GOVERNMENT COLLEGE OF ENGINEERING, JALGAON

(An Autonomous Institute of Government of Maharashtra)
''Globally Accepted Engineers with Human Skills''
National Highway No. 6, Jalgaon – 425002

Department of Electrical Engineering

Final Year B.Tech (Electrical) Syllabus

(WEF 2017-18)

Final Year B.Tech (Electrical) Syllabus

(WEF 2017-18)

SEMESTER
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EE401: ELECTRICAL DRIVES

Teaching Scheme: 03 L + 01 T Total 04 **Credits**: 04
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The subject explores the knowledge of different industrial drives, load characteristics, factors for selection of drives depending upon their electrical and mechanical characteristics. The subject also provides the knowledge of solid state microprocessor based electric drives. The course consists of general factors of electrical drives, material classification, temperature rise and rating of machines.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Electrical Machines and Power Electronics

COURSE OBJECTIVES: The objectives of course are to:

a. introduce to different types of drives and their applications in various industries.
b. gain the knowledge about operation of DC motor speed control using converters and choppers.
c. understand the modes of operation of a drive in various applications.
d. enable the students identify the need and choice for various drives.
e. acquire the knowledge of different speed control methods in AC motors using thyristor based control schemes.
f. identify the use of microprocessor based drives in industries.

COURSE OUTCOMES:

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

1. apply the knowledge of electrical drives in different industrial applications.
2. understand different speed control methods of DC and AC motors using thyristor base control schemes.
3. understand the characteristic of load and selection of derive in industrial sectors.
4. conduct practical and analyze data for proper selection of derive in realistic constrain of load requirement.
5. discharge professional duties in industries with innovative ideas of operation and control of drives.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	3	1
PO-b	2	1	1	3	2
PO-c	2	3	2	2	2
PO-d	2	2	2	2	2
PO-f	2	2	1	1	1

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE401: ELECTRICAL DRIVES

Teaching Scheme: 03 L + 01 T Total 04 **Credits**: 04
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Basics of Electric Drives and Control: Electrical drives, advantages, parts of drives, choice of electric drives, fundamental torque equation, speed torque convention and multi-quadrant operation, components of load torque, nature and classification of load torques, time and energy loss in transient operations, steady state stability, load equalization, mechanical loads, dynamics of electrical drive, constant torque drive, constant power drive, selection of DC and AC drives, modes of operation. Selection of motor power rating: Classes of motor duty, determination of motor rating, drive classification, close loop control of drives, phase locked loop (PLL) control, closed loop control by current and speed sensing, closed loop position control.

DC Motor Drives: Speed-torque characteristics of dc separately excited, shunt and series motors and their performance like starting, braking, transient analysis, speed control, ward Leonard control. Single phase and three phase half and fully controlled converter fed dc series, shunt and separately excited motor. Multi-quadrant operation, chopper controlled drives and its closed loop speed control of dc motor. Source current harmonics in choppers, converter ratings.

Induction Motor Drives: Three phase induction motor analysis, starting, braking and speed control methods, operation with unbalanced source voltage and rotor impedances, single phasing, voltage and frequency control, current control, closed loop control of induction motor drives, rotor resistance control, Slip power recovery – Static Kramer and Scherbius Drive, constant flux speed control structure, vector control model, vector control structure. Voltage source inverters,VSI fed induction motor. Current source inverters, CSI fed induction motor drives, Comparison between VSI CSI inverters, PWM inverters, sine-triangle comparison, harmonic elimination, hysteresis current controllers.
Single phase induction motor: starting, braking and speed control. AC regulators, cyclo-converter fed ac drives.

Synchronous Motor and Brushless dc Motor Drives: Synchronous motor types, operation with fixed frequency variable speed drives, PMAC and BLDC motor drives, switch reluctance motor drives.

Text Book:

1 “Fundamentals of Electrical Drives”, G. K. Dubey, Narosa Publishing house, 2nd edition (sixth reprint), 2001

Reference Books:

1. “Power Electronics”, M. H. Rashid Pearson Education Pvt. Ltd. New Delhi, India, 3rd Edition
2. “Modern Power Electronics and AC Drives”, B. K. Bose, Pearson Education Pvt. Ltd., New Delhi, India Low price edition.
3. “Electric Motor Drives: Modelling, Analysis and Control”, R. Krishnan Low price edition, PHI, India.
4. “Electric Drives Concepts and Applications”, Vedam Subramanian, Tata Mc-Graw Hill Publications, New Delhi, India.

CO430: DATA STRUCTURES AND ALGORITHMS

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

This course provides knowledge of data representation and how data is allocated in memory. It defines high level of abstraction of the needed linear and nonlinear data structure and algorithm.

DESIRABLE AWARENESS/SKILLS:

Fundamentals Knowledge of C and basics of algorithm

COURSE OBJECTIVES: The objectives of course are to:

a) study basic data structures and algorithm.
b) understand analysis and evaluation of data structure.
c) learn searching and sorting techniques.

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

1. understand the different ways of data representation.
2. study the representation and use of primitive data types and built in data structures.
3. develop the ability to synthesize and analyze algorithms.
4. study the representation, implementation and applications of linear and nonlinear data structures.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4
PO-a	1	2	1	3
PO-b	2	1	1	3
PO-c	2	3	2	2
PO-d	2	2	2	2
PO-f	2	2	1	1

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

CO430: DATA STRUCTURES AND ALGIRITHMS

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Introduction: Concept of data, data object, data structure, concept of primitive and non-primitive, linear and non-linear, static and dynamic, persistent and ephemeral data structures.
Algorithm and Analysis: Algorithm, properties of algorithm. Frequency count and its importance in analysis of an algorithm, time complexity & space complexity of an algorithm, big '**O**', '**Ω**' and '**θ**' notations, best, worst and average case analysis of an algorithm.

Stacks: Concept of stack as ADT, Representation and implementation of stack using sequential organization. Arithmetic expression conversion & evaluation.

Queues: Concept of queue as ADT, representation and implementation of linear queue & circular queue using sequential

Linked Lists: Understand the concept of linked list data structure, Pros & Cons of array compared with linked list, Creation, traversing, searching, insertion, deletion of single linked list, Pros & cons of single linked list, double linked list, Polynomial addition using single linked list, Generalized Linked List.

Trees: Difference in linear and non-linear data structure, trees and binary trees-concept and terminology, conversion of general tree to binary tree, recursive and non-recursive algorithms for binary tree traversals, binary search trees, concept of threaded binary tree. Huffman's Algorithm, Height Balanced Tree (AVL tree) and Heap: Max heap tree and min heap tree, heap sort.

Graphs: Introduction, representation of graphs using adjacency matrix and adjacency list, depth first search and breadth first search traversal. Prim's and Kruskal's algorithms for minimum spanning tree.

Searching and Sorting: Basics of searching techniques: Linear and Binary Search, Different sorting algorithms including Bubble, Insertion, Selection, Quick, Merge, Radix, average case time complexity of each of these algorithms.

Text Books:
1 Fundamentals of Data Structures in C, E. Horowitz by S. Sahani, S.Anderson-Freed, Universities Press ,2008 ,ISBN 10:8173716056.
2 Data Structures: A pseudo code approach with C, R. Gilberg, B. Forouzan, Cenage Learning, ISBN 9788131503140

Reference Books:
1 Data Structures and Algorithms, A. Aho, J. Hopcroft, J. Ulman, Pearson Education, 1998, ISBN-0-201-43578-0
2 Data Structures using C and C++, Y. Langsam, M. Augenstin and A. Tannenbaum, 2nd Edition, Prentice Hall of India, 2002, ISBN-81-203-1177-9
3 An introduction to data structures with Applications, J. Tremblay, P. Soresan, 2nd edition, Tata McGraw-Hill International Editions, 1984, ISBN-0-07-462471-7.

ELECTIVE I-A EE403: SMART GRID

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

As the world is becoming smarter day by day, the subject deals with the technologies used in today's power system for grid inter-connection. Subject introduces about conventional and modern methods. It also deals with current development of smart grid at national and international level. Further the role of communication and information technology in smart grid is also discussed.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power systems, generation and transmission, electrical and electronic measurement

COURSE OBJECTIVES:

The objectives of the course are to:

a. study the various aspects of the smart grid, including technologies, components, architectures and applications.
b. study the issues and challenges involved in smart grid technology.
c. take initiatives in the current development of smart grid at national and international level.
d. know the role of communication and information technology in smart grid.
e. understand the smart real time pricing

COURSE OUTCOMES:

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

1. various aspects of the smart grid, including technologies, components, architectures and applications.
2. the issues and challenges involved in smart grid.
3. current initiatives in the development of smart grid at national and international level.
4. the role of communication and information technology in smart grid.
5. the working of real time various smart meters.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	3	2
PO-b	2	1	1	3	2
PO-c	2	3	2	2	3
PO-d	2	2	2	2	2
PO-f	2	2	1	1	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE I-A EE403: SMART GRID

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Introduction to Smart Grid: Evolution of Electric Grid, concept of Smart Grid, definitions, need of smart grid, functions of smart grid. Opportunities and barriers of it, difference between conventional and smart grid. Concept of resilient and self-healing grid. Present development and international policies in smart grid. Case study of smart grid. CDM opportunities in smart grid.

Smart Grid Technologies- Part 1: Introduction to Smart Meters, real time pricing, smart appliances, automatic meter reading (AMR), outage management system (OMS). Plug in Hybrid Electric Vehicles (PHEV), vehicle to grid, smart sensors, home and building automation, phase shifting transformers.

