ELECTIVE COURSES

PROCESSOR APPLICATIONS IN ELECTRICAL ENGINEERING

Hours Per Week :

L	T	P	C
3	-	-	3

Course Description and Objectives:

This course deals with the introduction and study of microcontroller 8051, DSP and FPGA and the various applications of processors to electrical engineering.

Course Outcomes:

Upon successful completion of this course, the student should be able to:

a. Develop program in microcontroller to control converter.
b. Configure different registers in DSP.
c. Implement different PWM technique using DSP.
d. Design and implement different DSP based systems

SKILLS ACQUIRED:

- ✓ Able to generate pulse signals required for switches using microcontroller.
- ✓ Able to generate pulse signals using DSP.
- ✓ Able to design a rectifier.
- ✓ Able to design a inverter.

ACTIVITIES:

1. Design AC voltage controller using microcontroller.
2. Design 1 phase control rectifier using microcontroller.
3. Design DC-DC Buck converter using microcontroller.
4. Design DC-DC boost converter using microcontroller.

UNIT – I **L- 10**

Introduction to 8051

Micro controller 8051, Special Function Registers, Interfacing with external memory, programmable built in ports, on chip counters / timers, Serial Data Input / Output, Interrupts, assembly language Programming and applications.

UNIT – II **L- 10**

Introduction to Digital Signal Processor (DSP TMS 320 F2812)

Need of Digital Signal Processor (DSP), Examples of TI DSP family. Comparison of different DSPs of TI, Architecture of DSP TMS 320 F2812, pin diagram, main features, Block diagram, peripherals as CPU timers, Event managers, ADC, Enhanced controller area network (eCAN), Serial communication interface modules, Digital i/o and shared pin functions, serial peripheral interface module, PIE block.

UNIT – III **L- 10**

Register overview of DSP

Register Functional Overview, Register Bits I/O Mapping, PLL based Modes of Operation, PLL Control Register (PLLCR) field Description, Peripheral Clock Control, High-Speed Peripheral Clock Prescaler (HISPCP) Register, Watchdog Block, EALLOW Protected Registers, All GP registers, GP Timers, Compare units, Timer operating modes, DBTCON register, PWM waveform generation and programming.

UNIT – IV **L- 10**

Introduction to FPGA

FPGA based controller for PE and Drives.

UNIT – V **L- 10**

Application of DSP and FPGA to power electronics and drives

Applications of Digital Signal Processor in Power Electronics converters and drives.

TEXT BOOKS:

1. eZdspTM F2812 technical reference
2. TMS320x281x DSP Data manual.
3. Muhammad Ali Mazidi , “The 8051 Microcontroller And Embedded Systems Using Assembly And C, 2/E”, Pearson Education India, 01-Sep-2007.

REFERENCES:

1. Ayala, J. Kenneth, “The 8051 Microprocessor Architecture, Programming and Applications”, Penram International, 1996.
2. TMS320x281x DSP Event Manager (EV) Reference Guide
3. Trevor Martin, "The Insider's Guide To The Philips ARM7-Based Microcontrollers", Published by Hitex (UK) Ltd, April 2005.

MODERN CONTROL THEORY

Hours Per Week :

L	T	P	C
3	-	-	3

Course Description and Objectives:

This course provides glimpses into the advanced methods of modeling and analysis of the dynamical systems.

Course Outcomes:

Upon successful completion of this course, the student should be able to:

a. Obtain mathematical model of dynamical systems.
b. Appreciate concept of linear algebra.
c. Analyze the system dynamics and Lyapunov stability theory.

SKILLS ACQUIRED:

- ✓ Able to design linear quadratic controller .
- ✓ Able to apply Lyapunov stability theory for LTI systems.
- ✓ Able to linearize a non linear model.
- ✓ Able to predict the controllability and observability of a particular system.

ACTIVITIES:

1. Estimation of controllability for a given system.
2. Estimation of observability for a given system.
3. Estimation of stability for a given system
4. Conversion of non linear system to linear system.

UNIT – I **L- 10**

Math Modeling of Dynamical Systems: Newtonian and Lagrangian approaches, concept of dynamical state of a system, concept of equilibrium point, linearisation of non-linear model.

