMH
4. M V Deshpande; Switchgear and Protection; TMH
5. Ravindranath and Chander; Power system protection; New Age
6. T. S. Rao; Power system Protection static Relays with microprocessor application; TMH

EE 7.2 ADVANCED DRIVES AND CONTROLS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.2	Advanced Drives and Controls	4	--	2	3	100	25	--	--	--	**125**

Course Objectives:

1. To understand various operating regions of the induction motor drives.
2. To study and analyze the operation of VSI & CSI fed induction motor control.
3. To understand the speed control of induction motor drive from the rotor side.
4. To understand the field oriented control of induction machine.
5. To understand the control of synchronous motor drives.
6. To analyze the design considerations of BLDC motor drive

Course Outcomes:

On completion of this course, the students will be able to operate the induction motor in its various regions of operation. They will be able to design the various speed control schemes. They will also be able to design the control schemes for synchronous motors and BLDC motors.

UNIT - 1 (16 Hours)

Introduction to Induction motor drives: Induction Motor rotating magnetic field, torque production, equivalent circuit, speed torque characteristics, variable voltage constant-frequency operation, variable frequency operation, constant voltage /frequency operation, variable voltage, variable frequency operation, variable stator current operation, different braking methods.

UNIT - 2 (16 Hours)

Scalar control-voltage fed inverter control: open loop volts/Hertz contro, speed control with slip regulation, speed control with torque and flux control. Current controlled voltage fed inverter drive. Current fed inverter control- independent current and frequency control, speed and flux control in current fed inverter drive, volts/Hertz control of current fed inverter drive.

AC voltage controller circuit, six step inverter voltage control, closed loop variable frequency PWM inverter with dynamic braking, CSI fed IM variable frequency drives comparison.

UNIT - 3 (16 Hours)

Induction motor speed control by rotor resistance, speed control with rotor circuit chopper. Static Kramer drive- slip power recovery, phasor diagram, torque expression, speed control, commutatorless Kramer drive system. Static scherbius drive-system using dc link thyristor converters, modes of operation, variable speed constant frequency power generation.

Vector control of induction machines: DC drive analogy, equivalent circuit and phasor diagram, principles of vector control, direct vector control with rotor flux orientation, flux vector estimation, Indirect vector control theory, indirect vector control with open loop flux control, direct torque and flux control.

UNIT - 4 (16 Hours)

Synchronous motor drives: open loop V/F control, Voltage source inverter fed drive, Current source inverter fed drive, cycloconverter fed drive, self controlled mode of operation, self control technique with constant margin angle control, power factor control of synchronous motor drive. Vector control of permanent magnet synchronous motor.

BLDC motor drive: construction of permanent magnet BLDC motor, Principle of operation and dynamic model, closed loop control of PM BLDC drive, advantages and applications.

Recommended Readings:

1. B K Bose; “Modern power electronics and AC drives”; Pearson publication, New Delhi
2. G K Dubey; “Fundamentals of Electric Drive”; Narosa publishers
3. R Krishnan; “Electric motor drives : Modelling analysis and control “, PHI publications New Delhi
4. W Leonard; “Control of Electric Drives”, Springer publications
5. J M D Murphy and Turnbull; “Power electronic control of AC motors”; Pergamon press
6. P Vas; “Sensorless vector and direct torque control”; Oxford press

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

12. Speed control of Induction motor using 1-phase/3-phase Variable frequency drive
13. Speed control of Induction motor using 3-phase/3-phase Variable frequency drive

14. Speed control of Induction motor using soft starter
15. Speed control using Kramer drive
16. MATLAB simulation of six step VSI 3-phase Induction motor drive
17. MATLAB simulation of Field oriented control of 3-phase Induction motor drive
18. MATLAB simulation of sensorless field oriented control of 3-phase Induction motor drive
19. MATLAB simulation Brushless DC motor drive during speed regulation
20. MATLAB simulation of Direct Torque controlled 3-phase Induction motor drive
21. Comparison between detailed and simplified 3-phase Induction motor drive Models in MATLAB simulink.

EE 7.3 VLSI CIRCUIT DESIGN

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.3	VLSI Circuit Design	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

5. To make the students aware of MOS transistor, its modeling, scaling and effects of small device geometry.
6. To equip students with skills for designing various implementations of CMOS combinational and sequential Circuits.
7. To introduce concepts of High level VLSI design using HDL and FPGA.
8. To verify, and troubleshoot VLSI circuits using appropriate testing methods.

Course outcomes:

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

7. Familiarize with the concepts of MOS transistor, design challenges and remedies.
8. Design and test CMOS combinational and sequential circuits.
9. Formulate stick diagram and layout representation of complicated CMOS circuits and test the same.
10. Design and test at higher level of abstraction using VHDL and FPGA / CPLD.
11. Implement Design for testability.

UNIT - 1 (12 Hours)

MOS transistor: Structure, MOS system under external bias, operating regions, threshold voltage, MOSFET I-V characteristics.
MOSFET Scaling and small geometry effects: Full scaling, constant voltage scaling, short channel effects, narrow channel effects, MOSFET capacitances.
Spice Modeling: Modeling of MOS transistor using SPICE Level1 model equations.
Inverters: Passive and Active load MOS inverters, CMOS Inverter - Design, DC characteristics, Noise Margin, Power and Area considerations.

UNIT - 2 (12 Hours)

CMOS Layout: Design rules, stick diagrams.
Combinational MOS Logic circuits: CMOS NOR, NAND Logic circuits, Complex logic circuits, Euler's path, Adder circuits, Transmission gates.

Sequential MOS Logic Circuits: Latches, flip-flops, registers.
CMOS technology: Basic n-well and p-well CMOS process fabrication steps.

UNIT - 3 (12 Hours)

VHDL: Introduction, Basic language elements - identifiers, data objects, data types, entity, architectures, signals and variables, modeling styles.
Behavioral modeling: Sequential processing statements.
Dataflow modeling: Concurrent signal assignment and conditional signal assignment statements.
Structural modeling: Component declaration, instantiation.
Generics, Attributes, Configuration, Packages, Libraries.
VHDL Simulation: Simulation delta, transport and inertial delay models, test bench. VHDL Synthesis**.**

UNIT - 4 (12 Hours)

FPGA and CPLD: Construction, working, features, differences.
VLSI design: Design methodologies, design flow, Partitioning, Floor planning, Placement. Routing.
Validation and testing: Design for Testability (DFT), Scan – Based Test, Boundary Scan Design, Built in self test (BIST), Built in Logic Block Observer (BILBO), Linear Feedback Shift Register (LFSR), Automatic Test-Pattern generation (ATPG), fault models .

Recommended Readings:

1. Sung-Mo Kang Yusuf Leblebici ; CMOS Digital Integrated Circuits Analysis and design; Tata McGraw Hill Publication.
2. Debaprasad Das ; VLSI Design ; Oxford University Press.
3. Douglas Pucknell, Kamran Eshraghian ;Basic VLSI Design.
4. Jan M. Rabaey ; Digital Integrated Circuits ; Prentice Hall India.
5. Douglas Perry ; VHDL Programming by Example ; Tata McGraw Hill Publication.
6. J. Bhaskar; VHDL Primer.
7. Majid Sarrafzadeh ; An introduction to VLSI Physical Design; Tata McGraw Hill Publication.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

Spice based Experiments (At least 3 experiments)

1. Vd-Id and Vg-Id characteristics of nmos transistor
2. Vd-Id and Vg-Id characteristics of pmos transistor
3. Transfer Characteristics of CMOS Inverter
4. Effect of variation of W/L ratio on Transfer characteristics of CMOS Inverter

5. Transient response of CMOS Inverter to pulse and sine inputs
6. Transient response of CMOS NOR gate to pulse and sine inputs
7. Transient response of CMOS NAND gate to pulse and sine inputs

Magic Layout based Experiments (At least 2 experiments)

8. Layout of CMOS Inverter
9. Layout of CMOS NOR gate
10. Layout of CMOS NAND gate
11. Layout of CMOS Transmission Gate
12. Layout of CMOS Half adder

VHDL based Experiments (At least 3 experiments)

13. VHDL codes for simple gates
14. VHDL code for decoder using structural modelling
15. VHDL code for 4:1 multiplexer using structural modelling
16. VHDL code for 4 bit Parallel adder using structural modelling
17. VHDL code for 4 bit up / down counter using behavioral modelling
18. VHDL code for full adder using dataflow modelling
19. VHDL code for 4 bit ALU

EE 7.4.1 ELECTRICAL POWER SYSTEM PLANNING AND RELIABILITY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.4.1	Electrical Power System Planning and Reliability	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To learn National and regional power system planning including generation, transmission & distribution planning, planning tools, electricity regulation, load forecasting, modeling and aspects of cogeneration.
2. To learn about power sector finance, financial planning, private participation, rural electrification investment, concept of rational tariffs.
3. To learn Concept of reliability, reliability indices, component reliability, system reliability failure models.
4. To be aware of optimal power system expansion planning.

Course Outcomes:

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

1. Recite the concept reliability, significance of reliability and system reliability.
2. Carry out analysis of state enumeration techniques
3. Develop a power system plan using planning tools and system model.
4. Demonstrate the concepts of integrated power generation and economics of power system from trading point view and tariff structures.
5. Use programs for optimization in planning, operation and maintenance.

UNIT - 1 (12 Hours)

Load Forecasting: Introduction, Factors affecting Load Forecasting, Load Research, Load Growth Characteristics, Classification of Load and Its Characteristics, Load Forecasting Methods - (i) Extrapolation (ii) Co-Relation Techniques, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non-Weather sensitive load Forecasting, Weather sensitive load Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting, Objectives & Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning**.**

UNIT - 2 (12 Hours)

Power System Reliability: Basic Notions of Power System Reliability- sub systems, reliability indices, outage classification, value of reliability tools, Concepts and methodologies, power system structure, reliability based planning in power systems, effect of failures on power system, Planning criteria, Risk analysis in power system planning, multi-state systems ,Adequacy of Reliability, Reliability Cost.

UNIT - 3 (12 Hours)

Generation Planning and Reliability: Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factors affecting interconnection under Emergency Assistance.

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UNIT - 4 (12 Hours)

Transmission Planning and Reliability: Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.

Distribution Planning and Reliability: Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices. Parallel & Meshed Networks - Introduction, Basic Evaluation Techniques, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Weather Effects, Breaker Failure.

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Recommended Readings:

1. Roy Billinton & Ronald N. Allan; Reliability Evaluation of Power System; Springer Publication.
2. R.L. Sullivan; Power System Planning; Tata McGraw Hill Publishing Company Ltd.
3. Miler & Freund's; Probability and Statistic for Engineers; Pearson Education..
4. Richard Johnson; Proceeding of work shop on energy systems planning & manufacturing CI.
5. R.L .Sullivan; Power System Planning; McGraw Hill, New York; 1977.
6. Turan Gonen; Electric power distribution system Engineering; McGraw Hill; 1986.

List of Experiments/ Assignments:

(At least 8 experiments/assignments should be conducted/ subgmitted from the list of experiments.)

1. Assignment 1 to 4 on Load forecasting methodology, factors affecting load forecasting, system planning, factors affecting system planning and types, numericals.
2. Assignment 5 to 8 on Power System Reliability- sub systems,Planning criteria, Risk analysis in power system planning.
3. Assignment 9 to 12 on Objectives & Factors affecting Generation Planning, Objectives of Transmission Planning, Distribution Planning and Reliability, Expansion planning.