Smart Grid Technologies- Part 2: Smart substations, Geographic information system (GIS), intelligent electronic devices (IED) and their application for monitoring and protection, smart storage like battery, pumped hydro, compressed air energy storage, wide area measurement system (WAMS), phase measurement unit. International Electro-technical Communication 61850 standards and benefits, IEC Generic Object Oriented Substation Event - GOOSE, IEC 61850 Substation model, Intelligent Electronic Devices integration, Substation LAN, WAN, SCADA, Substation automation, feeder automation.

Micro Grids and Distributed Energy Resources: Concept of micro grid, need and applications of micro grid, formation of micro grid. Plastic and organic solar cells, thin film solar cells. Variable speed wind generators, fuel cells, micro turbines, captive power plants, integration of renewable energy sources. Carbon Footprint, Modelling PV and wind systems, Tackling Intermittency, Issues of interconnection, protection and control of micro-grid, Islanding

Power Quality Management in Smart Grid: Power Quality and 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.

Information and Communication Technology for Smart Grid: Advanced metering infrastructure (AMI), home area network (HAN), neighbourhood area network (NAN), wide area network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication, wireless mesh network, basics of CLOUD computing and cyber security for smart grid. Broadband over Power line (BPL). IP based protocols.

Smart Distribution Systems and Energy Storage: Introduction to Smart Meters, Real time pricing, Smart appliances, Automatic meter reading (AMR), Demand response, Battery storage, Plug in Hybrid electric vehicles, compressed air, pumped hydro, ultra capacitors, fly wheels, fuel cells.

Text books:

1. “Smart Grid: Technology and Applications”, Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley, March 2012.
2. “Smart Grids”, Jean Claude Sabonnadiere, Nouredine Hadjsaid, Wiley Blackwell

Reference Books:

1. “Smart Grid: Fundamentals of Design and Analysis”, James MomohIEEE Press Series on Power Engineering, March 20, 2012.
2. “Integration of Green and Renewable Energy in Electric Power Systems”,Ali Keyhani, Mohammad N. Marwali, Min Dai Wiley, November 2009.
3. “Smart Grids (Power Engineering)”, Stuart Borlase, CRC Press, October 2012.
4. “The Smart Grid: Enabling Energy Efficiency and Demand Response”, Clark W. Gellings, CRC Press

ELECTIVE I-B EE403: ENERGY AUDIT AND CONSERVATION

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The fossils fuels are depleting day by day. No one can live without electricity. Conserving electricity is producing electricity. The subject explores methods of energy conservation and its utilization in optimum way. The subject introduces modern methods used in various industries for energy conservation to save electricity which are its largest consumers and related issues.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power systems, generation and transmission, electrical and electronic measurement

COURSE OBJECTIVES:

The objectives of course are to:

a. identify, formulate and solve electrical engineering problems in the broad areas like electrical and mechanical installations, electrical machines, and power systems.
b. exhibit management principles and function as a member of a multidisciplinary team.
c. sensitive towards professional and ethical responsibility.
d. know contemporary issues.
e. use the techniques, skills, and modern engineering tools necessary for engineering practice.

COURSE OUTCOMES:

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

1. identify, formulate and solve electrical engineering problems in the broad areas like electrical and mechanical installations, electrical machines, and power systems.
2. exhibit management principles and function as a member of a multidisciplinary team.
3. sensitive towards professional and ethical responsibility.
4. know contemporary issues.
5. use the techniques, skills, and modern engineering tools necessary for engineering practice.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	1	1
PO-b	3	1	1	2	1
PO-c	2	3	2	3	2
PO-d	3	3	2	1	2
PO-f	2	2	3	2	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE I-B EE403: ENERGY AUDIT AND CONSERVATION

Teaching Scheme: 03 L Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Energy Scenario: Introduction, energy problems, energy use, trends in developing countries, prospects of changes in energy supply, strategies for sustainable development, finite fossil reserve. Energy and environment, need for renewable energy and energy efficiency, energy conservation principles, energy conservation in industries, generation, transmission and distribution, household, commercial sectors, transport, agriculture.

Energy Audit: Energy flow diagram, strategy of energy audit, comparison with standards, considerations in implementing energy conservations programmes, instruments for energy audit, energy audit of illumination system, energy audit of electrical system, energy audit of heating ventilation and air conditioning systems, energy audit of compressed air system, energy audit of building. Energy audit of steam generation, distribution and utilization system, economic analysis, bench marking. Energy conservation Act 2001.

Demand Side Management: Scope of demand side management, concept of DSM, DSM planning and implementation, load management as a DSM strategy, application of load control, end use energy conservation, tariff options for DSM, customer acceptance, implementation issues. Implementation strategies, DSM and environment, case studies of DSM, maximum demand control, power factor improvement and its benefits, selection and location of capacitors, performance assessment of power factor correction capacitors, distribution and transformer losses.

Energy Efficiency in Electrical and Mechanical Utility: Losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Compressed Air Systems: Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, leakage test, factors effecting the performance and saving opportunities, HVAC and refrigeration systems, vapour compression refrigeration cycle refrigerants, coefficient of performance, factors affecting refrigeration and air conditioning systems performance and saving opportunities, vapour absorption refrigeration systems, principle types, saving potential. Fan and blower, types, performance evaluation.

Captive Power Generation: Types of captive power plants, financing of captive power plants, power plants in India, energy banking, energy wheeling. Co-Generation**:** Co-generation technologies, industries suitable for cogeneration, allocation of costs, sale of electricity to utility, impact of pricing of cogeneration, electric power plant reject heat, agricultural uses of waste heat, use of power plant reject heat for west water treatment, integrated energy system, potential of cogeneration in India.

Text books:

1. “Energy Management & Conservation” Frank Kreith and George Burmeister Amazon Publishers
2. “ Energy Management Supply and Conservation”, Beggs and Clive, Wal Mart Publishers

Reference Books:

1. “Generation of Electrical Energy” B. R. Gupta, S. Chand Publication.
2. “Energy Technology: Non-conventional, Renewable and Conventional”S.Rao & Dr. B. B. Parulekar, Khanna Publishers
3. “Utilization of Electrical Energy”, S. C. Tripathy, Tata Mc Graw Hill
4. “Operation of Restructured Power System”K.Bhattacharya, MHJ Bollen, J.E.Dalder, Kluwer Academic Publications
4. Energy Conservation Act 2001.

ELECTIVE I-C EE403: ELECTRIC VEHICLES AND HYBRID VEHICLES

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Electric drives are clean and easy to control. With advent of modern power electronic devices and due to increasing availability of energy from renewable sources; research is going on electric and hybrid electric vehicles. Storage of energy is a major problem for electric vehicles. This subject introduces about current development in this area at national and international level.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power systems, electric drives and electric traction

COURSE OBJECTIVES:

At the end of this course students will understand:

a. concept of Electric Vehicles, Hybrid Electric Vehicles & Plug in Hybrid Electric Vehicles
b. power electronics & electric machine requirements of EVs & HEVs
c. design issues of EVs & HEVs
d. how to model EVs & HEVs
e. fuel economy of EV and HEV

COURSE OUTCOMES:

Upon successful completion of this course the students will learn:

1. operation of Electric Vehicles, Hybrid Electric Vehicles & Plug in Hybrid Electric Vehicles
2. modern power electronic devices used for EV and HEV
3. issues related to design of EVs & HEVs
4. model EVs & HEVs using software
5. difficulties in running EV and HEV

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	3	2
PO-b	2	1	1	3	2
PO-c	2	3	2	2	3
PO-d	2	2	2	2	2
PO-f	2	2	1	1	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE I-C EE403: ELECTRIC VEHICLES AND HYBRID VEHICLES

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

Introduction to Electric Vehicles and Hybrid Electric Vehicles: A brief history of electric vehicles and hybrid electric vehicles. Operation of electric vehicles and hybrid electric vehicles. Architectures of electric vehicles and hybrid electric vehicles. Electric vehicles and hybrid electric vehicles fundamentals.

Plug-in HEVs: Introduction to plug in hybrid electric vehicles, PHEV architectures, Power management of PHEVs, fuel economy of PHEVs, PHEV design and component sizing, vehicle-to-grid technology.

Power Electronics in EVs and HEVs: Introduction, Principles of power electronics, rectifiers, converters, inverters, battery chargers used in EVs and HEVs, emerging power electronic devices.

Electric Machines and Drives in EVs & HEVs: Introduction, induction motor drives, permanent magnet motor drives, brushed and brushless DC motor, switched reluctance motors

Components and design considerations of EVs & HEVs: Batteries, Ultra-capacitors, fuel cells, controls, aerodynamic considerations. Consideration of rolling resistance, transmission efficiency, consideration of vehicle mass, electric vehicle chassis and body design, general issues in design

Modelling, Simulation and Case Studies of EVs & HEVs: Introduction, Fundamentals of vehicle system modelling, HEV modelling using ADVISOR & PSAT, Case studies - Rechargeable battery vehicles, Hybrid vehicles

Text Books :

1. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Chris Mi M. Abul Masrur, David Wenzhong Gao, Wiley publication, 2011

Reference Books :

1. "Hybrid Vehicles and the future of personal transportation", Allen Fuhs, CRC Press, 2009
2. "Electric Vehicle Technology Explained", James Larminie, John Lowry, Wiley publication, 2003

ELECTIVE I-D EE403: CONTROL SYSTEM DESIGN

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The course on feedback control system deals with classical control theory for analysis of system either in time domain or frequency domain approach restricted to linear systems. But every real time system is a non-linear system for which state space analysis is required to analyse the system behaviour. This course introduces about this state space approach of stability.