UNIT – II **L- 10**

Review of Linear Algebra concepts: Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, diagonalisation

UNIT – III **L- 10**

Modern Control Analysis and stability analysis: Concept and computation of systems modes, controllability theorem and its proof, observability theorem and its proof, controllable and observable subspaces. Stability of linear systems, stability types and their definitions for any general system, stability of an equilibrium point, Lyapunov stability theory for LTI systems, quadratic forms and Lyapunov functions

UNIT – IV **L- 10**

Modern Control Design: Converting the math model to controllable canonical form and its use for pole placement, concept of linear observer and its design, design of reduced order observer, compensator design using separation principle, poles of compensator, open-loop and close-loop systems

UNIT – V **L- 10**

Optimal Control Theory: Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter

TEXT BOOKS:

1. Control System Design: An Introduction to State-Space Methods, Bernard Friedland, Dover Publications, Inc. Mineola, New York.
2. Linear Systems, Thomas Kailath, Prentice-Hall Inc., New Jersey.

REFERENCES:

1. Modern Control System Theory,M. Gopal, New Age International (P) Limited, New Delhi.
2. Linear System Theory and Design, Chi-Tsong Chen, Oxford University Press Inc., New York.

POWER QUALITY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
50	16	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course deals with the characteristics of solar radiation, its global distribution, and conversion methods of solar energy to heat and power, design and application of solar photovoltaic systems for power generation on small and large scale electrification.

Course Outcomes:

Upon successful completion of this course, the student should be able to:

a. Analyze three phase circuits under different conditions.
b. Compensate load in presence of harmonics and unbalance.
c. Design compensators at distribution level to mitigate power quality issues.

SKILLS ACQUIRED:

- ✓ Able to study the effect of non linear loads on power quality.
- ✓ Able to study the effect of ground loop.
- ✓ Able to study the effect of harmonics on energy meter reading.
- ✓ Able to study the effect of voltage sag on electrical equipments.

ACTIVITIES:

1. Calculate distortion power factor.
2. Calculate the specifications of filter to reduce current harmonics.
3. Demonstration of voltage and current distortions.
4. Study of capacitor switching transients.

UNIT – I **L- 10**

Introduction: Definitions of various powers, power factor and other figures of merit under balanced, unbalanced and non-sinusoidal conditions applied to single phase as well as three phase circuit.

UNIT – II **L- 10**

Voltage variations and Transients : Voltage variations, voltage sags and short interruptions, flicker, voltage variations, sources, range and impact on sensitive circuits,solutions and mitigations . Transients, origin and classification,capacitor switching transient,lightning,load switching , impact on users , protection and mitigation.

UNIT – III **L- 10**

Fundamentals of load compensation: Fundamental of load compensation, voltage regulation, phase balancing and power factor correction of unbalanced load. Generalized approach for load compensation using symmetrical components. Introduction to custom power devices and their applications in power system. There operating principles.

UNIT – IV **L- 10**

Analysis of DVR:Detailed modeling, analysis and design aspects, DVR. Modeling analysis and design aspects of DSTATCOM Compensators to mitigate power quality related problems. Realization of DVR and DSTATCOM by using VSC

UNIT – V **L- 10**

Power Quality Management in 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, Power Quality Audit.

TEXT BOOKS:

1. A. Ghosh and G. Ledwich, "Power quality enhancement using custom power devices", Kluwer Academic Publication, 2002.
2. C. Shankran. "Power quality", CRC Press, 2001.
3. Roger C. Dugan et al, "Electrical power systems quality", Tata McGraw-Hill, 2002.

REFERENCES:

1. Angelo Baggini (Ed), "Handbook of power quality", John Wiley & Sons, 2008.
2. H. Akagi et al , "Instantaneous power theory and application to power conditioning", IEEE Press, 2007.

Related Web-Links:

1. nptel.ac.in
2. Power Standards Lab - Tutorials & Standards

Website: www.powerstandards.com/tutor.htm

17EE XX -Optimization Techniques

Hours Per Week :

L	T	P	C
3	1	-	3

Total Hours :

L	T	P
40	10	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course deals with static optimization methods of linear and non-linear systems and also the dynamic programming. The ever-increasing demand on engineers to lower production costs, energy losses and to maximize operational reliability has prompted engineers to look for rigorous methods of decision making such as optimization techniques. The knowledge of optimization is needed in design and operation of electrical systems as these systems handle large power.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

a. understand importance of optimization of industrial process management
b. apply basic concepts of mathematics to formulate an optimization problem
c. analyze and appreciate variety of performance measures for various optimization problems

SKILLS ACQUIRED:

- ✓ Formulate the real world problem into mathematical equations.
- ✓ Analyze different optimization techniques suitable for linear and nonlinear programming problems.
- ✓ Understand various Meta- Heuristic optimization techniques.
- ✓ Adapt suitable optimization technique to the existing real world problems.