EE 7.4.2 HVDC TRANSMISSION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.4.2	HVDC Transmission	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To give an exposure to the new technology domain "HVDC Power Transmission".
2. To impart the basic knowledge regarding the HVDC Power Transmission.

Course Outcomes:

1. Know about the advantages and the relevance of HVDC Power Transmission.
2. Know about the applications and present status of HVDC Power Transmission.
3. Know about the role of Power Electronics in HVDC Power Transmission.
4. The different types of converters employed, the firing aspects, etc.
5. Know about the different control aspects of HVDC Power Transmission.
6. Know about the filters, measurement, monitoring aspects with reference to HVDC Power Transmission.
7. Know about the present technology trends in HVDC Power Transmission.

UNIT - 1 (12 Hours)

HVDC Transmission: Introduction; Comparison of AC-DC Transmission: Evaluation of Transmission Cost, Technical Consideration, Reliability and Availability Costs; Applications of dc Transmission; Types of HVDC Systems: Monopolar Link, Bipolar Link, Homopolar Link.

Types of Converters: Introduction; Current Source Converters (CSC): Case with no overlap period, Case with overlap period less than 60 degrees; Voltage Source Converters (VSC): Control of the DC Capacitor Voltage, VSC with AC Current Control, VSC with AC Voltage Control.

UNIT - 2 (12 Hours)

Synchronization Techniques for Power Converters: Introduction; Review of GFUs: Individual Phase Control (IPC) Unit, Equi-Distant Pulse Control (EPC) Unit; GFUs: Conventional GFU, DQO GFU, Comparison.

HVDC Controls: Historical Background; Functions of HVDC Controls; HVDC and FACTS Controllers; Control Basics for a Two-terminal DC Link; Current Margin Control Method: Rectifier Mode of Operation, Inverter Mode of Operation; Current Control at the Rectifier; Inverter Extinction Angle Control; Hierarchy of Controls.

UNIT - 3 (12 Hours)

Forced Commutated HVDC Converters: Introduction; Commutation Techniques for HVDC Converters; Examples of FC Converters for HVDC Transmission: Circuit-Commutated Converters, Self-Commutated Converters.
Capacitor Commutated Converters for HVDC Systems: Introduction; Reactive Power Management; Thyristor Valve Modules.
HVDC Systems Using Voltage Source Converters: Introduction; Basic Elements of HVDC using VSCs - Voltage Source Converters; Voltage Source Converter - Operating Principles of a VSC.

UNIT - 4 (12 Hours)

Active Filters: Introduction; DC Filters; AC Filters.
Measurement/Monitoring Aspects: Introduction; Monitoring of Signals; Protection against Over-currents; Protection against Over-voltages.
Modern HVDC - State Of The Art: Introduction; Past Decade Version; Present Decade Version.

Recommended Readings:

7. Vijay K Sood; HVDC and FACTs Controllers; Applications of Static Converters in Power Systems; BSP Books Pvt Ltd, First Indian reprint; 2013
8. K. R. Padiyar; HVDC Power Transmission Systems; New Age International; 2012.
9. E.W.Kimbark; Direct Current Transmission; Wiley Inter-Science, London; 2006.
10. Arrilaga; High Voltage Direct Current Transmission; The Institute of Engineering and Technology, 2ndEdition; 2007.
11. S Kamakshaiah and V Kamaraju; HVDC Transmission; TMH; 2011.

List of Experiments:

(At least 8 simulations and/or assignments should be completed from the list of topics)

1. Control of intermediate circuit (link) voltage
2. Provision of reactive power but with no effect on the flow of active power (STATCOM)
3. Manual and automatic synchronisation with the electric power grid
4. Control of HVDC reactive power with modification to the flow power
5. Individual control of reactive power for both converter stations
6. Observation of losses for various lengths of HVDC lines
7. Provision of a power network with passive consumers by means of HVDC (black start)
8. Coupling of wind turbines
9. Investigation of fault ride-through (FRT) behaviour in HVDC systems
10. Comparison between HVAC and HVDC
11. Study of HVDC links in INDIA
12. Stability issues in HVDC transmission lines

EE 7.4.3 SMART GRIDS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.4.3	Smart Grids	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand and analyze different aspects of smart grids
2. To identify the different technologies for effective utilization of smart grids
3. To impart industry oriented learning for effective utilization of smart grids

Course Outcomes:

On completion of this course, the students will be able to understand different concepts of smart grids. They will be able to understand and analyse implementation of different technologies which can be adopted for smart grid. Course will be useful to design the smart systems for domestic and industrial applications.

UNIT - 1 (12 Hours)

Introduction to smart grid: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Definitions of demand side management and its relevance, Present development & International policies in Smart Grid, global Smart Grid initiatives, Case study of Smart Grid.

UNIT - 2 (12 Hours)

Smart Grid Technologies-I: Demand response, architecture for DR implementation, DR strategies for various load categories, Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Smart Sensors, Home & Building Automation, Smart substations, Substation Automation, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid.

UNIT - 3 (12 Hours)

Smart Grid Technologies-II: Technology Drivers, Smart energy resources, Feeder Automation ,Transmission systems: EMS, HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT - 4 (12 Hours)

Power Quality Management & Information Technology for Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, advanced metering.
Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of Cloud Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

Recommended Readings:

1. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama; Smart Grid: Technology and Application; Wiley press.
2. Clark W. Gellings; The Smart Grid: Enabling Energy Efficiency and Demand Response; CRC Press.
3. Jean Claude Sabonnadière, NouredineHadjsaïd ;Smart Grids; Wiley Blackwell.
4. James Momoh ; Smart Grid :Fundamentals of Design and Analysis ; Wiley IEEE press.
5. Ali Keyhani, Mohammad N. Marwali, Min Dai; Integration of Green and Renewable Energy in Electric Power Systems ; Wiley press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Simulation & Analysis of Grid connected Microgrids
2. Simulation & analysis of Isolated microgrids
3. Case study on DSM /Demand response
4. Study & analysis of smart grid technologies
5. Study & Analysis of communication techniques for smart grids
6. Simulation & analysis of different storage systems in microgrid
7. Study & analysis of power quality issues in smart grid
8. Field visit to the site of smart grids
9. Case study of smart grids
10. Study of protocols /IEEE standards for implementation of smart grid

EE 7.4.4 OPERATION RESEARCH

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.4.4	Operation Research	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To analyze real life decision making situations and develop the art of converting these situations into mathematical models
2. To understand the working principles of techniques to solve LPP models and solve differently styled LP problems
3. To study standard network analysis problems and apply solution techniques
4. To solve problems wherein the dynamic decisions are made in stages and consolidated to arrive at final decision
5. To solve problems related to queuing and inventory systems

Course Outcomes:

After the successful completion of this course, the students will be able to

1. Formulate a real life situation into a mathematical model
2. Select and apply appropriate technique to solve a linear programming model
3. Construct project networks and identify the critical path
4. Recognize the need for a separate technique for specially structured linear programming models and accordingly apply the technique

UNIT - 1 (12 Hours)

Introduction: Historical development of operations research, Models and principles of modeling, Techniques in operations research

Linear Programming: Introduction, Formulation of linear programming problems (LPP), Graphical method to solve LPP, Special cases, Techniques to solve LPP: Simplex method, Analysis of special cases through simplex method, Big-M method, Two-phase method, Duality, Definition of a dual problem, Primal-Dual computations.

UNIT - 2 (12 Hours)

Specially structured linear Programmes: Transportation model, Definition and formulation, Transportation algorithm – finding initial basic feasible solution using Northwest corner rule, Least cost cell and Vogel's approximation method. Optimizing using stepping stone method and MODI method

Assignment model: Definition and formulation, Hungarian algorithm

UNIT - 3 (12 Hours)

Network Analysis: Introduction, scope, definitions, maximal-flow problems, Shortest-Route problem, Minimal spanning tree problem, Project management – PERT/CPM networks,
Game Theory: Introduction, Two-person zero-sum game, saddle point, pure and mixed strategy, Dominance rule, graphical solution, formulation and solution as an LPP

UNIT - 4 (12 Hours)

Dynamic Programming: Introduction, characteristics of dynamic programming, dynamic programming approach to Capital allocation problem, Knap-sack problem, Travelling salesman problem
Queing Theory: Introduction, general structure and performance measures of queuing system, Markovian model, Poisson-exponential single server queuing system, self-service system.

Recommended Readings:

6. Ravindran A., Philips, D., and Solberg, J. J.; *Operations Research: Principles and Practice*; 2nd edition, John Wiley & Sons Inc.; 2012.
7. Paneerselvam R.; *Operations Research;* 2nd edition, Prentice Hall of India Private Ltd.,; 2009.
8. Vohra N. D.; *Quantitative Techniques in Management;* 2nd edition, Tata McGraw-Hill Publishing Co. Ltd.; 2001
9. Sharma S. D.; *Operations Research: Theory, Methods and Applications*; Kedar Nath; 2012.
10. Sharma J. K.; *Operations Research*; 3rd edition 2009, Laxmi Publications; 2009.
11. Yadav S. R. and Malik A. K.; *Operations Research*; 1st edition, Oxford University Press; 2014.
12. Gupta P. K. and Hira D. S. ; *Operations Research*; 5th edition, S Chand; 1976
13. Taha, H.A.; *Operations Research: An Introduction*; 9th edition, Pearson Education, Inc.; 2014.
14. Hillier, F. S., and Lieberman, G. J.; *Introduction to Operations Research*; 8th Ed., Tata McGraw Hill; 2005.
15. Hadley, G.; *Linear Programming*; Addison Wesley Narosa, Narosa Publishing House; 1987.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

At least two assignments on each unit.

E.E. 7.4.5 ELECTRICAL DESIGN ESTIMATION & COSTING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.4.5	Electrical Design Estimation & Costing	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

12. To develop an understanding of important concepts of electrical estimation & costing
13. To be able to understand different I.E. rules related to the safety of electrical installation as well as operating personnel
14. To understand the design of capacity of distribution transformer
15. To understand the number of circuits in a domestic electrical installation
16. To design the size, length & number of wires & conduits for different types of installations as well as design the size of different components of overhead lines.
17. To understand the specifications of different types of panels

Course Outcomes:

On completion of this course, the students will have a thorough knowledge of the methods used for estimation of various types of installations. The student will be able to draw the wiring layout, draw the different types of related diagrams as well as estimate the material & cost of domestic & industrial installation. He/she will develop an ability to design the size of different components of overhead line & distribution.

UNIT – 1 (12 Hours)

Importance of Electrical estimation & Costing. Electrical schedule, determination of required quantity of material & its cost. Purchase systems , purchase mode, purchase inquiry, tender forms. Specifications of materials. Major applicable I.E. rule. Different methods used in Interior wiring system, different wiring system, comparison of various wiring systems

Choice of wiring system. Wiring materials and accessories, Earthing materials used for electrification, Inspection & testing of wiring installation. Lighting & power sub circuits, Schematic &Wiring diagram, layout of wiring for interior wiring installation

UNIT - 2 (12 Hours)

Load calculation, selection of size of wires in light & fan wiring circuit as well as power wiring circuit, wiring material used & their specifications.