DESIRABLE AWARENESS/SKILLS:

Knowledge of feedback control system, instrumentation, microprocessor/microcontrollers

COURSE OBJECTIVES:

The objectives of the course are to:

a. explain control system design by frequency response.
b. introduce digital control system.
c. estimate stability by using Jury criterion.
d. explain design of nonlinear control system using describing function concepts and phase plane techniques.
e. know the operation of various controllers

COURSE OUTCOMES:

Upon successful completion of this course the students will learn to:

1. determine the controllability and observability of a given system.
2. realize the desired performance by using pole placement and observer design.
3. use digital control system.
4. simulate various controllers using software like MATLAB
5. determine stability of a system

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	1
PO-b	2	1	1	1	1
PO-c	2	2	2	2	3
PO-d	1	2	2	2	2
PO-f	2	2	1	1	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE I-D EE403: CONTROL SYSTEM DESIGN

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

State Space Techniques: Concept of state variable, state model, state variable models of SISO/MIMO linear systems, from differential equations, transfer function and block diagrams. State diagram (Signal flow graphs) Decomposition of transfer functions in phase variable forms, canonical forms, Jordan canonical form, transfer function from the state model.

Control System Design by Frequency Response: Lag compensation, lead compensation, Lag-Lead compensation. State variable analysis and design: State space representation of continuous and discrete systems, solving the time- invariance state equation, state transition matrix, Eigen values and Eigen vectors, controllability and observability criteria for time invariant systems, pole placement using state variable feedback, design of state observers**.**

Sample data Control System: Representation of sample data (Discrete system) review of Z transforms, sample and hold zero order hold. Sampling theorem Z-transform analysis of sampling data control system. (Open loop and closed loop), Z transfer function of systems. Solutions of different equation by Z transfer methods. Pulse transfer functions of open loop and closed loop system with different sample locations. Stability analysis, relation between S and Z domain, stability by Jury's test and bi-linear transformation and root locus method.

Non Linear Control Systems: Characteristics of nonlinear systems, Linearizing techniques, Design of nonlinear control system using describing function concepts and phase plane techniques. Liapunov's stability criterion. Introduction to optimal control, introduction to process control, feed forward, ratio, cascade, DDC, supervisory control.

Stability Analysis By Lyapunov Method: Concept of stability, asymptotic stability, instability, the sense of a Lyapunov, Positive of a scale function, quadratic forms, stability theorems, Lyapunov functions, stability of linear time invariant systems, Lyapunov equations. Krasowakii's method for time examining the stability of non-linear time invariant system.

Industrial Controllers: PID controllers, tuning methods, pneumatic and hydraulic controllers.
ISE, IATE programmable logic controllers: Introduction to PLC, constructional features, working principle and applications, intelligent controllers, fuzzy logic controller.

Text Books:

1. "Control Systems Engineering", I. J. Nagrath M Gopal, New Age Publishers Fourth Edition
2. "Digital Control system", Benjamin Kuo, Oxford
3. "Modern Control System", K. Ogata, Prentice Hall

Reference Books:

1. "Control System Engineering", Norman, NiceNew Age Publishers
2. "Linear control system analysis and design", John J. D'Azzo, C. H. Houpis, (conventional and modern), McGraw Hill International Fourth edition
3. "Applied Non –Linear System", Lee StolinePrentice Hall
4. "Digital Control Systems", M. Gopal, New Age Publishers, Fourth Edition.

ELECTIVE I-E EE403: POWER SYSTEM STABILITY

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The persistent demand of electrical power is leading to operation of the power system at its limit. On top of this the need for reliable, stable and quality power is also on the rise due to electric power sensitive industries like information technology, communication, electronics etc. Meeting the electric power demand is not the only criteria but also it is the responsibility of the power system engineers to provide a stable and quality power to the consumers. These issues highlight the necessity of understanding the power system stability. The course discusses the stability of a power system, how to improve the stability and finally how to prevent system becoming unstable.

DESIRABLE AWARENESS/SKILLS:

Knowledge of electrical power system, generation and transmission of electric power

COURSE OBJECTIVES:

The objectives of the course are to:

a. develop a basic understanding of the transient effect of lightning, faults, and switching on power systems.
b. provide a basic understanding of the principles used to protect power system equipment from transients.
c. analyze power system stability
d. introduce the students software to design power system
e. understand the impact of rotor angle on stability

COURSE OUTCOMES:

Upon successful completion of this course the students will learn to:

1. develop a basic understanding of the transient effects
2. simulate various faults on power systems.
3. analyze steady state stability of the system.
4. protect power system equipment from transients
5. solve the problems on power system stability

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	-
PO-b	2	1	1	1	3
PO-c	2	2	2	3	3
PO-d	1	2	2	3	2
PO-f	3	2	1	3	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE I-E EE403: POWER SYSTEM STABILITY

Teaching Scheme: 03 L Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Basic Concept: Meaning of stability, rotor, voltage and frequency, steady state transient and dynamic stability limit, Park`s transformation equation, analysis of transient and sub transient state operation of salient and non salient pole machines, phasor diagrams, voltage behind the transient and sub-transient impedance, time constants Determination of parameters and time constants.

Steady State Stability: SSSL of short transmission lines, analytical and graphical methods of solutions, lossy line, effect of inertia, conservative criterion, synchronising co-efficient, multi machine system.

Factors Affecting Steady State Stability: Effect of saturation, saturated reactance, equivalent reactance, graphical method to find equivalent, effect of short circuit, effect of governor action, effect of automatic voltage regulator.

Transient State Stability: Review of transient stability, swing equation, assumption for swing equation, and classical model, shortcoming of classical model, equal area criterion, critical clearing angle and critical clearing time, point by point solution for transient stability.

Factors Affecting Transient State Stability: Effect of type of fault , effect of grounding, effect of high speed reclosing, pre-calculated swing curve and their use, effect of fault clearing time, effect of excitation and governing action , method of improving stability, multi-machine problem.

Text books:

1. ‘‘Power system operation and control’’, Aderson and Fouad, IEEE
2. ‘‘Power system stability’’, E. W. Kimbrak, vol-I & II, Wiley India Pvt Ltd
3. ‘‘ Power system stability’’, S. B. Cray, John Wiley

Reference Book :

1. ‘‘ Modern Power system analysis’’, Nagrath & Kothari, TMH
2. ‘‘Generalized Electrical Machinery’’, P.S. Bimbhra, Khanna Publishers
3. ‘‘ Power System Dynamics and Stability’’, Peter W. Sauer and M. A. Pai, Pearson Education

ELECTIVE II-A EE404: WIND AND SOLAR POWER TECHNOLOGIES

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The demand for electric power is increasing day by day. The fossil fuels will be depleted with its continuous usage and there is a fear that it may get vanished. Hence we all are searching for green energy/ renewable energy. Our country is rich in wind and solar energy for major part of year. This course explores the basic concepts associated with this and its sustainability and reliability.

DESIRABLE AWARENESS/SKILLS:

Knowledge of renewable energy sources, power generation, transmission and distribution

COURSE OBJECTIVES:

The objectives of the course are to:

a. appreciate problems and limitations of fossil fuels for electrical power generation.
b. know about distributed generation.
c. understand the interconnection of wind and solar generation.
d. study and make aware about photovoltaic power systems.
e. create awareness about wind energy sources.

COURSE OUTCOMES:

At the end of this course students will be able to:

1. understand the importance of energy crises.
2. understand the growth of the power generation from the renewable energy sources.
3. learn the physics of wind power generation and all associated issues.
4. understand the physics of solar power generation and the associated issues.
5. solve the problems of energy crises using wind and solar power technologies.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	-
PO-b	2	1	1	1	3
PO-c	2	3	3	3	3
PO-d	1	3	2	3	2
PO-f	3	2	1	3	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE II-A EE404: WIND AND SOLAR POWER TECHNOLOGIES

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Physics of Wind Power: History of wind power, Indian and Global statistics, wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power - cumulative distribution functions.

Wind Generator Topologies: Fixed and Variable speed wind turbines, power electronics converters, wind generator topologies, voltage and reactive power control, power quality standards for wind turbines, review of modern wind turbine technologies.

Network Integration Issues: Overview of grid code technical requirements for wind farms - real and reactive power regulation, voltage and frequency operating limits, wind farm behaviour during grid disturbances, power system interconnection experience in the world, economic aspects, hybrid and isolated operations of wind farms.

Solar Energy: Introduction, solar radiation spectra, solar geometry, earth Sun angles, observer Sun angles, solar day length, estimation of solar energy availability.

Solar Photovoltaic: Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Maximum Power Point Tracking (MPPT) algorithms.

Solar Thermal Power Generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis, prospects for India.

Text Books

1. "Wind Power in Power Systems", Thomas Ackermann, Editor, John Willy and sons ltd., 2005, ISBN 0-470-85508-8.
2. "Renewable and Efficient Electric Power Systems**",** Gilbert M. Masters, John Willy and sons, 2004, ISBN0-471-28060-7
3. "Solar Energy", S.P. Sukhatme, Tata McGrew Hill, 2nd edition, 1996, ISBN 0-07-462453-9.

Reference Books

1. "Grid integration of wind energy conversion systems", Siegfried Heier, John Willy Ltd .2006
2. "Renewable Energy Applications", Mullic and G.N.Tiwari, Pearson Publications
3. "Solar Engineering of Thermal Processes", John A. Duffie, William A. Beckman, Wiley Inter science Publication, 1991

ELECTIVE II-B EE404: OPTIMIZATION TECHNIQUES

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Optimization techniques are essential in the planning of large electrical systems, optimization of power flows, and a wide variety of other electrical engineering problems. The course covers linear programming method for the optimal allocation of electrical resources, constrained and unconstrained methods applied to the design of optimal power systems, nonlinear programming methods for the optimisation of power flows, genetic and evolutionary algorithms applied to a variety of electrical engineering tasks.