ACTIVITIES:

1. Formulation of Industrial problem into linear/non-linear programming problem.
2. Simplex method-Programming using MATLAB.
3. Powell's Method-Programming using MATLAB.
4. Newton's method-Programming using MATLAB.

UNIT – I **L- 8**

Introduction to Linear Programming: Introduction-objective function and constraints.

Examples from real world. Standard form of linear programming problem. Geometrical solution, System of linear equations. Simplex method, two phases of simplex method.

UNIT – II **L- 10**

Linear Programming: Dual simplex method, Transportation problem, Assignment problem, examples.

Nonlinear programming: Unconstrained optimization-direct methods: Powell's Method, conjugate direction, Indirect search methods: steepest descent, Newton's methods.

UNIT – III **L- 8**

Constrained optimization: Sequential linear programming, Methods of feasible directions, gradient projection method, penalty function method, Augmented Legrangian multipliers method. Kuhn-Tucker conditions.

UNIT – IV **L- 8**

Dynamic programming: Multistage decision processes, Principal of optimality, computational procedure, linear programming as a case of dynamic program. All integer and mixed integer programming, Branch and Bound method.

UNIT – V **L- 6**

Meta- Heuristic Optimization: Simulated annealing, Evolutionary Programming, Genetic Algorithm, Swarm optimization and other nature inspired algorithms.

TEXT BOOKS:

1. S.S.Rao, "Engineering Optimization", revised 3rd ed., New Age international publishers.
2. Ashok D. Bellegundu and T.R. Chandru Patla, "Optimization Concepts and Application in Engineering" Pearson Edition Asia, 2002

REFERENCES:

1. Kalyanmoy Dev, "Optimization for Engineering Design" Printice-Hallof India, 2005
2. Fred Glover, G. A. Kochenberger, "Handbook of Metaheuristics", Kluwer Academic Publishers
3. Gill Murray and Wright, "Practical Optimization", Academic Press.
4. Laurence A. Wolsey, "Integer Programming", John wiley and Sons.

17EE XXX - AI TECHNIQUES IN ELECTRICAL ENGINEERING

Hours Per Week :

L	T	P	C
3	1	-	3

Total Hours :

L	T	P
40	10	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course deals with concepts of artificial intelligence such as artificial neural networks ,fuzzy logic and genetic algorithms for solving electrical engineering problems. The objective of the course is to understand the operation of artificial neuron models, various topologies of artificial neural networks, fuzzy logic, genetic algorithm to model and study the behaviour of electrical systems..

Course Outcomes:

Upon completion of this course the students will be able to:

a. understand and apply fuzzy logic technique to optimization of electrical engineering problems.
b. understand and apply the concepts of artificial neural networks to optimization of electrical engineering problems.
c. apply genetic algorithms for optimization of electrical engineering problems

SKILLS:

- Design neural network for simple digital logic circuit.
- Design simple neural network for solving electrical engineering problems.
- Design fuzzy logic controller for solving electrical engineering problems.
- Implement genetic algorithm for solving electrical engineering problems.

ACTIVITIES:

1. Realize simple Boolean Expressions using an artificial neural network.
2. Design an artificial neural network for speed control of DC Motor
3. Design an artificial neural network for speed control of a ceiling fan.
4. Design fuzzy *logic controller for speed* control of DC Motor
5. Design fuzzy logic controller for speed control of AC Motor
6. Implement genetic algorithm for speed control of DC Motor

UNIT – I **L- 08**

FUNDAMENTALS OF NEURAL NETWORKS :Working of biological neuron, Model of an artificial neuron, Basic concepts of neural networks, Neural network architectures, Characteristics of neural networks, Learning methods, Taxonomy of neural network architectures, Broad application areas in electrical engineering

UNIT – II **L- 08**

BACKPROPAGATION NETWORKS: Architecture of a backpropagation network, Backpropagation learning, Illustration, Applications, Effect of tuning parameters of the backpropagation neural network, Selection of various parameters in BPN.