Estimation of interior wiring for domestic wiring installation, motor installation , pump set, workshop & theatres / auditorium

UNIT - 3 (12 Hours)

Transmission & distribution lines . Planning & surveying , Applicable I.E. rule.
Estimation of material required for 400 KV, 11 KV & 400 V lines. Estimates of 11KV, 400/230 V distribution system. Distribution transformer installation & estimation

UNIT - 4 (12 Hours)

Specifications- Importance of specifications. ISI specifications of alternator, transformer, induction motor & circuit breaker
Panel for transformer, overhead line conductor, insulator, underground cable, storage battery &, earthing electrode

Recommended Readings:

1. K.B. Raina & S.K. Bhattacharya , Electrical design :estimating & Costing
2. J.B. Gupta, Electrical installation, estimating& costing
3. B.D. Arora, A Hand book of Electrical Wiring, Estimating &Costing
4. S.L. Uppal, Electrical Wiring, estimating & costing
5. S.L. Bhatia, A Hand book of Electrical Engineering

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Drawing of symbols of different components used in Electrical wiring Installation
2. Calculation of total load in a wiring installation & design the number of light/ fan wiring as well as power wiring
3. To draw the shematic diagram, wiring diagram of single line representation , multiline representation& in joint box system
4. To design the size of conductor/s or used for a given wiring installation
5. To estimate the wiring material & its cost used for domestic wiring
6. To estimate the wiring material & its cost used for industrial wiring
7. To estimate the wiring material used in system earthing
8. To estimate the wiring material used in overhead & underground service connections
9. To design the capacity of a distribution transformer & the material used in its installation
10. To estimate the materials used for different service connections.

EE 7. 5.1 FUZZY LOGIC AND NEURAL NETWORKS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.5.1	Fuzzy logic and Neural Networks	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand the principles and components of soft computing.
2. To understand fundamentals of non-traditional technologies and approaches to solving hardwired problems.
3. To appreciate the programming and software environment required for soft computing.
4. To formulate problems and develop solutions for real time problems using soft computing techniques.

Course Outcomes:

On completion of this course students will be able to attain the knowledge of various methods of soft computing techniques and skills pertaining to the competency to apply soft computation method to solve real time application.

UNIT – 1 (12 Hours)

Soft computing Techniques: Introduction to of Neural Network, Fuzzy Logic, Genetic Algorithm, Advantages of using soft computational methods over conventional method.
Fuzzy Logic: Fuzzy logic vs Crisp Logic, Fuzzy sets, Basic Fuzzy set operation, Properties of Fuzzy sets, Fuzzy relations. Membership functions, Fuzzy rule based system. Introduction to fuzzification and defuzzification methods Fuzzy inference, Mamdani and Sugeno types, design parameters-linguistic hedges, developing membership functions, Design of fuzzy controllers- Speed control, Air conditioner Control , washing machine control and Industrial applications.

UNIT – 2 (12 Hours)

Introduction to neural networks: Basic concepts-structure of biological neuron, McCulloch Pitts neuron model, logic network realization by using Mc Culloch Pitts neuron model, modeling for artificial learning.

Learning process: Supervised learning, unsupervised learning, competitive learning- Hebbian learning rule, Perceptron learning rule, Delta learning rule. Single layer networks: Perceptrons-concept of line ar separability- perceptron training algorithm, concept of Non linear separability- Application of Neural network algorithm in pattern Classification.

UNIT – 3 (12 Hours)

Multilayer Networks: Back propagation algorithm, setting parameter values and design considerations Short term Load forecasting , Fault Classification. Support Vector Machine , application of SVM.

Associative Models: Auto associative and Hetero associative memory. Hopfield network -discrete and continuous, Counter propagation network, Image classification using CPN. , Kohonen's self organizing network, Application of Self Organizing maps. Neural network applications: process identification, control, fault diagnosis and load forecasting.

UNIT – 4 (12 Hours)

Genetic Algorithm(GA): Basic concepts, working principle, procedures of GA, flow chart of GA, genetic representations(encoding), initialization and selection, genetic operators, mutation, generational cycle, applications.

Introduction Hybrid System: Neuro fuzzy system, Fuzzy –GA approach in Optimization. Advantages of hybrid system.

Recommended Readings:

1. Timothy Ross; Fuzzy logic with Engineering Applications; Mc Graw Hill.
2. J. M. Zurada; Introduction to Artificial Neural systems; Jaico.
3. Malhotra, Mohan, Ranka; Elements of Artificial Neural Network; Penram.
4. Simon Haykin; Neural Networks A Comprehensive Foundation; PHI.
5. N.M.Martin, L.C.Jain; Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms Industrial Application; CRC Press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Program to realize Fuzzy logic operations
2. Program to compute Fuzzy relation using Composition method.
3. Design a mamdani based Fuzzy Logic controller and realization using software.

4. Design a Sugeno(TS) based Fuzzy Logic controller and realization using software.
5. Realization of Logic operation of logic gates using Neural Network.
6. Program to implement Character Reorganization using preceptor network
7. Program for Solving XOR problem using BPN
8. Implementing Auto/Hetro Associative memory.
9. Image Classification using suitable Neural network Learning algorithm(SOM/BPN)
10. Understanding Neuro fuzzy using ANFIS
11. Implementing Genetic Algorithm to solve load Forecasting
12. Mini project to solve problem related to classification/association/clustering.

EE 7.5.2 DATA COMMUNICATION AND NETWORKING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.5.2	Data Communication and Networking	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand the requirement, advantages of wired and wireless networking.
2. To study the various protocol used in Data communication at various layers .
3. To Analyze the flow control and congestion control services of TCP,
4. To understand network layer functionalities and apply routing protocols for forwarding packets.
5. To study various services at the application layer.

Course Outcomes:

On completion of this course, the students will know the benefits of networking. They will have an ability to assign IP address, selection of suitable protocol for data transfer applications.

UNIT – 1 (12 Hours)

Introduction to Data communication: Need for Networking, Classification of Network based on topology, size, media, and architecture. Applications and advantages of networking. Design Issues for the layers, Connection Oriented Vs Connection less services. Relationship of services and Protocol. Protocol Characteristics, Network Reference Models OSI, TCP/IP Model. Comparison of OSI and TCP/IP reference model. **Physical layer and Media**: Signals and data. Data transmission via guided and unguided media. Data encoding methods, Bandwidth Utilization .

UNIT – 2 (12 Hours)

Data Link Control: Functions of data link layer, Error detection and correction methods, Framing ,Flow control methods- Stop and wait protocol and Sliding window protocol. Media access control sub layer Channel allocation problem, Static and Dynamic channel allocation. MAC layer protocol. ALOHA, Slotted ALOHA. Carrier sense multiple access protocol, characteristics. Channelization using FDMA, CDMA techniques. IEEE 802 Standards, protocol performance of Ethernet, Token bus, Token ring. Wireless protocol.

Networking Devices: Hubs, Switches, Bridges, Routers and Gateways. Types of Bridges. Data Link layer Protocol HDLC, PPP.

UNIT – 3 (12 Hours)

Network layer Design Issues:, Circuit switching and packet Switching methods. Connection less vs. Connection Oriented services virtual Circuit switching and Data gram Switching. Routing algorithms static/dynamic merits of shortest path, distance vector algorithm. Link state routing. Congestion control prevention/detection mechanism in the Network.
IP protocol: format, Address mapping protocol ARP, RARP, Error reporting protocol ICMP. IP addressing: IPV4 and IPV6. Subnet mask and IP address calculation of given network. Functions of Transport layers, Concept of sockets, TCP protocol UDP protocol format TCP connection management, Performance of TCP over UDP. Wireless TCP and UDP.

UNIT – 4 (12 Hours)

Application layer protocol :Domain Name System, Remote login service (TELNET), FTP protocol. Function of Email Server, SMTP and POP Server. Architecture of Network Management system, Performance-Fault-Configuration-Security Fault management. SNMP protocol. Network Security-Cryptography, Symmetric Key and asymmetric key Cryptography. Internet security tools and Techniques used .Advantages of Wireless communication and applications .

Recommended Readings:

1) Behrouz A Forouzan ; Data Communication and Networking ;TMH
2) Andrew Tannenbaum; Computer Networks;PHI
3) Douglas Corner; Computer Network and Internets; PHI
4) Willam Stallings; Data and Computer Communications ;PHI
5) Achut Godbole; Data Communication and Networking;TMH
6) James Kurose Keith w Ross; Computer Networking; PHI

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1) To study the performance of token ring LAN protocol through simulation and using trainer kit.
2) To study the performance of token bus LAN protocol through simulation and using trainer kit.
3) To study the performance of wireless LAN protocol through simulation and verify using LAN trainer kit.
4) Study of networking devices/network commands

5) To study the IP addressing using BOSON simulator.
6) Simulation of Sliding Window ,Go back -N protocol
7) Simulation of transport layer protocol to measure the performance :TCP/UDP
8) Simulation of application layer protocol
9) To study security tools in Networking.
10) Analysis of traffic using wire shark software

EE 7.5.3 IMAGE PROCESSING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.5.3	Image Processing	3	1	2	3	100	25	--	-	25	**150**

Course Objectives:

9. To familiarize the students with Digital Image Model and Representation.
10. To introduce various image processing, segmentation and compression algorithms
11. To equip students with skills for image enhancement, segmentation and restoration.

Course outcomes:

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

1. Understand the concept of Digital image representation and transformations.
2. Apply image preprocessing and filtering to images
3. Restore degraded images
4. Compress image data
5. Separate out specific image data using segmentation
6. Apply morphological transformation on images

Unit-I (12 Hours)

Introduction to Image Processing: Digital Image representation, Types of images, Elements and fundamental steps in Image Processing systems, simple image model, Sampling and Quantization, Digital Image Properties

Basic relationship between pixels: Neighborhood, adjacency distance measures, Histograms. Image quality, Noises in the Image.

Image transformations: Arithmetic and logical operations, image geometry - translation, scaling, rotation, zooming, perspective transformation. Image transforms - Fourier transforms, Discrete Cosine transform.

Unit-II (12 Hours)

Data structure for Image analysis: Levels of image data representation, Image data structure - Matrices, Chains, Topological data structure, Relational structure, pyramids, quad trees.

Image preprocessing: Gray Level transformations - Negative, log, power law, piecewise linear. Geometrical transformation.

Local preprocessing: Image smoothing, Edge detectors, zero crossings of second order derivatives. **Image restoration:** Restoration methods, Inverse Filtering.

Unit-III (12 Hours)

Image segmentation: Detection of discontinuity, edge linking and boundary detection, Thresholding, Edge based Segmentation, Region oriented segmentation
Image Compression: Fundamentals of Image Compression, Compression models, error free compression, lossy compression.

Unit IV (12 Hours)

Morphology: Basic Concepts, dilation, erosion, inner and outer edge detection using morphology **Motion analysis:** Differential motion analysis methods, Optical flow in motion analysis. Analysis based on correspondence of interest points, Object tracking.

Geometry for 3D vision: Projective geometry, calibration of one camera.