DESIRABLE AWARENESS/SKILLS:

Knowledge of feedback control system, power system

COURSE OBJECTIVES:

The objectives of the course are to:

a. give students the basic knowledge and tools to recognize, classify and solve different questions related to optimization problems as they appear in engineering.
b. program with use of basics of convex analysis, least-squares, linear and quadratic programs, semi definite programming, optimality conditions, duality theory, interior point methods
c. solve variety of electrical engineering applications problems.
d. translate questions in optimization to the correct mathematical formalization.
e. apply the correct techniques to solve such questions.

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. recognize and formulate problems that arise in engineering in terms of optimization problems.
2. present the basic theory of such problems related to power system.
3. understand, and solve problems using optimization techniques.
4. implement different technique to electrical engineering field.
5. erite algorithms for electrical engineering application problem.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	-
PO-b	2	1	1	1	3
PO-c	2	2	2	3	3
PO-d	1	2	2	3	2
PO-f	3	2	1	3	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE II-B EE404: OPTIMIZATION TECHNIQUES

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Introduction: Concept of optimization and classification of optimization techniques. Linear Programming: Standard form of LPP Simplex Method of solving LPP, duality, sensitivity analysis. Decomposition principle, transportation problem and application of LPP to Electrical Engineering.

Non-Linear Programming: One dimensional methods, elimination methods, Fibonacci Method, Golden Section Method interpolation methods, quadratic and cubic interpolation Methods. Unconstrained optimization techniques, direct search and descent methods, constrained optimization techniques, direct and indirect methods.

Dynamic Programming: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem. Constrained Optimization, Complex Method, Cutting Plane Method, Method of feasible directions, integer programming, quadratic Programming.

Genetic Algorithm: Introduction to genetic Algorithm, working principle, coding of variables, fitness function. GA operators; Similarities and differences between GAs and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, global optimization using GA.

Applications to Power system: Economic Load Dispatch in thermal and Hydro-thermal system using GA and classical optimization techniques, Unit commitment problem, reactive power optimization. Optimal power flow, LPP and NLP techniques to optimal flow problems.

Text books:

1. "Optimization Theory and Applications", S. S. Rao, New Age International (P) Ltd.
2. "Operation Research", H. A. Taha, Prentice Hall of India Pvt. Ltd., 7th Edition.
3. "Optimization Methods for Engineering Design", R. L. Fox, Addison-Wesley, 1971.

Reference Books:

1. "Genetic Algorithms in Search, Optimisation", D. E. Goldbergand Machine Learning, Addison- Wesley, 1989
2. The Mathworks, Optimisation Toolbox, Users Guide, 1996
3. "Applied Nonlinear Programming", Himmelblau, D.M. McGraw-Hill, New York, 1972

ELECTIVE II-C EE 404: COMPUTER AIDED POWER SYSTEM ANALYSIS

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The present day power systems are characterized by large highly interconnected network. Simulation and analysis of such a large system is possible only with the help of digital computers. Load flow or power flow study is the most frequently carried out for steady state analysis, which determines system voltage profile and line flows/losses. A fault in the power system network results in excessive current flowing through its various components. This course will cover the modelling issues and analysis methods for the power flow, short circuit, contingency and stability analyses, required to be carried out for the power systems.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power system analysis, generation and transmission and distribution

COURSE OBJECTIVES:

The objectives of the course are to

a. know modern tools for power system analysis.
b. understand complexities in electrical power system.
c. analyse power system with less computational time and more accuracy.
d. analyze methods for the power flow, short circuit, contingency and stability analyses.
e. to learn the role of Computer aided power system analysis in utility-related applications which are becoming extremely important

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. describe the role of computer aided power system analysis in power flow, short circuit, contingency and stability analyses.
2. understand the network topology for the representation of power system components and networks.
3. form the bus impedance and admittance matrices by algorithms.
4. perform the short circuit studies for proper selection of protection scheme.
5. evaluate simultaneous faults by matrix transformations.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	3	2	-
PO-b	2	-	2	1	3
PO-c	2	3	2	3	3
PO-d	1	3	2	3	2
PO-f	3	3	1	3	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE II-C EE 404: COMPUTER AIDED POWER SYSTEM ANALYSIS

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Network Topology: Modelling of power system components, basic concept, single phase, three phase models and matrix. Representation of network topology of electric power system: Network Graphs, incidence matrices, fundamental loop and cutest matrix, primitive impedance and admittance matrix, singular transformation of network matrix.

Incidence Matrix: Formation of bus impedance and admittance matrices by algorithm, modification of bus impedance and admittance matrix to account for change in network. Derivation of loop impedance matrixes, algorithm for formulation of 3 phase bus impedance matrix.

Short Circuit Studies: Three phase network, Symmetrical component. Thevenin's theorem and Short circuit analysis of multimode power system using bus impedance matrix. Short circuit calculation for balanced and unbalanced short circuit, bus impedance and loop impedance matrices.

Load Flow Studies: Slack bus, load buses, voltage control buses, load flow equations, power flow model using bus admittance matrix, power flow solution through Gauss-Seidel and N-R method sensitivity analysis, second order N-R method, fast decoupled load flow method, sparsity of matrix.

Fault Analysis: Simultaneous fault, simultaneous fault by two port network theory (Z, Y and H-type fault), simultaneous fault by matrix transformation, analytical simplification of series and shunt fault.

Text Books:

1. "Power System Analysis'', J. J. Gringer, W. D. Stevenson, McGraw Hill.1994
2. "Modern Power System Analysis'', I. J. Nagrath and D. P. Kothari, Tata McGraw Hill, 1980

Reference Book :

1. ''Computer aided power system analysis,'' G. L. Kusic, Prentice Hall, 1986
2. ''Power system analysis'', Hadi Sadat, Tata McGraw Hill
3. "Computer method in power system analysis'', G. W. Stagg and AL Ebiad, McGraw Hill

ELECTIVE II-D EE404: INTELLIGENT CONTROL

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The limitations of conventional control made the rise of artificial intelligence associated with intelligent control. With increasing demand for smart controllers proves this fact. It is required in every industry like chemical, pharmaceutical, electronics, automation etc. These issues highlight the necessity of understanding the intelligent control. The course discusses the principles of neural networks, fuzzy logic controllers.

DESIRABLE AWARENESS/SKILLS:

Knowledge of feedback control system, instrumentation, microprocessor/microcontrollers

COURSE OBJECTIVES:

At the end of this course students will learn:

a. the meaning of system intelligent modelling.
b. to model proto type of automating systems.
c. the use of neural and fuzzy controllers
d. to train using conventional optimisation methods.
e. to simulate an intellectual control by using software such as MATLAB

COURSE OUTCOMES:

At the end of this course students will be able to:

1. learn the meaning of system intelligent modelling
2. design proto type of automating systems
3. analyze system of neural and fuzzy controllers
4. design using conventional optimisation and evolutionary search methods.
5. execute an intellectual control by using software such as MATLAB.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	-	-
PO-b	2	1	1	1	3
PO-c	2	3	2	3	3
PO-d	3	2	2	3	3
PO-f	3	2	1	3	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE II-D EE404: INTELLIGENT CONTROL

Teaching Scheme: 03 L + 0 T Total 03 **Credits** : 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Introduction: Introduction to Intelligent Control, Architecture of Intelligent Control, Symbolic Reasoning System, Rule- based Systems, Knowledge based System

Neural Networks: Biological and artificial neuron models, basic properties of neurons, types of neuron. Activation functions, perceptions, convergence theorem. LMS algorithm; Multilayer networks, exact and approximate representation, training of the feed forward networks, back propagation algorithm, variants of back propagation. Unsupervised and reinforcement learning, symmetric hopfield networks and associative memory. Competitive learning and self organizing networks, hybrid learning; Computational complexity of ANNs.

Neural Networks Based Control: Representation and identification, modelling the plant, control structures, supervised control, model reference control, examples and simulation studies.

Introduction to Fuzzy Logic: Fuzzy Controllers: Preliminaries Fuzzy sets and Basic notions – Membership Functions, Knowledge base and Defuzzification Strategies. Mamdani-type and Takagi-Sugeno type fuzzy inference. Indices of Fuzziness, comparison of Fuzzy quantities, Methods of determination of membership functions.

Fuzzy Logic Based Control: Reed-Solomon codes, interleaving and concatenated codes, coding and interleaving applied to the compact Disc, Bose-Choudury-Hocquenghem Codes (BCH)

Text Books

1. “Systems and Control”, Zak, Oxford University
2. “Neural Networks”, James A Freeman and Davis Skapura, Pearson, 2002
3. “Neural Networks”, Simon Hykins, Pearson Education
4. “Neural Engineering”, C. Eliasmith and CH. Anderson, PHI

Reference Books

1. ”Biomimicry for Optimization, Control and Automation”, K. Passino, Springer-verlag,2005.
2. “Fuzzy Control”, Addison Wesley Longman, Menlo Park, CA 1998
3. “Fuzzy logic with engineering applications”, Timothi J. Ross, Wiley, 1995.

ELECTIVE-II-E EE404: ROBOTICS AND AUTOMATION

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Most of to-days controllers used in industry, home appliances are PLC based. This course will improve the knowledge of the students about industrial processes using automation. Robotics is the base of automation motion control. The subject explores about robot kinematics/ dynamics. In addition it also describes PLC and SCADA used for control of machinery.