UNIT – III **L- 08**

CLASSICAL AND FUZZY SETS: Introduction to classical sets - Properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.

UNIT – IV **L- 08**

FUZZY LOGIC SYSTEM COMPONENTS: Fuzzification, Membership value assignment, Development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods, Fuzzy logic applications - Fuzzy logic control and fuzzy classification; Application of fuzzy logic in basic problems of electrical engineering.

UNIT – V **L- 08**

GENETIC ALGORITHMS : History, Basic concepts, Creation of offsprings, Working principle, Encoding, Fitness function, Reproduction, Inheritance operators, Cross over, Inversion and Deletion, Mutation operator, Bit-wise operators, Generational cycle, Convergence application of GA in power systems and power electronics (Qualitative treatment only).

TEXT BOOKS:

1. Rajasekharan and Pai, “Neural Networks, Fuzzy logic, and Genetic algorithms: Synthesis and Applications”, 1st edition, Prentice Hall of India Publication, 2009.
2. Jacek M. Zurada, “Introduction to Artificial Neural Systems”, 1st edition, Jaico Publishing House, 2006.

REFERENCES:

1 James A Freeman and Davis Skapura, “Neural Networks”, 1st edition, Pearson, 2008.
2. Simon Haykins, “Neural Networks”, 2nd edition, Pearson Education, 2009.
3. Bork Kosko, “Neural Networks and Fuzzy Logic System” 1st edition, Prentice Hall of India Publications, 2009.

17EE XXX - PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS

Hours Per Week :

L	T	P	C
3	1	-	3

Total Hours :

L	T	P
40	10	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course deals with the fundamentals, construction and operation of Programmable Logic Controllers. It also explains the methods of programming the PLCs and different industrial PLC applications.

Course Outcomes:

Upon completion of this course the students will be able to:

a. Understand the fundamentals Programmable Logic Controllers.
b. Identify the types of PLC communications and network systems.
c. Design, edit, test, and document PLC Ladder Logic Programs.
d. Diagnose and troubleshoot PLCs using software.
e. Specify safety consideration for personnel, field devices and automated equipment.

SKILLS:

- ✓ Understand the construction of PLC system
- ✓ Understand the programming format and data handling functions.
- ✓ Identify the electrical wiring of an industry
- ✓ Automate the electrical wiring of an industry.

ACTIVITIES:

1. Design of PLC system for traffic control
2. Design of PLC system for a residential water pump.
3. Design of PLC system for conveyer system .
4. Design of PLC system for railway Gate control.

UNIT – I **L- 08**

PLCBasics: PLC system, I/Omodules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/Omodules. PLC programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils, drill press operation.

UNIT – II **L- 08**

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 – III **L- 08**

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 – IV **L- 08**

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 axis and three axis Robots with PLC, Matrix functions.

UNIT – V **L- 08**

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

TEXT BOOKS:

1. John W. Webb and Ronald A. Reiss, "Programmable Logic Controllers– Principle and applications" 5th ed., PHI.
2. JR. Hackworth and F.D. Hackworth, "Programmable Logic Controllers– Programming Method and applications", Jr. Pearson, 2004.

REFERENCES:

1. Micrologix 1000 Programmable Controllers – User Manual
2. Allen-Bradley – Advanced Programming Software
3. Logix5000 Controller Common Procedures
4. SLC500 User Manuel Cat. No. 1747-KFC15

17EEXXX- New and Renewable Energy Sources and Technologies

Hours Per Week :

L	T	P	C
3	1	-	3

Total Hours :

L	T	P
40	10	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course is aimed at offering fundamental concepts and knowledge of working principles and the importance of renewable energy resources. Renewable Energy Systems are an important technology that has the potential to advance environmental goals and eventually support a sustainable future. In this subject students are exposed to Geothermal, Biomass, Ocean Energy, and Fuel cells. It also includes the concepts of Small hydro and MHD energy technologies.

Course Outcomes:

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

a. Work on principles of wind energy technology.
b. Work on principles and components of geothermal power plant.
c. Work on principles and components of tidal and OTEC power plants.
d. Work on operating principles of biomass plants.
e. Work on principles and components of small hydro and MHD power plants.