Recommended Reading

1. R.C. Gonzalez and R.E. Woods; Digital Image Processing; Addision Wesley.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle; Image processing, analysis and Machine Vision; Vikas Publishing.
3. S. Sridhar; Digital Image Processing; Oxford University Press.
4. R.C. Gonzalez, R.E. Woods, Steven L. Eddins; Digital Image Processing using MATLAB; Pearson Education
5. A. K. Jain; Fundamentals of Digital Image Processing; PHI.
6. A. Rosenfield and A. C. Kak; Digital image processing; Academic press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Geometric transformations on Image
2. Mirroring images
3. Image Negation
4. Image Contrast stretching
5. Bit Plane slicing of image
6. Image Enhancement using Laplacian second order derivatives
7. Low pass filtering of image in spatial domain
8. High pass filtering of image in spatial domain
9. Median filtering of image in spatial domain
10. Image segmentation using Thresholding

11. Region based segmentation
12. Edge detection using Laplacian first order derivatives
13. Morphological transformations - dilation and erosion
14. Morphological edge detection
15. Object Tracking

EE 7.5.4 STATISTICS AND PROBABILITY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.5.4	Statistics and Probability	3	1	2	3	100	25	--	-	25	**150**

Course Objectives:

1. To study the pattern of randomness found in many real life situations.
2. To introduce the students to describe historical data and derive useful information from the data
3. To study various randomness models.
4. To study the unknown parameters of the population and apply the test of hypotheses.

Course outcomes:

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

1. Understand randomness in field and model it
2. Apply various descriptive tools for representing the data.
3. Have good exposure towards advanced Statistical Analysis.
4. Use statistical methods to collect and analyze the data.

Unit I (12 Hours)

Randomness and its Characteristics:
Probability Preliminary: Review of set theory, definition, conditional events, theorem on total probability, Baye's theorem;
Random variable- characteristics- mean, variance, distribution function, E and V-operators, moment generating function (MGF), characteristic function,
Function of one dimensional random variable: discrete and continuous case, E and V-operations with approximations
Two dimensional random vector: marginal distribution, conditional distribution, conditional expectation, independence, covariance and correlation

Unit II (12 Hours)

Discrete Probability distribution: Bernoulli trial, Uniform, Binomial, Geometric, Pascal, hyper-Geometric and Poisson- establishment, mean, variance and MGF derivations, application-memoryless property and reproductive property
Continuous Probability distribution: Uniform, Exponential, Gamma, normal, lognormal and Weibull-establishment, mean, variance and MGF derivations, application-memoryless property, convolution, additive and multiplicative property, reproductive property, Central Limit Theorem

.

Unit III (12 Hours)

Inferential Statistics:
Preliminary: Definitions, sampling distributions- Normal, Student't, Chi-square and F distributions (only structure and concepts without theorems and proofs)
Parameter Estimation:
Point Estimation: Definition, properties-unbiased,efficientand consistent; method of maximum likelihood, method of moments,
Confidence Interval Estimation: Concept with confidence interval, confidence interval of single and double population on mean and difference in means, variance known and unknown, confidence interval on variance(s) of normal distribution of single, Error and selection of sample size
Tests of Hypotheses: Introduction, Type I and II errors, significance level and power of the test, O.C curve, Statistical analysis- on test on mean and equality of two means of single and two populations with variance(s) known and unknown, on variance and variances of single and two normal population(s), choice of sample size,

Unit IV (12 Hours)

Goodness fit test: Chi-square test- Introduction, concept, algorithm for testing discrete and continuous distributions mentioned in Unit II, P-value; probability paper- concept, construction and application except Gamma distribution; Kolmogorov-Smrinov test- concept and application for except Gamma
Test for Independence: Introduction, concept, algorithm for testing discrete and continuous distributions mentioned in Unit II, P-value.
ANOVA: Concept, one way and Two-way classification, statistical analysis on fixed effect model
Simple Linear Regression: Concept, hypothesis testing, model adequacy- residual analysis, lack of fit

Recommended Reading

7. Montgomery D. C. (2001); Introduction to Statistical Quality Control; John Wiley & Sons, Inc., New York,
8. Montgomery D. C, Runger C. G; Applied Statistics and Probability for Engineers; 6th Edition, John Wiley & Sons, Inc., New York.
9. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers , Keying E. Ye; Probability and Statistics for Engineers and Scientists; 9th Edition
10. Grant E.L. and Leavenworth R.S.(2000); Statistical Quality Control; 7th Edition McGraw-Hill publisher, New Delhi.

11. Johnson A. R. ;Probability and Statistics for engineers; Prentice Hall of India, New Delhi
12. Smith M. G. ; Statistical process control and Quality improvement; 5th Edition, Pearson Education, Delhi.
13. Zaidi (1997); SPC concepts, methodologies and tools; Prentice Hall of India, New Delhi
14. Juran G. M., Gryn M. F.; Quality planning and analysis: from product development through use; 3rd Edition, Tata McGraw Hill, Pub., New Delhi.
15. Mitra A. ; Fundamentals of Quality Control and improvement, 2nd Edition, Pearson Education, Delhi.
16. Paranthaman D. ; Quality Control; Tata McGraw Hill, Pub., 11th Edition,New Delhi.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

At least two assignments on each unit.

EE 7.5.5 ADVANCED CONTROLLERS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.5.5	Advanced Controllers	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

12. To introduce the students to advanced controllers such as MSP 430 and TI 320F28X.
13. To equip students with skills for designing controllers for low power applications.
14. To apply basic knowledge in controller design.

Course outcomes:

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

12. Design and implement controllers for power electronic systems.
13. Implement controllers for Low power applications.
14. Implement Digital Signal Control.

UNIT - 1 (12 Hours)

Introduction and motivation for MSP430microcontrollers: Low Power embedded systems, On-chip peripherals (analog and digital), low-power RF capabilities. Target applications (Single-chip, low cost, low power, high performance system design).
Introduction to Digital Signal Controller: DFT, Frequency Domain Sampling and Reconstruction of Signal, Requirements of digital signal processor, Introduction to C2000 family of controllers, Comparison between PICCOLO, DELFINO, 28M3x etc, with reference to on chip peripherals, processing capacity, applications etc.

UNIT - 2 (12 Hours)

MSP430 CPU architecture: Compiler-friendly features, Instruction set, Clock system, Memory subsystem. Key differentiating factors between different MSP430 families. Digital I/O, On-chip peripherals -Watchdog Timer, Comparator, Op-Amp, Basic Timer, Real Time Clock (RTC), ADC, DAC, SD16, LCD, DMA, muxing scheme of the MSP430 pins,

UNIT - 3 (12 Hours)

Low-power features of MSP430: Clock system, low-power modes, Clock request feature.

MSP430 Programming: I/O ports programming using C and assembly, Interrupt programming, Low- power programming and Interrupt.
MSP430 Interfacing: Interfacing LED, LCD, Seven segment Display modules, Real- time clock.

UNIT - 4 (12 Hours)

TI 320F28X Digital Signal Controller Architecture:
TMS320F28335 Introduction, Functional Overview, Memory map, brief description of available peripherals, register maps, device emulation registers, interrupts, system control, On chip Peripherals -Timers, PWM generation, ADC, Serial Communication, GPIO, Flash Memory.
TI 320F28X Digital Signal Controller Programming:
Initializing peripherals, timer interrupt and ISR for timer interrupt, PWM generation

Recommended Readings:

9) Davies; MSP430 Microcontroller Basics; Newnes Elsevier.
10) Adrian Fernandez, Dung Dang; Getting Started with the MSP430 Launchpad; Newnes Elsevier. Publishers
11) TMS320C28x Assembly Language Tools User's Guide SPRU513F
12) Andrew Bateman, Iain Paterson-Stephens; The DSP Handbook Algorithms, Applications and design techniques; Pearson Education
13) Hamid A. Toliyat, Steven G. Campbell; DSP-Based Electromechanical Motion Control; Power Electronics and Applications Series; CRC press
14) Code Composer Studio User's Guide, Document no. SPRU328B; Texas Instruments
15) Data Manual 28335, SPRS439MDiscrete; Texas Instruments
16) TMS320C28x Optimizing C/C++ Compiler, SPRU514F

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

(Experiment 1 is compulsory)

23. To study Code Composer studio as Integrated Development Environment for Assembly, C, Assembly+C projects for MSP430 microcontroller and TMS320C28x.

MSP430 Experiments

24. A Simple Counter
25. Using Interrupts and Low-Power Modes
26. Interrupt-Driven Counter Using the Watchdog as an Interval Timer.
27. Interrupt-Driven RTC Using the Basic Timer
28. Polling User Button connected to port
29. Using the Timer/Port to Measure a Thermistor
30. Using the 14-Bit ADC to read Sensor

TMS320C28x Experiments

31. Program for Reading Analog Signal
32. Generating Timer interrupt and writing program for Interrupt service routine
33. Generation of PWM signal
34. Implementation of simple operations on signals
35. Reading digital signals from GPIO port
36. Writing signals to GPIO port

EE 7.6 PROJECT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
EE 7.6	Project	--	--	4	--	--	--	--	--	25	25

Guidelines for Project Work:

1. Project can be undertaken in-house or in an industry or in a research /service organization.
2. Generally a Project batch consists of two to four students, limited to six.
3. The project groups and title be preferably decided by the end of VIth semester.
4. The Project Title/Synopsis should be submitted by the first fortnight of the term and approved by a designated departmental committee/Head of Department.
5. The topic of the project may be in the area related to Electrical & Electronics Engineering involving investigation/analytical study/experimental work/prototype fabrication/statistical study/simulation etc
6. The project shall involve applications of concepts learnt during curriculum.
7. The project work should be appropriately planned for VIIth and VIIIth semester.
8. VIIth semester Project Report will preferably consist of Problem identification and Statement, Formulation of the objective and Scope of the study, Literature review, Methodology to be adopted, Part execution etc.
9. Students shall submit project report to the department at the end of Semester.
10. Students shall present their work in three progress reviews (beginning, midsem and end-sem).

EE 8.1 FLEXIBLE AC TRANSMISSION SYSTEM

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.1	Flexible AC Transmission System	3	1	-	3	100	25	--	--	--	**125**

Course Objectives:

9. To understand that the power system interconnection has led to the complexity of operation and control of transmission system. The advent in the semiconductor and consequent power semiconductor technology and also the sophisticated processors have made the Flexible AC Transmission System more relevant in the reliable and secured operation transmission system taking many benefits.
10. To give students a focused insight of Flexible AC Transmission system. Moreover the different types of FACTS controllers used in the practical situation and their modeling, design, operation and applications.
11. To learn how to make performance comparison of different FACTS controllers.

Course Outcomes:

On completion of this course, the students will

1. Recite the concept of AC power transmission networks and basic types of FACTS Controllers.
2. Demonstrate the knowledge of power semiconductor devices and their application to the FACTS controllers.
3. Analyse the operation of different types of FACTS controllers.
4. Use different types of FACTS controllers in the transmission system applications.

UNIT - 1 (12 Hours)

Introduction: Basics of power transmission networks - control of power flow in AC - transmission line- flexible AC transmission system controllers – Basic type of FACTS controllers and definitions. Application of FACTS controllers in transmission and distribution system

AC Transmission Line and Reactive Power Compensation: Analysis of uncompensated AC Line - passive reactive power compensation - compensation by a series capacitor connected at the midpoint of the line - shunt compensation connected at the midpoint of the line - comparison between series and shunt capacitor - compensation by STATCOM and SSSC - some representative examples.