DESIRABLE AWARENESS/SKILLS:

Knowledge of feedback control system, instrumentation, microprocessor/microcontrollers

COURSE OBJECTIVES:

The objectives of the course are to:

a. understand the history, concept development and key components of robotics technologies.
b. analyze basic mathematic manipulations of spatial coordinate representation and transformation.
c. understand and able to solve basic robot forward and inverse kinematic problems.
d. ability to solve basic robotic dynamics, path planning and control problems
e. know controllers used in automation

COURSE OUTCOMES:

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

1. understand the history, concept development and key components of robotics technologies.
2. use controllers in automatic systems.
3. understand basic mathematic manipulations of spatial coordinate representation and transformation.
4. solve basic robot forward and inverse kinematic problems.
5. solve basic robotic dynamics, path planning and control problems.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	3	21	1	2	1
PO-b	2	1	1	1	3
PO-c	2	2	2	3	3
PO-d	1	2	2	2	2
PO-f	3	2	1	2	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE-II-E EE404: ROBOTICS AND AUTOMATION

Teaching Scheme: 03L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Basic Concepts in Robotics: Definition, anatomy of robot, basic structure of robot, terms related to robot: resolution, accuracy, reliability, robot classification. Drives for Robots: Electric, hydraulic and pneumatic. Sensors, Internal-External, Contact-noncontact, position and velocity, force and torque, tactile, proximity and range. Vision: Introduction to techniques, image acquisition and processing

Robot Kinematics and Dynamics: Rotation matrix, Homogeneous transformation matrix, Denavit-Hartenberg convention, Euler angles, Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity. Robot Dynamics: Lagrangian formulation, link inertia tensor and manipulator inertia tensor, Newton-Eller formulation for RR and RP manipulators, Trajectory planning, interpolation, static force and moment transformation, solvability, stiffness, singularities

Control of Robot Manipulators: Control of the Puma Robot Arm, Computed torque technique, Near-Minimum Time Control, Nonlinear Decoupled Feedback control, Resolved Motion Control, Adaptive Control.

Applications of Robots and Systems: Material handling, loading and unloading, welding and painting. Introduction to robot programming languages like AL and AML. Automation Systems: Expectations from automation, Basic functions, Historical development of control systems, Processing systems, Supervisory control and data acquisition systems. Direct digital control systems: DDC structure, DDC software.

Programmable Controllers: Introduction, Principles of operation, Architecture of programmable controllers, Programming the programmable controllers, software, configuration, applications.
Distributed Control Systems**:** DCS introduction, Functions, advantages and limitations, DCS as an automation tool to support Enterprise Resources Planning, Architecture, configuration, some popular distributed control system, Instrumentation Standard Protocols: Field bus, CAN Bus, Profit bus, Industrial Ethernet, Real time programming, Modelling and simulation for plant automation.

Text Books

1. " Robotics Technology And Flexible Automation", S. R. Deb, Tata MH Ltd.
2. "Robotics and Image Processing", P. A. Janakiraman, Tata McGraw Hill, 1995
3. "Distributed Computer Control for Industrial Automation", Poppovik Bhatkar, Dekkar Publications.
4. "Programmable Logic Controllers: Principles and Applications", Webb and Reis, PHI.

Reference Books

1. "Robotics Control, Sensing, Vision and Intelligence", K. S. Fu, C. G. S. Lee, R. C. Gonzaler, TMH
2. "Robotic Engineering, An Integrated Approach", Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, Prentice Hall of India
3. "Kinematics and Dynamics of Machinery", J. Hirchhorn, McGraw Hill Book Co
4. "Robot Analysis and control", H. Asada John,
5. "Fundamentals of Robotics-Analysis and Control", Robert J. Schilling, Prentice Hall India.
6. "Introduction to Robotics", John J. Craig, Pearson Education.
7. "Introduction to Programmable Logic Controllers", Garry Dunning, Thomson Learning.
8. "The Management of Control System: Justification and Technical Auditing" N.E.Battikha.

INTER-DISCIPLINARY ELECTIVE–A EE405: RENEWABLE ENERGY SYSTEMS

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Energy technology is the backbone of modern civilization and national economy. It is an applied science dealing with various renewable energy routes comprising the exploration and extraction of energy and by-products, transportation, storage, distribution and supply of secondary forms of energy. This course explores available renewable energy sources and provides the platform to study judicious and economic choice of energy for environment friendly and sustainable development.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power generation, PV cells, fossil fuels.

COURSE OBJECTIVES:

The objectives of the course are to:

a. understand problems and limitations of fossil fuels for electrical power generation.
b. know the various renewable energy sources, their conversion technology and application.
c. know gap between energy demand and energy generation.
d. learn opportunities in field of energy conversion.
e. create awareness about renewable energy sources.

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. understand the concept of distributed generation.
2. study and make aware about photovoltaic power systems.
3. classify wind turbines.
4. calculate maximum output power from wind turbine.
5. understand Micro-Hydro Power system.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	1
PO-b	2	1	1	1	1
PO-c	2	2	2	2	3
PO-d	1	2	2	2	2
PO-f	1	2	1	2	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

INTER-DISCIPLINARY ELECTIVE–A EE405: RENEWABLE ENERGY SYSTEMS

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Solar Energy: Introduction to energy technology and energy sciences, energy and environment, laws of conservation of energy. essential subsystem in solar energy plant, phenomena of light and energy, energy from sun, power density for various wavelength of sun light, clarity index , angle of latitude and solar insolation at different geographical locations, Solar thermal collectors and its types.

Solar Photovoltaic: Introduction to solar photovoltaic system, merit and limitations, economic consideration of solar PV system, principal and characteristics of solar cell, efficiency of solar cell, configuration of solar PV panel, solar PV cell technology and small solar PV system for residence and rural areas.

Geothermal Energy: Introduction to geothermal energy, geothermal energy resources, origin of geothermal resources, geothermal gradient, hydro geothermal resources, geo-pressure geothermal resources, geothermal fluid for electric power plant and classification and type of geothermal power plant.

Wind Energy: Introduction to wind energy, nature of wind energy conversion system, wind power density, forces on the blades of a propeller, wind turbine efficiency, wind velocity, characteristics, type of wind turbine – generator unit, planning of wind farm and grid connection.

Biomass Energy: Introduction to biomass energy resources, biomass conversion process, direct combustion of biomass, gaseous fuels from biomass, Introduction to urban solid waste-to-energy by incineration process and energy plant, location plant, wood and wood waste as primary energy sources and cogeneration plant.

Text books

1. "Wind Power in Power Systems", Thomas Ackermann, John Willy and sons Ltd., 2005
2. "Renewable and Efficient Electric Power System**s",** Gilbert M. Masters, John Willy and sons,2004,
3. "Solar Energy", S.P. Sukhatme, Tata McGrew Hill, 2nd edition, 1996,

Reference Books

1. "Grid integration of wind energy conversion systems", Siegfried Heier, John Willy Ltd , 2006.
2. "Renewable Energy Applications", Mullic and G.N.Tiwari, Pearson Publications.
3. "Solar Engineering of Thermal Processes", John A. Duffie, William A. Beckman, Wiley Inter science Publication, 1991.
4. "Energy Technology", S. Rao & B. B. Parulekar, Khanna publishers.
5. " Understanding Clean Energy and fuel From Biomass", Dr. H.S.Mukunda, Wiley India

INTER-DISCIPLINARY ELECTIVE – B EE405: ELECTRICAL MACHINES AND DRIVES

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The subject explores the knowledge of different industrial drives, load characteristic, factors effecting selection of drives depending upon their electrical, mechanical characteristic. The subject also provides the knowledge of selection of rating of motor for various applications.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering, electrical machines and power electronics

COURSE OBJECTIVES:

The objectives of the course are to:

a. learn different types of industrial loads and sizing of a motor for common applications.
b. analyze thyristor / MOSFET/IGBT based dc and ac drives.
c. know different control methods for dc and ac motor drives
d. understand clearly the different applications of dc and ac drives.
e. appreciate the impact of other technologies in the domain of electric drives.

COURSE OUTCOMES:

After undergoing the course students will be able to:

1. understand different types of industrial loads and sizing of a motor for common applications.
2. know operation of thyristor / MOSFET/IGBT based dc and ac drives
3. understand the different control methods for dc and ac motor drives
4. learn different applications of dc and ac drives.
5. understand the impact of other technologies in the domain of electric drives

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	1
PO-b	2	1	1	1	1
PO-c	2	2	2	2	2
PO-d	1	2	2	2	2
PO-f	3	2	1	3	-

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

INTER-DISCIPLINARY ELECTIVE – B EE405: ELECTRICAL MACHINES AND DRIVES

Teaching Scheme: 03 L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks: 100**
Duration of ESE: 03 hrs

Basics of Drives: Introduction, Characteristics of typical loads, friction, torque balance equation for drives, Types of dc and ac drives, quadrants of operation, types of the duties, ratings, various control loops for drives.

DC Drives: Basic characteristics of DC motors, starting and braking, single phase and three phase controlled rectifier fed drives, DC-DC converter drives, fractional hp drive, closed loop control of the drives, Multi-quadrant operation of the dc drive, PMDC drive.

Induction Motor Drives: Performance characteristics, starting and braking, speed control methods, closed loop control of induction motor drives, rotor resistance control, Slip power recovery – Static Kramer and Scherbius Drive, single phase induction motor drives.

Synchronous Motor and Brushless dc motor Drives: Synchronous motor types, operation with fixed frequency, variable speed drives, PMAC and BLDC motor drives, stepper motor drives, switch reluctance motor drives.

Industrial Drives: Criteria for drive selection, drives for various industrial loads, traction drives, solar and battery powered drives, drives for electric vehicles.

Special Topics: Drives and actuators for robotics, CNC's, linear motors drives, energy conservation in electrical drives.

Text Books :

1. "Fundamentals of Electrical Drives", G. K. Dubey, 2nd edition (sixth reprint), Narosa Publishing house, 2001.
2. "Power Electronics by-Circuits, devices and Applications", M.H. Rashid, 3rd Edition, PHI Pub, 2004.