SKILLS ACQUIRED:

- ✓ Able to understanding the different types of Renewable energy resources.
- ✓ Able to understand different biomass energy conversion routes.
- ✓ Able to acquire a skill of understanding different types of batteries.
- ✓ Able to get a skill of understanding and operation of new energy technologies.

ACTIVITIES:

1. Able to design a prototype of wind mill.
2. Able to design a prototype of biogas plant.
3. Review the status of Technical Aspects of Ocean Energy in the World.
4. Review the status of Technical Aspects of Geothermal Energy in the World.
5. Review the status of small hydro and MHD generation in India.

UNIT - I **L- 08**

Wind Energy: Wind energy - energy chains, application - historical background, merits and limitations, nature of wind, planetary and local day / night winds, wind energy quantum, variables and units used in calculations, wind power density Pw, Power calculations, power in wind, power by turbine, efficiency, kinetic energy, incoming velocity Vi, exit velocity Ve, Power, torque thrust calculations, velocity at different heights, site selection, Favourable wind speed range, wind energy wind velocity duration, energy pattern factor.

UNIT - II **L- 08**

Biomass Energy : Biomass energy resources : Photosynthesis and origin of biomass energy, biomass energy resources, cultivated biomass resources, waste to biomass resources, Terms and definitions, Incineration, wood and wood waste, Harvesting super trees and energy forests, pyrolysis, Thermo chemical biomass conversion to energy, gasification, Anaerobic digestion, Fermentation, Gaseous fuel from biomass, Design of a bio gas plant.

UNIT - III **L- 08**

Ocean and Tidal Energy : Ocean and Tidal energy conversion, Energy sources in ocean - Ocean tidal, wave and thermal energy, Ocean saline gradient concept, ocean currents, ocean chemical energy, ocean energy conversion routes, electrical and non electrical routes, Bipolar, mono polar HVDC cable transmission Advantages and merits of ocean energy technologies, limitation, preconditions for commercial installation. Tides - spring tide, neap tide, daily and monthly variation, Tidal range, Tidal Power, Types of tidal power plants, single basin & double basin schemes, main requirements in tidal power plants, energy storage, prospects of tidal power, economic factors. Ocean Thermal Energy conversion (OTEC) – open and closed cycle operation – Ecological & environmental impacts.

UNIT - IV **L- 08**

Geothermal Energy : Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.

UNIT – V **L- 08**

New Energy Technologies: Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Turbines and Generators for Small Scale Hydro Electric plants, Advantages and Limitations of Small Scale Hydro-Electric plants, MHD Generators Basic, Principle of MHD, Open Cycle and Closed Cycle MHD Technologies, Applications Advantages & Disadvantages.

TEXT BOOKS:

1. G.D. Rai, “Non Conventional Energy Sources”, 4th edition, Khanna Publishers, New Delhi, 2011.
2. Anne-Marie Borbely, Jan F.Kreider, “Distributed Generation”, CRC Press LLc, 2001

REFERENCES:

1. S.P. Sukhatme, J.K.Nayak., “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
2. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
3. Chauhan D.S., Srivastava S.K. “Non-Conventional Energy Resources”, New Age, 2009.
4. Georgiadis M.C., “Energy Systems Engineering”, Wiley-VCH, 2008.

17EE XXX - SOLAR ENERGY CONVERSION

Hours Per Week :

L	T	P	C
3	1	-	3

Total Hours :

L	T	P
40	10	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course deals with the characteristics of solar radiation, its global distribution, and conversion methods of solar energy to heat and power, design and application of solar photovoltaic systems for power generation on small and large scale electrification.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

a. Understand the solar radiation and measurement techniques.
b. Calculate the radiation availability at a given location.
c. Understand the fundamentals of thermal and direct conversion of solar energy to power.
d. Understand the principle of direct solar energy conversion to power using PV technology
e. Design a PV system for various applications.

SKILLS ACQUIRED:

- ✓ Able to understand different types of solar cell technologies.
- ✓ Able to understand the working of soar water heating systems.
- ✓ Able to acquire a skill of understanding different components of a PV system.
- ✓ Able to design a solar system for a home.

ACTIVITIES:

1. Draw the V-I characteristics of a solar panel.
2. Design of Solar PV system for a residential application.
3. Design of solar cooker.
4. Design of solar still.