UNIT – 2 (12 Hours)

Static VAR Compensator: Analysis of SVC, Configuration of SVC, SVC Controllers, harmonics and filtering - protection aspects – modeling of SVC – applications of SVC**.**

Thyristor and GTO Controlled Series Capacitor: Introduction - basic concepts of controlled series compensation operation of TCSC - analysis of TCSC- control of TCSC - modeling of TCSC for stability studies - GTO thyristor controlled series capacitor (GCSC) – Issue sub synchronous resonance with TCSC - Applications of TCSC**.**

UNIT - 3 (12 Hours)

Static Phase Shifting Transformer: General - basic principle of a PST - configurations of SPST improvement of transient stability using SPST - damping of low frequency power oscillations - applications of SPST**.**

Static Synchronous Compensator (STATCOM): Introduction - principle of operation of STATCOM - a simplified analysis of a three phase six pulse STATCOM -- multi-pulse converters Control of type I Converters - multilevel voltage source converters, Comparison between SVC and STATCOM Applications of STATCOM**.**

UNIT - 4 (12 Hours)

SSSC and UPFC:

SSSC-operation of SSSC and the control of power flow –modeling of SSSC in load flow and transient stability.

Unified Power Flow Controller (UPFC) – Principle of operation – modes of operation – applications – modeling of UPFC for power flow studies.

Special Purpose FACTS Controllers: Interline Power Flow Controller - operation and control.

Recommended Readings:

1. K. R Padiyar; FACTS Controllers in Power Transmission and Distribution; New Age International, 2007.
2. Narain G Hingorani and L. Gyugyi; Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems; Wiley India, 2011.
3. Y. H. Song and A. T. Johns; Flexible AC Transmission System; Institution of Engineering and Technology; 2009.
4. Mohan Mathur, R., Rajiv. K. Varma; Thyristor – Based Facts Controllers for Electrical Transmission Systems; IEEE press and John Wiley & Sons, Inc.

EE 8.2 PLC AND ITS APPLICATIONS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.2	PLC and its Applications	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

1. To provide knowledge levels needed for PLC programming and operating.
2. To make the students know devices to which PLC input and output modules are connected
3. To train the students to create ladder diagrams from process control descriptions.
4. To make the students understand various types of PLC registers, PLC Timers and Counters for the control of industrial processes
5. To make the students understand PLC functions.

Course Outcomes:

On completion of this course, the students will have ability to

1. Ability to gain knowledge on Programmable Logic Controllers
2. Understand different types of Devices to which PLC input and output modules are connected.
3. Understand various types of PLC registers.
4. Create ladder diagrams from process control descriptions.
5. Apply PLC timers and counters for the control of industrial processes and use different types PLC functions.

UNIT - 1 (12 Hours)

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils, drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT – 2 (12 Hours)

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers.

PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT - 3 (12 Hours)

Data handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications.Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axes and three axis Robots with PLC, Matrix functions.

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples.

UNIT - 4 (12 Hours)

PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Recommended Readings:

5. John W. Webb and Ronald A. Reiss; Programmable Logic Controllers – Principle and Applications; Fifth Edition, PHI
6. JR. Hackworth and F.D Hackworth Jr; Programmable Logic Controllers – Programming Method and Applications; Pearson; 2004.
7. Gary Dunning; Introduction to Programmable Logic Controllers; Cengage Learning.
8. W.Bolton; Programmable Logic Controllers; Elsevier publisher

List of Experiments:

1. Interfacing of lamp and button with PLC for ON/OFF operation
2. Perform delayed operation of lamp by using push button.
3. Multiple push button operation with delayed lamp for ON/OFF operation
4. Combination of Counter & Timer for Lamp ON/OFF operation
5. To study Set and Reset operation of lamp
6. DOL Starter & Star Delta Starter operation by using PLC
7. PLC based temperature sensing using RTD

8. PLC based thermal ON/OFF control.
9. Water level controller using programmable logic controller
10. Batch process reactor using programmable logic controller
11. Speed control of ac servo motor using programmable logic controller
12. Lift control system using plc

EE 8.3.1 ILLUMINATION ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.3.1	Illumination Engineering	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

By learning this course, a student will be able to understand different characteristics & qualities of light / lighting sources, types of lighting, as well as measurement of different lighting parameters . It will also enable a student to apply right type of lighting system for the right application, get familiarized with different laws of illumination as well as understand the design of interior & exterior lighting.

Course Outcomes:

After successful completion of this course the student will

1. Understand different factors affecting good lighting as well as qualities of good lighting
2. To understand qualities of luminaires & their functions
3. To understand the use of polar curves & other photometric diagrams for calculation of L.O.R
4. To understand the methods used in interior & exterior lighting.

UNIT- 1 (12 hours)

Introduction to light: Natural light , artificial light & supplementary light Radiations their wavelength & colour - colour characteristics - Colour temperature, colour sensitivity, vision & their types- scotopic & photopic vision. Factors affecting good lighting , different types of glares, glare index, ways of their minimization, types of shadows & their types , ways of minimization of hard shadows, different contrast levels between visual task, working plane, surrounding & field of vision, colour rendering effect & CRI, reflection& its types, stroboscopic effect & its ways of minimization. Types of lighting sources and their comparison w.r.t. their characteristics, switching & control ckts .Qualities of good lighting, Method of artificial lighting, Types of Lighting systems and lighting schemes and the application of each . Types of luminaires- their functional aspects & applications

UNIT- 2 (12 hours)

Measurement of light: Terms related to lighting, types of candle powers- M.S.C.P, M.H.C.P, and their measurements using Rousseau diagram, efficacy of lamp, Polar curves- its significance& types , procedure for drawing polar curves. Laws of Illumination and their applications, Illumination from point, line & flat source. Photometry & spectro metry. procedure for photometry , photometer & its types. Photo cells, Illuminance meter. Determination of luminance & illuminance for round source, flat source, , tubular source/ diffuser. Photometric diagrams, efficacy of lamp, DLOR, ULOR, LFF, UFF, LFU. UFU & COU . LED& LCD display- their merits & demerits, LASER & its applications.

UNIT- 3 (12 hours)

Design of interior lighting: Illumination required for various work plane. Terms related to interior lighting. Standard practice for illumination required in different areas.Different factors related to interior lighting design, their selection and range of their nominal values. Room index, cavity index, mounting height, suspension height, Space to mounting height ratio- their nominal values & factors affecting them. Factors affecting C.O.U. Selection of lamps & luminaires, their methods of mounting, Methods used in interior lighting design, Layout of luminaires Design of lighting for industries, residential areas, office, departmental stores, indoor stadium , stores, theater & hospital , Auditorium lighting & spot lighting.

UNIT- 4 (12 hours)

Design of exterior lighting: Terms related & standard practice for illumination level. Design of street lighting & flood lighting- types of luminaires used , their merits & demerits & their selection, arrangement of luminaires, different factors involved & the range of their nominal values. Aiming of flood light projectors. Aviation & Transport lighting. Lighting for display & signaling, surveillance lighting, Emergency lighting systems.

Recommended readings

1. D.C. Prichard: Lighting
2. Cayless & Marsden; Lamps & lightings
3. J. Lindsay; Applied Illumination Engineering
4. Dr. Warren G. Julian; Principles of lighting published by indian society of lighting Engineers
5. Gibson; Lighting

List of Experiments

Term work shall consist of the following experiments, out of which minimum eight experiments are to be performed .

1. To study the operating characteristics of different types of Incandescent lamps and determine their luminous efficiency, efficacy and operating temperature.
2. To study the operating characteristics of different types of low pressure gas discharge lamps and determine their luminous efficiency, efficacy and operating temperature.
3. To study the operating characteristics of different types of high pressure gas discharge lamps & LEDs and determine their luminous efficiency, efficacy and operating temperature
4. To determine the absorption factor and reflection factor of different types of luminaire surface materials
5. To plot the vertical & horizontal polar curve for different types of lamps and the lamp shades &determine the light output ratios, LFF & UFF.
6. To determine the illumination level at the stage lighting & audience gallery in case of auditorium lighting.
7. To study the existing lighting scheme in the Gymkhana & suggest the improvements in the existing design.
8. To study the lighting system & lighting scheme adopted for outdoor sports lighting.

EE 8.3.2 ENERGY AUDITING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.3.2	Energy auditing	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand and analyse various aspects of energy use , energy conservation measures , energy audits and environmental impacts.
2. To identify the various methodologies / technologies for effective utilization of energy sources and promotion of energy efficiency.
3. To carry out practical energy audit of various sectors.
4. To do analysis of the environmental and cost economics of using energy use in various sectors

Course Outcomes:

On completion of this course, the students will be able to understand different aspects of Energy management . They will be able to do environmental , economic assessment of the various energy resources used in Industry. Course will be useful to undertake the audit of various equipments and suggest suitable energy conservation and efficiency measures for domestic as well as Industrial applications.

UNIT - 1 (12 Hours)

General aspects of energy management: Energy scenario, Forms of Energy, Primary & secondary Energy, Commercial and non-commercial Energy, Renewable and non-renewable Energy, Energy pricing, energy sector reforms, Energy Security.
Energy Conservation and its importance, EC act 2001, Definition and objectives of Energy Management, Energy Audit, Types and methodologies, Energy auditing report format, Energy Audit Instruments, Benchmarking and Energy performance, Energy Management centers and their importance, Energy and Environment.

UNIT - 2 (12 Hours)

Energy efficiency in electrical utilities: Electrical system, Electric motors, Compressed air system, HVAC and refrigeration system, Pumps, pumping system. Lighting system, DG set system, Demand side Management ,load control, Energy efficient technologies in Electrical system.

UNIT - 3 (12 Hours)

Energy efficiency in thermal utilities: Fuels and combustion, Boiler systems, Boiler types and classification, performance evaluation of Boilers, Boiler blowdown, energy conservation opportunities. Steam system, Furnaces, Insulation, Refractories, Cogeneration, Waste heat recovery Systems.

UNIT - 4 (12 Hours)

Economics and Finance: Project management, steps in project management, project planning techniques Case studies of energy audit Projects.
Financial management, investment need, Appraisal and criteria for Energy management projects, financial analysis techniques, Sensitivity and risk analysis, financing options, costing techniques.

Recommended Readings:

1) Amlan Chakrabarti; Energy engineering and management; Prentice hall India ltd
2) Wayne C. Turner, Steve Doty; Energy Management Handbook; Lulu Press
3) W.R .Murphy, Gmckay Butterworths; Energy Management; London
4) Guide books on Energy audit & Management; Bureau of Energy Efficiency, New Delhi.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Study & analysis of Energy Audit Instruments
2. Load flow & Harmonic analysis of Non linear loads
3. Experiment on energy conservation aspects in Lighting systems
4.. Experiment on energy conservation aspects in Motoring systems
5. Energy Audit of GEC substation
6. Experiment on energy conservation aspects in Pumping systems
7. Experiment on energy conservation aspects in HVAC systems
8. To find out the carbon footprint
9. Study & analysis of Energy Efficient Technologies
10. Energy Audit case study of Industry

EE 8.3.3 MICRO GRID & DISTRIBUTED GENERATION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 7.4.3	Micro Grid & Distributed Generation	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand and analyze different aspects of Distrubuted Generation & Microgrids
2. To study and analyse different modes of operation & control of Microgrids
3. To do modeling and stability analysis of DG integration with conventional grid.

Course Outcomes:

On completion of this course, the students will be able to understand different concepts on Distributed Generation & Microgrids . They will be able to analyse integration and implementation aspects of DG & Microgrid with conventional grid. Course will be useful for students to get insight into operation and control aspects of Microgrid.

UNIT 1 (12 Hours)

Distributed Generation: Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT 2 (12 Hours)

Microgrids: Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid. AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure.