Reference Books :

1. "Modern Power Electronics and AC Drives", B. K. Bose, Pearson Education, Asia, 2003

INTER-DISCIPLINARY ELECTIVE-C EE405: INDUSTRIAL AUTOMATION AND CONTROL

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

This course describes PLC and SCADA based Industrial Automation system which will improve the knowledge of the students about industrial processes using automation. The course will cover SCADA & PLC systems in terms of their architecture, their interface to the process hardware, the functionality and the application development facilities. It also provides the knowledge required for the development of industrial control systems.

DESIRABLE AWARENESS/SKILLS:

Knowledge of feedback control system, instrumentation, microprocessor/microcontrollers

COURSE OBJECTIVES:

The objectives of the course are to:

a. describe the various components of automation.
b. explain the various configurations of control system.
c. explain necessity and working of PLC.
d. learn and develop PLC programs.
e. design control system for industrial application.

COURSE OUTCOMES:

At the end of this course students will be able to demonstrate the ability to:

1. identify the need of automation system and to formulate automation problem.
2. identify and compare various control configuration.
3. develop ladder diagram for any given logic.
4. distinguish and compare various control system configuration.
5. design ladder diagram for an application

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	-
PO-b	2	1	1	1	3
PO-c	2	2	2	3	3
PO-d	1	2	2	3	2
PO-f	3	2	1	3	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

INTER-DISCIPLINARY ELECTIVE-C EE405: INDUSTRIAL AUTOMATION AND CONTROL

Teaching Scheme: 03 L + 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1 + 15 ISE2 + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Introduction to Industrial Automation, basics of PLC and Automation Strategy: Introduction to Industrial Automation, Role of automation industry, Programmable Logic Controller, Basic operation, PLC architecture and components, Programming language, PLC application and Manufacturers, Introduction to Automation tools like PLC, SCADA, DCS, Hybrid DCS etc.

PLC Functions and Configuration: PLC registers, PLC modules, Addressing System, Field Input/ Output system, PLC timers functions, PLC counters, Industrial process Timing application, Selection of PLC and I/O modules

Instructions, Data Handling Functions: PLC logical instructions, PLC arithmetic instructions, PLC repetitive clock functions, PLC numbering systems, conversion function, PLC master relay control function, Jump, Data Move instructions and other data handling functions, scaling instructions.

Programming of PLC: Introduction Ladder/ FBD language, PLC configuration with I/O designations, addressing system in programming, Process to develop ladder language in software, Uploading/ Downloading the program to/ from PLC, ladder for ON/OFF controlling of motor, Traffic signal light, etc.

Application of PLC/Industrial application and Introduction to SCADA System: Robotics: Introduction to robot technology, sensors, drives, kinematics, different manufacturing systems, CNC.
Intelligent Controllers: Fuzzy logic system, Neural network, Model predictive controllers, Expert Controllers Applications related to power, pharmaceuticals, automobile, rubber industry.

Text Books.:

1. "Introduction to Programmable Logic Controllers", Garry Dunning, Thomson Learning.
2. " Programmable Logic Controllers: Principles and Applications", Webb and ReisPHI

Reference Books:

1. "Distributed Computer Control for Industrial Automation", Poppovik Bhatkar, Dekkar Publications.
2. " Computer Aided Process Control", S.K. Singh, PHI
3. "The Management of Control System: Justification and Technical Auditing", N.E.Battikha, ISA.
4. "Computer Based Process Control", Krishna Kant, PHI
5. "Robotic Control, sensing and Intelligence", Fu, Lee, Gonzalez, Tata McgrawHill.

EE406: PROJECT- I

Teaching Scheme: 02 Pr Total 02 **Credits**: 02
Examination Scheme: 50 ICA + 50 ESE **Total Marks:** 100
Duration of ESE: 03

1. It is expected that the broad area of Project-I shall be finalized by the student in the beginning of the VII semester / extension of Minor project undertaken may be Project-I.

2. A group of Minimum 3 and Maximum 5 students shall be allotted for Project-I and same project group for Project-II.
3. Fabrication, design or analysis

4. Approximately more than 50% work should be completed by the end of VII semester.
5. Each student group is required to maintain log book for documenting various activities of Project-I and submit group project report in the form of thermal bound at the end of semester – VII. Submit the progress report in following format:

    a. Title

    b. Abstract

    c. Introduction

    d. Problem identification and project objectives

    e. Literature survey

    f. Case study/Analysis/Design Methodology

    g. Work to be completed (Progress status)

    h. Expected result and conclusion

    i. References.

5 Evaluation Committee comprising of the Guide, Project Coordinator and Expert appointed by the Head of the department will award the marks based on the work completed by the end of semester and the presentation based on the project work.

Guide lines for ICA: The Internal Continuous Assessment shall be based on the active participation of the students in the Project work and knowledge / skill acquired. Assessment of the project-I for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given in **Table-A.**

Guide lines for ESE: The End Semester Examination for Project shall consist of demonstration if any, presentation and oral examinations based on the project report**.**

Assessment of Project-I

Name of the Project: _____

Name of the Guide: _____

Table-A

SN	Name of Student	Problem Identification and project objectives	Literature Survey	Project Methodology/ Design/PCB/ hardware/ simulation/ programming	Progress Status	Presentation	Total
		5	5	5	5	5	25

EE 407: ELECTRICAL DRIVES LABORATORY

Teaching Scheme: 02 Pr Total 02 **Credits**: 01
Examination Scheme: 25 ICA + 25 ESE **Total Marks:** 50
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The subject explores the practical knowledge of different industrial drives, load characteristic, factors effecting on selection of derives depend upon their electrical , mechanical characteristic and service duty. The practical also provides the knowledge of electric traction, ideal requirement of traction motor, operation and control. The practical provides brief knowledge of heat, ventilation and air conditioning system also.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering and its concepts.

COURSE OBJECTIVES:

The objectives of the course are to:

a. differentiate between electrical, mechanical characteristic and service duty
b. select proper motor for given load characteristic
c. identify operation and control of electrical drives
d. knowledge of four quadrant operation of drives

COURSE OUTCOMES:

On the successful completion of this course, student shall be able to:

1. understand the basics of electric drives and fundamentals of drive dynamics.
2. learn and analyze DC drives.
3. learn and analyze different steady state speed control methods for Induction motors, and understand the closed loop block diagrams for different methods.
4. get introduced to modern synchronous motors and drives.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4
PO-a	1	1	1	2
PO-b	1	1	1	2
PO-d	2	2	2	2
PO-f	3	-	-	2

1- Strongly correlated 2 – Moderately correlated 3–Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE 407: ELECTRICAL DRIVES LABORATORY

Teaching Scheme: 02 Pr Total 02 **Credits**: 01
Examination Scheme: 25 ICA + 25 ESE **Total Marks:** 50
Duration of ESE: 03 hrs

The laboratory work should consist of experiments based on theory syllabus of EE401. Experiments should involve simulation performance/design of practical, result and conclusion based on it. The sample list given below is just a guide line.

1. Modelling of separately excited DC Motor (system identification / parametric measurement).
2. Armature control of S.E.DC Motor - Constant Torque, Constant HP.
3. Four quadrant DC Drive - Motoring and Braking
4. Simulation of closed loop DC drive
5. Simulation of closed loop V/F drive
6. Study of commercial AC and DC drives.
7. Study of half wave controlled DC motor control.
8. Study of V/F Induction Motor control.
9. Study of vector control of Induction Motor.
10. Study of Synchronous Motor drive
11. Study of brushless motor drive
12. Study of fully controlled dc drive
13. Study of choppers
14. Study of diac- triac controlled universal motor
15. Study of chopper controlled dc drive

Note:

Guide lines for ICA: Internal Continuous Assessment shall support for regular performance of minimum 10 practical's and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by student. The performance shall be assessed experiment wise using internal continuous assessment format (S10).

Guide lines for ESE: The end semester examination(ESE) for the laboratory course of three hrs duration, shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

CO431: DATA STRUCTURES AND ALGORITHMS LABORATORY

Teaching Scheme: 02 Pr Total 02 **Credits**: 01
Examination Scheme: 25 ICA + 25 ESE **Total Marks:** 50
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

This practical course introduces to student about data structure, how to allocate data in memory. To introduce various techniques for representation of the data in the real world.

DESIRABLE AWARENESS/SKILLS:

Fundamentals of C /C++ programming

COURSE OBJECTIVES:

The objectives of the course are to

a. describe the usage of various data structures
b. teach efficient storage mechanisms of data for an easy access.
c. design and implementation of various basic and advanced data structures.
d. introduce various techniques for representation of the data in the real world.

COURSE OUTCOMES:

On the successful completion of this course, student shall be able to:

1. learn the different ways of data representation.
2. study the allocation of data structures
3. represent the implementation and applications of linear data structures
4. solve real world problems.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4
PO-a	1	1	1	2
PO-b	1	1	1	2
PO-d	2	2	2	2
PO-f	3	-	-	2

1- Strongly correlated 2 – Moderately correlated 3–Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

CO431: DATA STRUCTURES AND ALGORITHMS LABORATORY

Teaching Scheme: 02 Pr Total 02 **Credits**: 01
Examination Scheme: 25 ICA + 25 ESE **Total Marks:** 50
Duration of ESE: 03 hrs

Minimum 10 experiments (five from Group A and five from Group B) shall be performed to cover entire curriculum of course CO430.The list given below is just a guideline. Every assignment should include use of syntax, use of command/function used for coding and printout of code with proper comment and output.

Group A:

1. Program for linear queues using array.
2. Program for circular queue using array.
3. Program for stack using array.
4. Create a singly linked list with options:
   a) insert (at front, at end, in the middle),
   b) delete (at front, at end, in the middle),
   c) Display
5. Implement stack as an ADT using Linked List.
6. Implement Queue as an ADT using Linked List.
7. Represent a single variable polynomial using Singly Linked List and perform Addition, Display and Evaluation.