UNIT – I **L- 08**

Solar Radiation and Measurement: Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar isolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E)

UNIT – II **L- 08**

Solar Radiation Geometry and Calculations: Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability

UNIT – III **L- 08**

Solar Thermal Energy Conversion: Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electric power plant, central tower receiver power plant, Liquid based solar heating system; Natural and forced circulation systems, Solar Thermal Energy Storage - Sensible storage; Latent heat storage; Thermo-chemical storage. Solar still; solar cooker; Solar passive heating and cooling systems: Trombe wall; Solar drying.

UNIT – IV **L- 08**

Solar photovoltaic energy conversion: Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell, semiconductor properties, energy levels, basic equations. Solar cell, p-n junction, structure and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Concept of maximum power point, cell efficiency, fill factor effect of irradiation and temperature, Solar PV power plants.

UNIT – V **L- 08**

PV system components and applications: System components - PV arrays, inverters, batteries, charge controls, net power meters. PV array installation, operation, costs, reliability, Design of a PV system. Central Power Station System, Distributed PV System, Stand alone PV system, grid Interactive PV System, small system for consumer applications, hybrid solar PV system,

TEXT BOOKS:

1. Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt., Ltd., 2009.
2. S.P. Sukhatme, J.K.Nayak., "Solar Energy", Tata McGraw Hill Education Private Limited, New Delhi, 2010.

REFERENCES:

1. Garg H.P., Prakash J., "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
2. Yogi Goswami D., Frank Kreith, Jan F. Kreider, "Principles of Solar Engineering", Second Edition, Taylor & Francis, 2003.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
4. Chauhan D.S., Srivastava S.K. "Non-Conventional Energy Resources", New Age, 2009.
5. Georgiadis M.C., "Energy Systems Engineering", Wiley-VCH, 2008.

17EEXXX - ENERGY AUDIT, CONSERVATION & MANAGEMENT

Hours Per Week :

L	T	P	C
3	1	-	3

Total Hours :

L	T	P
40	10	0

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

To familiarize the students with energy auditing, conservation and management. Energy audit is usually conducted to understand how energy is used within the plant and to find opportunities for improvement and energy saving.

Course Outcomes:

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

a. Use Energy conservation principles.
b. Use Energy conservation in thermal systems.
c. Use Energy conservation in electrical systems.
d. Use Basic concepts of energy management.

SKILLS ACQUIRED:

- ✓ Able to understanding the energy conservation measures for various equipment.
- ✓ Students can able to get the knowledge of different lighting schemes.
- ✓ Able to design of the capacitor bank required conserving energy for an energy utility.
- ✓ Able to conduct Energy Auditing of an energy utility

ACTIVITIES:

1. Surveying the Air–conditioning systems in VFSTRU campus to implement Energy conservation measures.
2. Surveying the VFSTRU campus to modify the existing lighting schemes.
3. Design of the capacitor bank required conserving energy for VFSTRU Campus.
4. Energy Auditing of different blocks in VFSTRU campus

UNIT - I **L- 08**

Basic Principles of Energy Management : Energy scenario - Energy Management - strategies - Energy conservation - Energy audit – definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes and energy saving potential, Energy Instruments – watt – hour meter, data loggers, thermocouples pyrometers, lux meters, tong testers, Power analyzer.

UNIT - II **L- 08**

Co-generation, Tri-generation & Waste Energy Recovery: Co-generation & Tri-generation: Definition, need, application, advantages, classification, saving Potential.

Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

UNIT - III **L- 08**

Energy Efficient Lighting : Modification of existing systems-Replacement of existing systems – priorities: definition of terms and units, luminous efficiency – Polar curve- Calculation of illumination level- Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings(luminaries) – flood lighting – White light LED and conducting Polymers – Energy conservation measures.

UNIT - IV **L- 08**

Energy Efficiency in Electrical Appliances: Power factor – Causes of low p.f - Methods of Improving p.f - static Capacitors, synchronous condensers phase advancer –Most economical p.f. for constant KW load and constant KVA type loads, Numerical Problems, location of improvement, location of capacitors, Pf with non linear loads, effect of harmonics on p.f., motor controllers – Energy efficient motors (basic concepts), Load scheduling and Shifting, Demand side management.