UNIT 3 (12 Hours)

Impact Of Grid Integration: Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability issues. IEEE standards to be followed for grid integration, Power quality aspects in microgrids

UNIT - 4 (12 Hours)

Modes of Operation & Control: Modes of operation and control of microgrid : grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure.
Modelling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids

Recommended Readings:

1. Nikos Hatziargyriou; Microgrids : Architectures & Control; Wiley IEEE press.
2. S. Chowdhary , P. Crosseley; Microgrids & Active distribution network; Institution of Engineering & Technology
3. Suleiman Sharkh, Mohammad Abusar, Babar Hussain; Power Electronic converters for Microgrid; Wiley IEEE press.
4. Amirnaser Yezdani, Reza Iravani; Voltage Source Converters in Power Systems: Modeling, Control and Applications; IEEE John Wiley Publications.
5. Ali Keyhani, Mohammad N. Marwali, Min Dai; Integration of Green and Renewable Energy in Electric Power Systems; Wiley press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1) Simulation & analysis of SPV system
2) Simulation & analysis of Wind turbine system
3) Simulation & analysis of Small hydro power system
4) Simulation & analysis of Fuel cell system
5) Simulation & analysis of Hybrid system
6) Simulation & analysis of Grid/Isolated power system with RES
7) Analysis of Integration issues of RES to the grid
8) Study of communication techniques in Microgrid
9) Case study of the Microgrids
10) Field visit to the site of Microgrids /Smart grids

EE 8.3.4 POWER SYSTEM OPERATION AND CONTROL

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.3.4	Power System Operation and Control	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

12. To understand that the power system interconnection has led to the complexity of operation and control of transmission system. The advent in the semiconductor and consequent power semiconductor technology and also the sophisticated processors have made the Flexible AC Transmission System more relevant in the reliable and secured operation transmission system taking many benefits.
13. To give students a focused insight of Flexible AC Transmission system. Moreover the different types of FACTS controllers used in the practical situation and their modeling, design, operation and applications.
14. To learn how to make performance comparison of different FACTS controllers.

Course Outcomes:

On completion of this course, the students will

5. Recite the concept of AC power transmission networks and basic types of FACTS Controllers.
6. Demonstrate the knowledge of power semiconductor devices and their application to the FACTS controllers.
7. Analyse the operation of different types of FACTS controllers.
8. Use different types of FACTS controllers in the transmission system applications.

UNIT - 1 (12 Hours)

Control centre operation of power systems:

Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, expression for tie-line flow and frequency deviation, parallel operation of generators, area lumped dynamic model, examples

UNIT – 2 (12 Hours)

Power System Control: Basic generation control loops, Load frequency control(LFC) modeling, steady state frequency deviation, AGC in single area system and multi area system, tie line bias control. Examples to be solved with MATLAB and Simulink

UNIT - 3 (12 Hours)

Reactive Power and Voltage Control: Automatic voltage control (AVR) modeling, steady state voltage response, excitation system stabilizer-rate feedback ,and PID controller, power flow through transmission line, relation between voltage, real power and reactive power, supplementary methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse. Examples to be solved using MATLAB and Simulink

UNIT - 4 (12 Hours)

Optimal dispatch of generation: Introduction, equality and inequality constraints, operating cost of thermal plant, economic dispatch neglecting losses and no generator limits, economic dispatch neglecting losses and including generator limits, economic dispatch including losses. Examples

Unit Commitment: Statement of the problem, need and importance of unit commitment, example with shut down rule, constraints ,Spinning reserve, thermal unit constraints and other constraints,

Recommended Readings:

9. G. L. Kusic; Computer Aided Power System Analysis; 2/e, Taylor & Francis; 2008.
10. Hadi Saadat; Power system engineering; 2/eTMH ; 2002.
11. Kotrhari, Nagrath; Power System Analysis; 2/e,TMH; 2008.
12. A. J. Wood & B. F. Woolemberg; Power generation, operation and control; 1/e, JohnWiley and Sons; 1984.

List of Experiments:

Term work shall consist of the following experiments, out of which minimum eight experiments are to be performed

1. Term work shall consist of four assignments covering UNIT 1 to Unit 4**.**
2. MATLAB programme on economic operation with no generator constraints neglecting transmission losses

3. MATLAB programme on economic operation with no generator constraints including transmission losses
4. MATLAB programme on economic operation with generator constraints neglecting transmission losses
5. MATLAB programme on economic operation with generator constraints including transmission losses
6. MATLAB programme to form X matrix for evaluating line outage contingency factors given transmission line network
7. MATLAB programme to evaluate line outage generation factors
8. MATLAB programme to evaluate line outage generation factors
9. MATLAB programme to evaluate transmission loss using beta coefficients
10. MATLAB programme to evaluate generation shift distribution factors
11. MATLAB programme to perform contingency analysis using distribution factors

EE 8.3.5 POWER QUALITY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.3.5	Power Quality	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand and analyze different aspects of power quality issues
2. To do measurement & analysis of power quality parameters
3. To do modeling, analysis of power quality parameters and suggest mitigation measures for overcoming power quality problems.

Course Outcomes:

On completion of this course, the students will be able to understand different concepts on power quality issues faced by consumers and utility. They will be able to do monitoring, analysis of power quality parameters and suggest suitable measures for overcoming power quality problems.

UNIT 1 (12 Hours)

Introduction to Power Quality: Definition of Power Quality, Power Quality Progression, Power Quality Terminology, Power Quality Issues, Susceptibility Criteria, Responsibilities of Power Suppliers and Users, Power Quality Standards- IEEE Standards 519 and 1159.

Power Frequency Disturbance: Introduction to Power Frequency Disturbance, Common Power Frequency Disturbances, Cures for Low Frequency Disturbances, Voltage Distortion, Voltage Sag, Voltage Swell, Impulsive Transient, Oscillatory Transient, Interruption, Notching, Voltage Fluctuations and Flicker, Voltage Imbalance, Voltage Tolerance Criteria- ITIC Graph.

Electrical Transients: Introduction to Transients, Transient System Model, Examples of Transient Models and Their Response. Power System Transient Modeling, Types and Causes of Transients, Examples of Transient Waveforms.

UNIT 2 (12 Hours)

Harmonics: Definition of Harmonics, Harmonic Number (h), Odd and Even Order Harmonics, Harmonic Phase Rotation and Phase Angle, Voltage and Current Harmonics, Individual and Total Harmonic Distortion, Harmonic Signatures. Effect of Harmonics On Power System Devices, Guidelines For Harmonic Voltage and Current Limitation, Harmonic Current Mitigation.

Power & Power Factor: Analysis of single phase & three phase circuits for sinusoidal & Non sinusoidal voltage source, balanced, unbalanced loads, Linear and Non linear loads. Apparent, Active and Reactive Power, Displacement and True Power Factor, Arithmetic & vector power factor.
Power Factor correction: Methods and advantages of correction.

UNIT 3 (12 Hours)

Harmonic Current Sources: Background, Single-Phase Rectifiers, Three-Phase Rectifiers, High-Frequency Fluorescent Ballasts, Transformers, Switch Mode Power Supplies, Other Systems and loads that draw Harmonic Currents.
Power Harmonic Filters: Introduction, A Typical Power System, IEEE Std. 519-1992, Practical Considerations in the design & use of Passive Filters.
Introduction to active filters, various types and their applications.

UNIT 4 (12 Hours)

Measuring And Solving Power Quality Problems: Introduction to Power Quality Measurements, Power Quality Measurement Devices, Power Quality Measurements Test Locations, Test Duration, Instrument Setup, Instrument Guidelines, Assessing power quality data, data analysis.
Methods For Correction Of Power-Quality Problems: Introduction, Various Correction Methods, Remedies from Customer side & Utility side.

Recommended Readings

1. C. Shankaran; Power Quality; CRC Press.
2. Roger C. Dugan et al.; Electrical Power System Quality; Tata Mc Graw-Hill.
3. H. Akagi et al.; Instantaneous power theory and applications to power conditioning; IEEE press.
4. A. Ghosh, G. Ledwich; Power Quality Enhancement using custom power devices; Kluwer Academic publications.
5. Math H. Bollen; Understanding power quality problems; IEEE press.

List of Experiments

(At least 8 experiments should be conducted from the list of experiments.)

1) To study and analyse the effects of sinusoidal voltage source supplying linear loads on various parameters using MATLAB software

2) To study and analyse effects of Non sinusoidal voltage source supplying Non linear loads on various parameters using MATLAB software
3) To study and analyse effects of Non sinusoidal voltage source supplying linear loads on various parameters using MATLAB software
4) Simulation and analysis of Linear loads using Matlab Simulink
5) Simulation & analysis of Various Non linear loads using Matlab simulink
6) Simulation & analysis of various motoring & dynamic loads using Matlab Simulink
7) Analysis & design of passive filters
8) Analysis & design of Active Filters
9) Study & practical implementation of various power Quality Instruments
10) Case study of power quality issues in substation/ Industry.

EE 8.3.6 HIGH VOLTAGE ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.3.6	High Voltage Engineering	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

18. To analyze the breakdown processes in solid, liquid and gaseous insulations.
19. To model and analyze the high voltage generation and measurement circuits.
20. To perform insulation co-ordination.
21. To analyze the Travelling wave theory, aspects of HV power transmission & HV cables.
22. To perform High voltage tests on insulators, Transformers, cables and High voltage bushings.

Course Outcomes:

On completion of this course, the students will be able to learn and analyze the advantages of high voltage systems, applications and generation of high voltages, breakdown processes in solid, liquid and gaseous insulations. They will be able to perform insulation co-ordination. They will be able to perform High voltage tests on insulators, Transformers, cables and High voltage bushings.

UNIT - 1 (12 Hours)

Introduction: Introduction to HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory. Important applications of high voltages.

Generation: HVAC: HV transformer - working of transformer connected in cascade. Series resonant circuit. Tesla coil. **HVDC:** voltage doubler circuit, Cockcroft- Walton type. Calculation of percentage voltage regulation, percentage ripple and optimum number of stages.

Generation of Impulse Voltage and Current: Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator. Multistage impulse generator working of Marx impulse generator and components. Triggering gap and time sweep circuits for oscillographic records. Generation of switching impulse voltageand high impulse current.

UNIT - 2 (12 Hours)

Insulation co-ordination : Overvoltages and their significance, Standard Lightning impulse and Switching impulse waveforms, Principle of insulation coordination,

Terminology related to insulation co-ordination, Conventional method of insulation co-ordination, Statistical method of insulation co-ordination

Breakdown of Liquid insulation : Breakdown in liquids, Suspended particle theory, electronic, cavity/bubble's theory and electro convection breakdown of commercial liquids, breakdown due to gaseous inclusions, liquid globules and solid particles.

Breakdown of Solid insulation material : Intrinsic, avalanche, Electromechanical breakdown, Breakdown due to internal discharges, Surface breakdown, Thermal breakdown, Electrochemical breakdown, Chemical deterioration, Breakdown of composite insulation.

UNIT - 3 (12 Hours)

Classification and Properties of HV insulating media. Gaseous dielectrics, Ionizations, primary and secondary ionization processes.Townsend's theory, Streamer's theory. Corona discharges. Expression for disruptive and visual critical voltages and corona power loss. Breakdown in electro negative gases. Paschen's law. Time lags of Breakdown.

Direct measurement of High voltages : Electrostatic voltmeter, Sphere gap, Rod gap, chubb-Fortescue method, Transformer ratio method, Resistive Potential divider method, Capacitive Potential divider method. Generating voltmeter- Principle of operation & construction. Series resistance micro ammeter

Measurement of Lightning surges using Klydonograph.