Group B:

1. Program for operations on doubly linked list.
2. Create binary tree and perform recursive and non-recursive traversals.
3. Represent a graph using array or linked list and calculate degree of each node.
4. Program for linear and binary search.
5. Program for merge sort.
6. Program for quick sort.

NOTE:

ICA – Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (journal) based on practical performed by him/her. The performance shall be assessed experiment wise using internal continuous assessment format (S 10).

ESE – The End Semester Examination (ESE) for this laboratory course shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

EE409: SEMINAR

Teaching Scheme: 02 Pr Total 02 **Credits**: 01
Examination Scheme: 50 ICA + 0 ESE **Total Marks:** 25

1. Each Student shall select a topic for seminar which is not covered in curriculum. Seminar topic should not be repeated and registration of the same shall be done on first come first serve basis.
2. Topic of Seminar shall be registered within a three weeks from commencement of VII Semester and shall be approved by the committee.
3. The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Seminar-II. Seminar shall be related to the state of the art topic of his/her choice approved by the committee.
4. Each student should deliver a seminar in scheduled period (Specified in time table or time framed by department) and submit the seminar report (paper bound copy/Thermal bound) in following format:

    a. Title
    b. Abstract
    c. Introduction
    d. Literature survey
    e. Concept
    f. Functional and Technical Details
    g. Applications
    h. Comparison with similar topics / methods
    i. Future scope
    j. References

ASSESSMENT OF SEMINAR

Guide lines for ICA: ICA shall be based on topic selection, presentation and Seminar-II report submitted by the student in the form of thermal bound. Assessment of the Seminar-II for award of ICA marks shall be done jointly by the guide and a departmental committee, as per the guidelines given in **Table- B**

Name of Guide: _____

Table-B

SN	Name of Student	Seminar Topic	Topic Selection	Literature survey	Report writing	Depth of under-standing	Presentation	Total
			5	5	5	5	5	25

Proposed Final Year B.Tech (Electrical) Syllabus

(WEF 2017-18)

SEMESTER

II

EE451: ELECTRICAL MACHINE DESIGN

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The course consists of general factors of electrical machine design, material classification, temperature rise and rating of machines. It explores the design concept of transformer core, windings overall dimension, performance and cooling design of transformer. The course also provides sound understanding and basic concepts of rotating machine design.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Electrical Machines -I and Electrical Machines –II

COURSE OBJECTIVES:

The objectives of course are to

1. understand concept of specific loading
2. design single phase and three phase transformer
3. design starters of rotating machines
4. design rotating machines
5. aware them about use of latest software in electrical machine design

COURSE OUTCOMES:

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

1. differentiate between power and distribution transformer
2. determine main dimensions of rotating machines
3. design windings of rotating machines
4. differentiate between power and distribution transformer
5. differentiate between the design specifications of asynchronous and synchronous machines

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	--	--	--
PO-b	2	3	3	3	3
PO-c	2	3	2	2	2
PO-d	2	2	2	2	2
PO-e	2	2	1	1	1

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE451: ELECTRICAL MACHINE DESIGN

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+ 15 ISE2+ 10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Design, Analysis and Performance of Transformer: Design of distribution and power transformer, classifications, output equation, core and yoke sections, main dimensions design, core loss from design data, winding design, calculations of magnetising current, winding resistances and leakage reactance, cooling methods, radiators, tank wall dimensions. Calculation of losses, determination of voltage regulation, temperature rise of transformer, transformer oil as a cooling medium, temperature rise in planed wall tanks, design of insulation, air blast cooling, forced oil circulation, thermal rating, heating time constant of transformer.

Fundamentals of Rotating Machine Design: Magnetic circuit, specific electric and magnetic loadings selection, choice of specific loading, Output equation of ac machines, factors affecting the size of rotating machines. Separation of main dimensions, design of starters-shunt motors, series motor, slip ring induction motor. Principals of design and design factors, rating, specifications, standards, brief study of magnetic, electric insulating and other material, theory of solid body heating, heating and cooling time curve, rating of machines .

Design of D.C. Machine: Types of windings, choice and design of simplex, duplex, lap and wave windings, equalizer connections, dummy coils, concept of multiplex windings, reason for choosing them A.C. Machine Windings**: S**ingle and double layer, single phase ac windings with integral and fraction slots, three phase windings.

Design of Asynchronous Machines: Principles of three phase induction motor design, performance and other criterion to be considered. Output equation, stator design, selection of stator slots, Stator winding, stator core, air gap, choice of average flux density in air gap, choice of ampere conductors per meter, efficiency and power factor, main dimensions. Selection of rotor slots, rotor bars/windings calculations, Design of end rings, magnetic circuit calculation, calculation of ampere turns of magnetic circuit for electrical machines.

Design of Synchronous Machine: Types of synchronous machines, prime movers for synchronous generators, construction of hydro and turbo alternators. Output equation, main dimensions, short circuit ratio, length of air gap, Armature design, armature windings, slot dimensions, length of mean turn, stator core, elimination of harmonics, design of rotor, armature parameters, magnetic circuit, open circuit characteristics.

Computer Aided Design: Limitations (assumptions) of traditional designs, need of CAD analysis, synthesis and hybrid methods, design optimisation methods, variables, constraints and objective function, problem formulation **Electrical Machine Design software Packages:** Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM,LSPMSMs machines etc, need of commercial FEA based software, analytical design modules, 2D and 3D machine models, analysing steady state and transient performance of the designs

Text books:

1. "A Course in Electrical Machine Design", A.K. Sawhney, Dhanpat Raiand sons New Delhi**.**10th edition,
2. "Theory and Performance & Design of A.C. Machines", M.G. Say, ELBS London 3rd edition,
3. "Performance and Design of DC Machine" A.E.Clayton, , ELBS, ISAAC Pitman Sons.3rd edition,
4. "Performance and Design of AC Machine" A.E.Clayton, , ELBS,ISAAC Pitman Sons, 3rd Edition,

Reference books:

1. "Principles of Electrical Machine Design with computer programmes", S. K. Sen, Oxford and IBH Company Pvt. Ltd., New Delhi
2. "Electrical Machine Design Data Book", A Shanmugasundaram, G. Gangadharan, R. Palani, , 3rd edition, 3rd reprint 1988 - Wiely Eastern Ltd., New Delhi

EE452: POWER SYSTEM OPERATION AND CONTROL

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+ 10ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Interconnection of grids has led to more complex operational problems and need very advanced computing techniques. This course explores knowledge of economic load scheduling and dispatch. It also discusses knowledge of power system operation voltage and frequency control. It explores the basic concept of voltage stability, voltage collapse and FACTs devices.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Electrical Machines, Generation, Transmission

COURSE OBJECTIVES:

The objectives of course are to

a. study power system operation and control.
b. analyze the stability problem for complex and large capacity units.
c. understand voltage and frequency control,
d. know enhancement of power handling capacity by use of FACTs
e. understand need of reactive power compensation

COURSE OUTCOMES:

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

1. learn the complexity of power system
2. know the optimal load scheduling
3. function and operation of load dispatch centre for economic growth of electric utilities
4. know the significance of real power and reactive power flow in the system for effective utilization of electrical installations
5. learn the concept of frequency control , mathematical modelling

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	-
PO-b	2	3	1	3	3
PO-c	2	3	2	2	2
PO-d	3	2	2	2	2
PO-e	2	2	1	2	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE452: POWER SYSTEM OPERATION AND CONTROL

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+ 10ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Economic Load Dispatch & Optimal Operation of Power System: Input output characteristics, heat-rate characteristics, Incremental fuel rate and cost, Incremental Production cost, optimum scheduling of generation between different units. (Neglecting transmission losses), Transmission loss as a function of plant generation (A simple system connection two generating plant to load) and incremental transmission loss for optimum economy, calculation of loss coefficients (two plant system), Optimum scheduling of generation between different plant considering transmission loss concept and significance of penalty factor, Automatic load dispatch, function and applications.

Generator Voltage control: Automatic voltage control, generator controllers, Cross coupling between P-F and Q-V control channel, automatic voltage regulator, types of exciters and excitation system, exciter modelling, transfer function modelling for control static performance and dynamic response of AVR loops.

Load Frequency Control: Automatic load frequency control, speed governing system and hydraulic valve actuator for individual generator, turbine modelling, generator and load modelling transfer function representation of power control mechanism of generator.

Electric Power Control: Concept of control area, division of power system into control areas, load frequency of single area, two area and multi area power system without integral control Advantage of pool operation , tie line bias control area exchange.

Voltage Stability and Compensation: Power system security, Operating stage (state transition diagram), voltage stability, Comparison of angle and voltage stability, reactive power flow and voltage collapse, voltage stability analysis and prevention of voltage collapse.

Compensation in power system: load compensation, load ability of compensated and uncompensated over head transmission line , compensation of transmission line (shunt & series) .