UNIT - V **L- 08**

Energy Efficiency in Space Heating and Ventilation: Ventilation, Air – Conditioning (HVAC) and Water Heating: Introduction- Heating of buildings-Transfer of Heat- space heating methods-Ventilation and air – conditioning- Insulation – cooling load – Electric water heating systems-Energy conservation methods.

TEXT BOOKS:

1. Energy management by W. R. Murphy & F. McKay Butter worth, Elsevier publications. 2012.
2. Energy efficient electric motors by John. C. Andreas, Marcel Inc Ltd- 2nd edition. 1995.

REFERENCES:

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc- graw Hill Book company- 1st edition, 1998
3. V.K Mehta and Rohit Mehta, "Principles of Power Systems", 1st ed.,S.Chand & Company Ltd., New Delhi, 2009.
4. Reay, D. A., "Industrial energy conservation", Pergamon Press, 1st edition, 2003.
5. White, L. C., "Industrial Energy Management and Utilization", Hemisphere Publishers, 2002.
6. Beggs, Clive, "Energy – Management, supply and conservation", Taylor and Francis, 2ndedition, 2009.
7. Smith, C.B., Energy "Management Principles", Pergamon Press, 2006.

EEXXX- ANALYSIS OF INVERTERS

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
51	-	24

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course enables the students to learn about the different working modes of inverters and designing of power converters. It also introduces the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation. It deals with the design different single phase and three phase inverters.

Course Outcomes:

Upon successful completion of this course, the student should be able to:

a. Understand the characteristics of power diodes and power handling capability of switching devices
b. Understand the static and dynamic characteristics of current controlled power semiconductor devices
c. Understand the static and dynamic characteristics of voltage controlled power semiconductor devices
d. Enable the students for the selection of firing and protection circuit for different power semiconductor switches
e. Understand the methods of thermal protection for different semiconductor devices

SKILLS ACQUIRED:

- ✓ They will be able to design a diode clamped multilevel inverter for speed control of BLDC motor.
- ✓ They will be able to design solar smart inverter system.
- ✓ They will be able to design Space vector Modulation Technique.
- ✓ They will be able to design Pulse Width Modulation (PWM) Inverters.
- ✓ They will be able to design UPS system.

ACTIVITIES:

1. Design of different parts of UPS.
2. Design a single PWM.
3. Design a multiple PWM.
4. Design a SPWM.
5. Design a SVPWM.
6. Design a multilevel inverter.

UNIT - I **L- 11**

Single phase inverters : Introduction to self commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated Thyristor inverters.

UNIT - II **L- 10**

Three phase voltage source inverters: 180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques.

UNIT - III **L- 10**

Current source inverters: Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters

UNIT - IV **L- 10**

Multilevel inverters: Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters

UNIT - V **L- 10**

Resonant inverters: Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters.

TEXT BOOKS:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, Second Edition, 2002.

REFERENCES:

1. Reissland, M.U, "Electrical Measurements: Fundamentals, Concepts, Applications" 1st ed., New Age International (P) Ltd. Publishers, 2010.
2. J.B. Gupta, "Electronic and Electrical Measurements and Instrumentation", 12th ed., S.K. Katharia, 2006.
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.

EEXXX- POWER SEMICONDUCTOR DEVICES AND PASSIVE COMPONENTS

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course is aimed at offering fundamental concepts of power electronic devices and switches. It also introduces the different cooling circuits. It also introduces the operation of power semiconductor devices like Power BJT, MOSFET, IGBT, GTO and to understand various static and dynamic performances of static switches.

Course Outcomes:

Upon successful completion of this course, the student should be able to:

a. Design switching using power semiconductor devices.
b. Specify design criteria (power, efficiency, ripple voltage and current, harmonic distortions, power factor).
c. Select components, interpret terminal characteristics of the components, model components, design circuit, and understanding operation of power electronics circuits.
d. Select a suitable device can be selected for a particular application.
e. To identify basic requirements for power electronics based design application.
f. understand the behavior of semiconductor devices operated as power switches
g. To understand and design single-phase and three-phase thyristor converters.
h. Learn the basic concepts of operation of dc-dc converters in steady state in continuous and discontinuous modes and be able to analyze basic converter topologies.
i. Elucidate the frequency changing operation using Cyclo Converter.
j. Expound the operation of various Inverters.

SKILLS ACQUIRED:

- ✓ They will be able to design variable power supply charger.
- ✓ They will be able to design linear voltage regulator.
- ✓ They will be able to design Preamplifier for Phones.
- ✓ They will be able to design Sensitive Moisture Detector.