UNIT - 4 (12 Hours)

High voltage transmission: need, types of transmission conductors, GMR, mechanical aspects of transmission lines. Traveling wave theory, surge impedance, Transmission line parameters, charging current, reflection and refraction on transmission line, power circle diagram, Beweley Lattice diagrams.

Surge protection : Overhead ground wire, Spark gaps, Expulsion type lightning arrester, Valve type Lightning arrester, Gapless Lightning arrester, Switching overvoltages, methods of reducing switching overvoltages.

High voltage cables : Constructional details and power loss.

High voltage testing : General tests carried out on High voltage equipments – Sustanined low frequency tests, High voltage direct current tests, High frequency tests, Surge or impulse tests, Flash over tests. Tests on solid dielectric materials – nature of dielectric breakdown, determination of dielectric strength. Impulse testing. Tests on insulators, Transformers, cables and High voltage bushings.

Recommended Readings:

9. M. S. Naidu ;High voltage Engineering ; Tata McGraw Hills
10. C. L. Wadwa; High Voltage Engineering; New Age International
11. Kuffel Ea Zaengal, Pergam; High Voltage Engineering
12. R. Begamudre; High voltage Transmission; Tata Mc Graw Hills
13. Subir Ray; An introduction to High Voltage Engineering; Prentice hall of India.

List of Experiments:

1) Study of layout of HV lab,its equipments and safety measures.
2) study of cascaded HV transformer and its operation
3) Breakdown of spherical gap using cascaded transformer
4) Testing of 11kV transmission line disc insulator.
5) Measurement of HV using Chub Fortescue Method
6) Measurement of HV using Sphere Gap
7) Performance of HV Long transmission Line
8)Testing of transformer Oil using spark gap method
9) Testing of Solid insulation using HV Testing Tranformer
10) study of different types of lightning arrestors

EE 8.4.1 DIGITAL SYSTEM DESIGN USING HDL

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.4.1	Digital System Design using HDL	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To study VHDL and Verilog and systemC Hardware description Languages
2. To model combinational and sequential logic using HDL using various modeling styles
3. To simulate the logic using delay models
4. To synthesize the models
5. To design combinatorial and sequential systems

Course Outcomes:

On completion of this course, the students will have a understanding of VHDL, Verilog and SystemC . They would be able to design, simulate and synthesize the combinational and sequential logic using the HDL languages.

UNIT – 1 (12 Hours)

VHDL: Constructs, data objects, data types, arithmetic ,logical relational operators, modelling styles, Generic and configuration, subprograms and overloading, packages and libraries, simulation –testbenches , delay modeling , synthesis.

UNIT – 2 (12 Hours)

Verilog: Data types, constructs in Verilog, modules and ports, gate level modelling in Verilog, Data flow modelling in Verilog, Behavioral modelling in Verilog .
Tasks and functions in Verilog , Delay modeling, synthesis

UNIT – 3 (12 Hours)

SystemC: SystemC introduction, data types, module description, logical, arithmetic and relational operators, if-switch statement, loops, modeling combinational and sequential logic, testbenches.

UNIT – 4 (12 Hours)

System Design: Modelling Flipflops, memory modeling, FSM modeling-Moore and Mealy, Shift Registers and counters, ALU, ,combinational logic using any of the above hardware description languages.

Recommended Readings:

1. Douglas Perry ;VHDL –Programming by Example; McGraw Hill Publication
2. J. Bhasker ;VHDL Primer; Pearson Education, Asia
3. J. Bhasker; Verilog HDL Synthesis – A Practice Primer; B.S. Publications
4. S. Palnitkar; Verilog HDL: A Guide to Digital Design and Synthesis; Prentice Hall (NJ, USA), 1996
5. J. Bhasker ; System C ; Star Galaxy Publishing
6. IEEE Std. 1364-95; Verilog Language Reference Manual; IEEE Press (NY, USA,1995)
7. IEEE Std. 1076-2000; VHDL Language Reference Manual; IEEE Press

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1) Combinational logic design
2) Sequential logic design
3) Memory modeling
4) Controller design using FSM
5) UART Modeling
6) ALU Modeling
7) FIFO Modeling
8) Port Expansion
9) Switches and LED Interfacing
10) Seven Segment LED interfacing
11) VGA interfacing
12) LCD interfacing
13) ADC interfacing
14) DAC interfacing

EE 8.4.2 BIOMEDICAL INSTRUMENTATION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.4.2	Biomedical Instrumentation	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

By studying this course the student will be able to understand

1. The different sources of bioelectric potential & electrodes
2. The different types of heart sounds
3. The application of right types of transducer used in biomedical applications
4. Different waveforms of ECG, EEG & EMG.
5. The rules related to patient safety & safety of medical equipment

Course outcomes:

On completion of this course, the students will have a thorough understanding of biomedical techniques used for measurement of different human body parameters, possibility of electric shock hazards from biomedical instruments & the safety measures to be adopted to prevent accidents

UNIT- 1 (12 Hours)

Biomedical Instrumentation System: Block diagram and specification, problems encountered in the design of a living system, general constraint in the design of biomedical instrumentation system. Physiological system of human body.

Sources Of Bioelectric Potential: resting & action potential- propagation of action potential. biomedical electrodes- Skin surface, needle type, micro electrode & their application. Heart & cardio vascular system. Systolic & Diastolic heart sound. Transducers used in biomedical applications (physiological transducer)

Measurement of blood pressure- methods used. Measurement of blood flow and cardiac output using magnetic blood flow meter- electromagnetic type, NMR type, ultrasonic type, indicator dilution method Electro cardiograph,- block diagram, ECG electrodes and leads, types of ECG recorder.

UNIT- 2 (12 Hours)

Plethismography- measurement of heart sounds- PCG, Anatomy of nervous system, nervous system measurement, neuronal communication , EPSP & IPSP. Neoronal receptors, neuronal firing measurements.

Electroencephalograph (EEG)- block diagram , various rhythms, EEG in diagnostics. Electromyograph (EMG)- Block diagram, ophthalmology instruments- elec

troretinogram, electroculogram, ophtalmoscope, tubometer for eye pressure measurement
Clinical laboratory instrument- blood cells- tests on blood cells, measurement of blood parameters, blood cell counters. Oximetry- invitro Oximetry, invivo oximetry, Ear oximeter

UNIT- 3 (12 Hours)

Therapeutic instrument- Cardiac pacemaker & their types, Cardiac defibrillator& their types. Artificial kidney,Dialysis, Dialyser, hemodialysis, hemodialyser- types. Diathermy- short wave & microwave, Surgical diathermy – principle& machine. Biomedical telemetry- physiological parameters adaptable to biotelemetry- components of bio telemetrical system, implantable units

UNIT- 4 (12 Hours)

Patient safety & electrical safetyof medical equipment, physiological effects of electric current. Electrical shock hazards from medical equipment. Methods to prevent accidents. Patient care & monitoring system- bedside monitor & control specification Imaging system- Xray machine, basic principle, CT& MRI Scanner -ultrasound diagnostic

Recommended readings:

1. R.S. Khandpur; Hand book of biomedical instrumentation; Tata MC graw Hill.
2. Crombell, Weibell, Pfeitter; Biomedical instruments & measurements.
3. Cromwell; biomedical instrumentation& measurements; PHI
4. John G. Webster; Medical Instrumentation Application & Design; John Wiley & Sons New York 1998.
5. Onkar Pandey & Rakesh Kumar; Biomedical Electronics & Instrumentation; S.K. kataria publication

List of experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Study of Biomedical electrodes
2. Measurement of blood flow & cardiac output using magnetic blood flow meter
3. Measurement of blood pressure
4. Measurement of different types of heart sounds
5. Study of Cardiac pace maker
6. Measurement of blood parameters
7. Study of Cardiac defibrillator
8. Study of Ultrasonography
9. Study of ear Oximeter
10. Measurement of eye pressure
11. Study of tubometer.

EE 8.4.3 WIRELESS SENSOR NETWORK

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.2	Wireless Sensor Network	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1) To study the architecture of sensor networks for various application setups. Explore the design space and conduct trade-off analysis between performance and resources.
2) Understand devise appropriate data dissemination protocols and model links cost.
3) To study suitable medium access protocols and radio hardware.
4) To learn the tools used in WSN programming

Course Outcomes:

On completion of this course, the students will have a thorough understanding of

Architecture of WSN , selection criteria sensor network and a Protocol , Programming ,Design and Develop wireless sensor network based applications.

UNIT - 1 (12 Hours)

Overview of Wireless Sensor Networks : Introduction to Sensor Networks, Advantage of Sensor Networks Applications of Sensor Networks .Unique constraints and challenges for Wireless Sensor Networks, Enabling Technologies - Wireless Sensor Networks.

Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.

UNIT - 2 (12 Hours)

Deployment and Configuration: Localization and positioning, Coverage and connectivity, Single-hop and multi -hop localization, self configuring localization systems, sensor management.

MAC and Routing Protocols for Wireless Sensor Networks: Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network.

UNIT - 3 (12 Hours)

Routing protocols: Issues in designing routing protocols. Routing Strategies in WSNs,Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing.
Middleware for Wireless Sensor Networks: Introduction, WSN Middleware Principles, Middleware Architecture, Existing Middleware.
Data Storage and Manipulation: Data centric and content based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique.

UNIT - 4 (12 Hours)

Operating Systems for Wireless Sensor Networks: Introduction, Operating System Design Issues, Examples of Operating Systems. SENSOR NETWORK PLATFORMS AND TOOLS for Sensor Node Hardware.

Performance and Traffic Management: WSN design issues Performance Modeling of WSNs, Basic Models, Network Models,

Programming: Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

Recommended Readings:

1) Holger Karl & Andreas Willig; Protocols And Architectures for Wireless Sensor Networks;Wiley,
2) Feng Zhao & Leonidas J. Guibas; Wireless Sensor Networks- An Information Processing Approach; Elsevier
3) Kazem Sohraby, Daniel Minoli, & Taieb Znati; Wireless Sensor Networks Technology, Protocols, And Applications; Wiley
4) Anna Hac; Wireless Sensor Network Designs; Wiley
5) Ian F. Akyildiz, Mehmet Can Vuran ;Wireless Sensor Networks; Wiley

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1) Program to understand various WSN motes.
2) Program to turn on/off light using WSN motes
3) Wireless Sensor Network Duty Cycle Implementation vs. Analysis of Power Consumption
4) Selecting different transmission range with respect to the available power levels and simulate using tools
5) Program the WSN to acquire sensor data, transmit it to the nearby nodes, and aggregate it

6) Implementation of wireless sensor network (WSN) to acquire sensor data from the wireless sensor board and also from external sensors such as dielectric moisture sensor, rain gauge, temperature sensor, humidity sensor.
7) Describes the RF communication using Wireless sensor nodes
8) Design, develop, and implement, different wireless sensor network algorithms for grouping the nodes.
9) Developing any suitable application using WSN.(Home automation/Smart parking)

EE 8.4.4 ADVANCED CONTROL SYSTEMS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE8.4.4	Advanced Control Systems	3	1	2	3	100	25	--	--	25	**150**

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Course Objectives:

1. To understand the concepts in state variable analysis, non-linear systems and optimal control
2. To study the design of state space controller
3. To understand the concepts in the phase plane analysis.
4. To understand the concepts in describing function analysis.
5. To analyze the stability of the nonlinear systems using different techniques.
6. To study the design of optimal controller.