ACTIVITIES:

1. Designing of class A commutation circuits
2. Designing of gate firing circuits
3. Generation of pulses.
4. Designing of class B commutation circuits
5. Designing of class C commutation circuits
6. Designing of class D commutation circuits
7. Designing of class E commutation circuits
8. Report on characteristics of SCR, GTO and MOSFET.

UNIT - I **L- 10**

Power semi-conductor devices : Structure, operation and characteristics of SCR, TRIAC, power transistor, MOSFET, IGBT and GTO-turn on and turn off characteristics – protection schemes, Triggering and commutation of SCR.

UNIT - II **L- 10**

Phase–controlled converters : 2- pulse, 3-pulse, 6-pulse and dual converters- inverter operation of fully controlled converter – effect of source inductance – distortion and displacement factor – ripple factor

UNIT - III **L- 09**

Choppers : Step-down and step-up choppers – time ratio and current limit control –Voltage commutated, current commutated and load commutated choppers, switching mode regulators – buck, boost, buck-boost converter

UNIT - IV **L- 08**

Inverters : Classification of inverters – single phase, three phase inverters– series inverter – parallel inverter –voltage control of single phase, three phase inverters – current source inverters, harmonic reduction in inverters, Multilevel inverter.

UNIT - V **L- 08**

AC to AC converters : Single phase AC regulators – sequence control of AC regulators –three phase AC regulators – single phase to single phase cyclo converter – three phase half wave cyclo converter – control circuit output voltage equation.

TEXT BOOKS:

1. Dr.P.S.Bimbra, "Power Electronics" 4th ed., Khanna publishers, 2009.
2. M.D. Singh & K.B Khanchandani, "Power Electronics", 2nd ed., Tata MC Graw Hill, 2009.

REFERENCES:

1. Vedam Subrahmanyam, "Power Electronics", 1st ed., New Age, 2001.
2. Ned mohan, "Power Electronics", 2nd ed., Wiley, 1995.
3. C.W Lander, "Power Electronics", 3rd ed., MCGraw Hill, 1993.
4. M.H.Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd ed., Prentice Hall of India, 2009.

EEXXX- SMPS Based Converters

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
51	-	24

WA/RA	SA	SSH	S	BS
5	8	40	5	5

Course Description and Objectives:

This course enables the students to learn about the different parts of SMPS and different SMPS based converters. It also introduces the concept of SMPS and analysis of the different SMPS based converters.

Course Outcomes:

Upon successful completion of this course, the student should be able to:

a. Able to model a fly back converter.
b. Able to model a forward converter.
c. Able to model a luo converter.
d. Able to model half bridge and full bridge converter

SKILLS ACQUIRED:

- ✓ They will be able to design different PWM techniques.
- ✓ They will be able to design flyback converter.
- ✓ They will be able to design forward converter.

ACTIVITIES:

1. Designing of different parts of SMPS.
2. Design a SPWM.
3. Design a SVPWM.
4. Design a flyback converter.
5. Design a forward converter.

UNIT - I **L- 11**

SMPS : Introduction to SMPS- Circuit description of SMPS-Types of SMPS-PWM techniques.

UNIT - II **L- 10**

Flyback converter: Analysis and state space modeling of flyback converter-control circuit-applications.

UNIT - III **L- 10**

Forward converter: Analysis and state space modeling of Forward converter-control circuit-applications.

UNIT - IV **L- 10**

Luo converter: Analysis and state space modeling of luo converter-control circuit-applications.

UNIT - V **L- 10**

Half bridge and full bridge converter: Analysis and state space modeling of luo converter-control circuit-applications.

TEXT BOOKS:

1. M.H. Rashid -Power Electronics handbook, Elsevier Publication, 2001.
2. Kjeld Thorborg, "Power Electronics –In theory and Practice", Overseas Press, First Indian Edition 2005

REFERENCES:

1. Philip T Krein, " Elements of Power Electronics", Oxford University Press
2. Ned Mohan, Tore. M.Undeland, William. P.Robbins, Power Electronics converters, Applications and design-Third Edition-John Wiley and Sons-2006
3. M.H. Rashid – Power Electronics circuits, devices and applications-third edition Prentice Hall of India New Delhi, 2007.