Course Outcomes:

On completion of this course, the students will have a understanding of stability of non linear systems and optimal control theory. They will be able to analyze stability of a system and design a controller using state space analysis.

UNIT – 1 (12 Hours)

State Variable Analysis: Concept of state, State Variable and State Model .State models for linear and continuous time systems. Solution of state and output equation , controllability and observability. Pole Placement, State observer, Design of Control Systems with observers.
Modal control: Effect of state feedback on controllability and observability, Design of State Feedback Control through Pole placement. Full order observer and reduced order observer

UNIT – 2 (12 Hours)

Non-Linear Control System:
Features of linear and non-linear systems, Common physical non-linearities. Methods of linearising non-linear systems. Concept of phase portraits , Singular points ,Limit cycles , Construction of phase portraits.
Phase plane analysis of linear and non-linear systems , Isocline method.

UNIT – 3 (12 Hours)

Describing Function Analysis: Basic concepts, derivation of describing functions for common non-linearities. Describing function, analysis of non-linear systems
Stability Analysis: Conditions for stability – Stability of oscillations. Liapunov's stability concept, Liapunov's direct method ,Lure's transformation, Aizerman's and Kalman's conjecture ,Popov's criterion , Circle criterion.

UNIT – 4 (12 Hours)

OptImal Control: Introduction , Decoupling, Time varying optimal control, LQR steady state optimal control , Optimal estimation ,Multivariable control design.
Variation: Calculation of variation, Minimization of functionals of single function, Constrained minimization. Minimum principle. Control variable inequality constraints. Control and state variable inequality constraints. Euler Lagrangine Equation

Recommended Readings:

1. J. Nagrath and M. Gopal,; Control Systems Engineering; New Age International Publishers
2. Ashish Tewari; Modern control Design with Matlab and Simulink; John Wiley, New Delhi, 2002.
3. George J. Thaler; Automatic Control Systems; Jaico Publishers, 1993.
4. M.Gopal; Modern control system theory; New Age International Publishers, 2002.
5. Gene F. Franklin, J. David Powell and Abbasemami-Naeini; Feedback Control of Dynamic Systems; Fourth edition; Pearson Education, Low price edition;2002.
6. Benjamin C. Kuo; Digital Control Systems; Oxford University Press; 1992.
7. Raymond T. Stefani & Co; Design of feedback Control systems; Oxford University; 2002.
8. K. Ogata; Modern Control Engineering; 2nd edition; PHI
9. M. Gopal; Digital Control & State variable methods; Tata MC Graw Hill;2003.
10. M.Vidyasagar; Non Linear System analysis; Prentice Hall
11. Brian Anderson ,John Moore; Optimal Control

List of Experiments:

1. State space representation of continuous system in to discrete time using Matlab/Scilab.
2. Analyze the effect of sampling on discrete time state space using Matlab/Scilab.
3. Analyse stability of discrete time state space model using Eigen value analysis and plot its state response using Matlab/Scilab/simulink.
4. Design state feedback controller for the discrete time state space model using Matlab/Scilab.
5. Design state observer for the discrete time state space model using Matlab/Scilab.
6. Implement discrete PI/PD controller for the discrete time state space model using Matlab/Scilab/simulink
7. Implement discrete PID controller for the discrete time state space model using Matlab/Scilab/simulink

8. Analyze the effect of nonlinear element on sinusoidal input using Matlab/Scilab/simulink
9. Obtain phase trajectory of any feedback control system using Matlab/Scilab/simulink.
10. Optimal Control design using Matlab/Scilab
11. Stability Analysis using Matlab/Scilab

EE 8.4.5 SWITCH MODE POWER CONVERTERS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.4.5	Switch Mode Power Converters	3	1	2	3	100	25	--	--	25	**150**

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Course Objectives:

The advent of new power electronic devices having better features as regards ratings and switching speed has paved the way for wide ranging application spanning power systems and electric drives which makes it imperative to understand the functioning of basic building blocks this subject will introduce the students to understand the features of new devices along with their use in building different circuits having wide area of applications

Course Outcomes:

The student will be able to understand the basics of switching operation and how the different arrangement of switches with the switching sequence control can lead to formation of different circuits that can have wide ranging application in power systems and electric drives

UNIT – 1 (12 Hours)

DC-DC Converters without Galvanic Isolation: Linear power supplies - overview of switching power supplies - introduction to dc - dc switched mode converters - step down converters – continuous conduction mode - boundary between continuous and discontinuous conduction - discontinuous conduction mode - output voltage ripple. Step up converter - continuous conduction mode - boundary between continuous and discontinuous conduction - discontinuous conduction mode - buck boost converter - continuous conduction mode -boundary between continuous and discontinuous conduction - discontinuous conduction mode – output voltage ripple - full bridge dc-dc converter - PWM with bipolar and unipolar voltage switching - dc-dc converter comparison

UNIT – 2 (12 Hours)

Switching dc power supplies with isolation: dc-dc converters with electrical isolation - flyback converters - double ended flyback converter - forward converters - double ended forward converter - push pull converters - half bridge converters - full bridge converters.

Voltage mode control of SMPS: loop gain and stability considerations - shaping the error amp frequency response - error amp transfer function - transconductance error amps - study of popular PWM Control ICs
(SG 3525, TL 494, MC34060 etc.)
Current mode control of SMPS : current mode control advantages - current mode Vs voltage mode - current mode deficiencies - slope compensation - study of a typical current mode PWM control IC UC3842

UNIT – 3 (12 Hours)

Switch mode dc-ac converters: Basic concepts of switch mode converters - PWM switching scheme - square wave switching scheme - single phase inverters - half bridge and full bridge inverters - SPWM with bipolar and unipolar voltage switching - push pull inverters - switch utilization in single phase inverters -three phase inverters.
SPWM in three phase voltage source inverters - square wave operation - switch utilisation - ripple in the inverter output - conduction of switches in three phase inverters - effect of blanking time on voltage in PWM inverters - square wave pulse switching - programmed harmonic elimination switching - current regulated modulation - Single Phase Switched Mode Rectifier and its control.

UNIT – 4 (12 Hours)

Introduction to modeling of switched mode power supplies: State space averaging - state space averaged models - equivalent circuits and small signal transfer functions for basic converters.
Introduction to resonant converters: Classification of resonant converters - basic resonant circuit concepts - load resonant converter - resonant switch converter - zero voltage switching clamped voltage topologies - resonant DC link inverters with zero voltage switching - high frequency link integral half cycle converter.

Recommended Readings:

12. Pressman A I; Switching Power Supply Design; Mcgraw Hill
13. Mitchell D M; DC –DC Switching Regulator Analysis; Mcgraw Hill
14. Ned Mohan; Power Electronics; John Wiley and Sons
15. Otmar Kilgenstein; Switched Mode Power Supply in Practise; John Wiley
16. Billings K H; Handbook of Switched Mode Power Supplies; McGraw Hill
17. Nave M J; Power Line Filter Design for Switched Mode Power Supplies.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments.)

1. Design and fabrication of DC- DC buck CONVERTER
2. Design and fabrication of DC- DC boost CONVERTER
3. Design and fabrication of DC- DC buck boost CONVERTER
4. Design and fabrication of single phase half bridge converter

5. Design and fabrication of single phase full bridge converter
6. Design and fabrication of single phase half bridge DC-AC converter
7. Design of PWM switching scheme for sinusoidal PWM
8. study of popular ICs used like IC 3524 IC 3824
9. study of SMPS circuit with reference to waveform at different points
10. Design and fabrication of inductor to be used in DC-DC converters

EE 8.4.6 ENTREPRENEURSHIP DEVELOPMENT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/ week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
EE 8.4.6	Entrepreneurship Development	3	1	2	3	100	25	--	--	25	**150**

Course Objectives:

1. To equip them with requisite knowledge so that they can take up entrepreneurship a s their career.
2. An understanding of qualities and requirements of an entrepreneur.
3. An ability to understand the requirements of Project identification, formulation and implementation.
4. An understanding of Break even analysis.
5. An understanding of the complexity of managing in a global world.

Course Outcomes:

After the successful completion of this course, the students will be able to:

1. Explain the skills for project identification, formulation and implementation.
2. Explain the essential qualities and requirements of an entrepreneur.
3. Apply the concepts of Break even analysis.
4. Apply managerial concepts to solve complex problems related to global issues.

UNIT 1 (12 Hours)

Entrepreneurship Development: Meaning, objectives, scope & philosophy, type of entrepreneurs, factors affecting entrepreneurship, entrepreneurial qualities, major motives Influencing an Entrepreneur, need for promotion of entrepreneurship & small business, linkage between entrepreneurship and economic development, Entrepreneurship Support System.

Identification of Business Opportunities: SWOT Analysis, Environmental Screening-features, why, significance of environmental screening, Identification of business opportunities.

Small Scale Industry: Definition; Characteristics; Need and rationale: Objectives; Scope; role of SSI in Economic Development. Advantages of SSI, Steps to start an SSI – Government policy towards SSI; Different Policies of S.S.I.

UNIT 2 (12 Hours)

Project Identification: Assessment of viability, Formulation, Evaluation, Financing, Field-study and Collection of information, Preparation of project report, Demand analysis, Material balance and Output methods, Benefit cost analysis, Discounted cash flow, Internal rate of return and net present value methods. Guidelines by Planning Commission for Project report, Network Analysis, Errors in Project Report, Project Appraisal.

Project Planning and Control: The financial functions, cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures. Profit planning and programming, planning cash flow, capital expenditure and operations. Control of financial flows.

UNIT 3 (12 Hours)

Financing and Accounting: Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Break Even Analysis.

Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control. Marketing, industrial relations. Sales and purchases, advertisement, wages and incentive, inventory control, preparation of financial reports, accounts and stores studies.

UNIT 4 (12 Hours)

Introduction to Production Management: Types of production systems, production planning and control, functions of production manager & materials management. Introduction to Human Resource Management: Manpower planning, recruitment, selection, placement & induction, training & development, compensation.

Laws concerning entrepreneur viz, partnership laws, business ownership, income taxes and workman compensation act.

Role of various national and state agencies which render assistance to small scale industries.

Recommended Readings:

1. V. Havinal; Management and Entrepreneurship; New Age International; 1e; 2011.
2. J. Forbat; Entrepreneurship; New Age International; 1e.; 2007.
3. P. Chandra; Fundamentals of Financial Management; 3rd Edition; Tata McGraw-Hill, New Delhi; 1995.
4. C. B. Gupta; Management: Theory and Practice; 19th Revised and Enlarged edition; Sultan Chand & Sons; 2017.

5. P. C. Tripathi, P. N. Reddy; Principles of Management; 2e; Tata McGraw Hill; 1991.

List of Experiments:

At least eight assignments, two on each unit must be submitted by students within stipulated time.

EE 8.5 PROJECT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
EE 8.5	Project	--	--	8	--	--	--	75	--	75	**150**

Guidelines for Project:

1) Students should present their work in two progress reviews (mid-sem and endsem).
2) VIIIth semester Project work being the concluding part of the Project, should preferably have details such as Statement of problem, Objective and Scope of the study, Literature review, Methodology, Results and Discussions, Conclusions and Future Scope, References etc.
3) Students shall submit final project report to the department in the form of hard and soft copy at the end of the term.
4) Term Work in project is a separate Head of Passing. The project work conducted and its report will be assessed under this Head.