Text Books:

1. "Electric Energy Systems Theory: An Introduction", O. L. Elgerd, 2nd edition, McGraw-Hill Book Comp. N.Y. 1987.
2. "Power System Analysis", Hadi Saadat, WCB/McGraw-Hill International Edition 1999

References:

1. "Modern Power System Analysis",I. J. Nagrath, D. P. Kothari, 2nd edition, TMH, New Delhi. 2000
2. "Economic Operation of Power System", L. K. Kirchamayor, Wiley Eastern Pvt. Ltd., New Delhi 2007
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu

ELECTIVE III-A EE453: GENERATION, PLANNING AND LOAD DISPATCH

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03

Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100

Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Electric energy generation is an old subject but it is now rejuvenated with important new development. The greater awareness of the environmental effects of electrical generation and economical consideration the subject contain different topics. The subject explores the knowledge the new trends and considerations in generation, generation planning , load forecasting, economics and reliability of generation system.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Electrical Machines, Generation, Transmission

COURSE OBJECTIVES:

The objectives of course are to

a. analyze the different power generation organization.
b. understand the generation planning,
c. know coordination and scheduling between different power plant,
d. understand economical aspects, load forecasting and reliability of generation system
e. give consideration towards Green energy

COURSE OUTCOMES:

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

1. familiarize the new trends in power generation for sustainable development.
2. understand different issues in electrical generation like economical, forecasting, environmental and safety.
3. analyze cost of generation and load scheduling in different type of power plants. understand concept of reliability in electrical power generation system.
4. discharge duties as power system engineer in technical and professional way.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	1
PO-b	2	3	1	3	3
PO-c	2	3	1	2	2
PO-d	2	2	2	2	2
PO-e	2	2	2	1	1

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE III-A EE453: GENERATION, PLANNING AND LOAD DISPATCH

Teaching Scheme: 03L Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+ 15 ISE2+ 10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Generation: Growth of electrical energy consumption, electrical energy sources, organization of power sector, role of private sector in energy management, Indian electricity grid code.
Environmental issue in electric power generation.
Cogeneration: Scope, advantages, cogeneration technology and industries suitable for cogeneration. Captive power generation: advantages, constrain, government policies, energy banking and energy wheeling. Distributed power generation: advantages and function electricity deregulation: need advantages, power player, metering and energy billing deregulation: need advantages, power player, metering and energy billing deregulation. Roll of load dispatch centres.

Generation Planning: Objectives of generation system planning, long term and short term planning, low range and short range hydro thermal scheduling of generation, co ordination equation.
Policy studies, co ordination of steam, hydro and nuclear power stations. Optimum generation allocation, line losses neglected and including the effect of transmission losses for thermal power generation.

Load Energy Forecasting: Classification of loads, load forecasting methodology. Peak demand forecasting, non whether sensitive forecast, weather sensitive forecast, annual and monthly peak demand forecast.

Generation System Cost Analysis: Capacity cost, generation cost, depreciation, effect of load factor on unit energy cost, analysis of fixed and operating cost of steam plant, hydro plant and nuclear plant, roll of diversity in power system economics, fuel inventories, off peak energy utilization.

Generation system reliability analysis: Probabilistic generation unit model and effective load, reliability analysis for isolated system, reliability of interconnected system.

Text books:

1. ”Generation of Electric Energy”, B. R. Gupta, Euresia Publishing House Pvt. Ltd.

Reference Book:

1. “Power System Planning”, R. L. Sullivan, McGraw Hill
2. “Economic Control Of Interconnected System”, Kirchmayers L. K. John Wiley and Sons, New York

ELECTIVE III-B EE453: HVDC AND FACTS

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Flexible AC Transmission System (FACTS) is one aspect of the power electronics revolution that is taking place in all area of electric energy. In the transmission area, application of power electronics consists of HVDC and FACTS. New technology based on power electronics devices offers an opportunity to enhance controllability, stability of power transfer capability of AC transmission system. The subject also explores the principles, operation of HVDC associated with FACT controller.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Electrical Machines, Generation, Transmission, Planning ,Load forecasting

COURSE OBJECTIVES:

The objectives of course are to
On completion of the course the students will be able to :

a. analyze the different control strategies for power flow using HVDC and FACTS devices.
b. understand the working of different FACTS controllers.
c. familiar with the latest advances in Power Electronics
d. study power transmission by EHV AC and FACTS.
e. study different FACTS component and power quality issues.

COURSE OUTCOMES

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

1. analyze the different control strategies for power flow using HVDC and FACTS devices.
2. understand the working of different FACTS controllers.
3. model power system problems using software
4. know the latest advances in Power Electronics
5. understand issues related to enhancement of controllability, stability and power transfer capability of AC transmission system at high voltage

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	2	1	2	1
PO-b	3	3	1	3	3
PO-c	3	3	1	2	3
PO-d	3	2	2	2	3
PO-e	2	2	2	1	-

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE III-B EE453: HVDC AND FACTS

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Introduction to HVDC: Introduction of DC Power transmission technology – Comparison of AC and DC transmission, Application and Description of DC transmission system, Planning for HVDC transmission, Modern trends in DC transmission, Types of HVDC Systems.

Analysis of HVDC Converters: Pulse Number-Choice of converter configuration, simplified analysis of Gratez circuit, 12- pulse converter based HVDC systems and their characteristics, Control of Converters.

Harmonics and Filters: Introduction – Generation of Harmonics, Design of AC filters and DC filters, HVDC light and HVDC PLUS (Power Universal Link), Series and Parallel operation of converters.

Introduction to FACTS: The concept of flexible AC transmission – reactive power control in electrical power transmission lines, uncompensated transmission line, Introduction to FACTS devices and its importance in transmission Network, Introduction to basic types of FACTS controllers , Comparison of HVDC and FACTS.

Shunt and Series Compensation: Principles of series and shunt compensation, description of static VAR compensators (SVC), thyristor controlled series compensators (TCSC), static phase shifters (SPS), static synchronous series compensator (SSSC), STATCOM.

Hybrid FACTS Controllers: Unified Power Flow Controller (UPFC) – Principle of operation, modes of operation, applications, IPFC, Modelling and analysis of FACTS Controllers.

Text Books

1. "HVDC Power Transmission System", K. R. Padiyar, Wiley Eastern Limited, New Delhi, First Edition 1990
2. "Understanding FACTS: Concepts and Technology of FACTS Systems", N. G. Hingorani, IEEE Press, 2000
3. "FACTS Controllers in Power Transmission and Distribution", K. R. Padiyar New Age International (P) Ltd. 2007
4. "Flexible AC Transmission System", A. T. John, Institution of Electrical and Electronic Engineers (IEEE) 1999

References

1. "High Voltage Direct Current Power Transmission", Colin Adamson and N. G. Hingorani, Garraay Limited, London 1960
2. "High Voltage Direct Current Transmission", J. Arrillaga, Peter Pregnnus, London 1983
3. "Direct Current Transmission", Edward Wilson Kimbark Vol.1 Wiley Interscience, New York, London Sydney 1971
4. "Power Electronics in Electric Utilities: Role of Power Electronics in Future power systems", Narin G. Hingorani, Proc. of IEEE, Vol.76, no.4, April 1988
5. "Concepts for design of FACTS Controllers to damp power swings", Einar V. Larsen, Juan J. Sanchez-Gasca, Joe H.Chow, IEEE Trans On Power Systems, Vol.10, No.2, May 1995

ELECTIVE III-C EE453: POEWER SYSTEM DESIGN

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

This course starts from fundamental concept such as constants of overhead transmission line and the performance of transmission lines. The design of transmission lines is both electrical and mechanical. Design of EHVAC and HVDC transmission and power has been described. Power system control and methods of compensation are also discussed. Latter part of this deals with the design of distribution systems including their economics.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Power system and switchgear protection

COURSE OBJECTIVES:

The objectives of course are to

1. design power system for given power rating.
2. judge the effects of various design parameters on the performance of transmission line
3. analyse distribution systems
4. know the significance of design parameters from electrical and mechanical point
5. understand knowledge of substation layout and site selection

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. design power system for given power rating.
2. draw lay out of a substation
3. understand the limitations of effects of various design parameters
4. determine ratings of capacitor for power factor improvement.
5. solve problems related to sag.

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	-	2	-
PO-b	3	1	1	3	-
PO-c	3	2	2	2	3
PO-d	3	2	2	2	3
PO-e	2	2	2	1	-

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE III-C EE453: POEWER SYSTEM DESIGN

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Overview of transmission systems: Constants of overhead transmission lines(resistance, inductance, capacitance), characteristics and performance of transmission lines, bundled conductors Selection of voltage for high voltage transmission line, choice of conductor, spacing of conductor, Insulators, specification of transmission line, surge impedance loading, Electrical & mechanical design of transmission line. Design of EHV transmission lines. Transmission of electric power at extra high voltage, design consideration of EHV line, insulation coordination, Radio and television interference.

Electrical Design of EHV Transmission lines: Requirements and specifications, selection of voltage, choice of conductors, spacing of conductors, corona, radio and television interference, insulation coordination, insulators, surge impedance loading. Mechanical Design of Transmission lines: Main considerations, sag-tension relation, stringing of transmission lines, transmission towers. Circuit breakers: Operating mechanism, testing rating and selection, operating under special conditions, specification and technical details for tender preparations

Lightning Arrestors: Rating characteristics, testing technical defects, standards followed for details insulation co ordination. Power transformers different types, tapping , fittings, cooling, cost comparison, testing technical details for ordering and tender preparations.

Design of Power System: Selection of sizes and location of generating stations, sizes and location of substations, interconnection, power system grounding design, Lightning. Need, construction, location, connections, protection, analysis, special types, testing, technical details. Earthing: Earthing systems, step potential, touch potential and transfer potential.

Design of Distribution System: Development of distribution plan, types of distribution system arrangement, Types of cables, primary distribution design, secondary distribution design, design of electrical substation, design of deign of rural industrial distribution system. Power system planning and control: Forecasting loads and energy requirement, generation planning, transmission and distribution system planning. Voltage control, control of reactive power and power factor, line compensation.

Text Books

1. “Electrical Power System Design” M.V. Deshpande, TMH
2. “Extra High Voltage AC Transmission Engineering”, Rakosh D. Begamudre, Wiley Eastern Limited, 2/e

Reference Book

1. “Elements of Electrical Power Transmission”, Turan Gonen
2. “Elements of Electrical Power Distribution”, Turan Gonen

ELECTIVE III-C EE453: EXTRA HIGH VOLTAGE AC TRANSMISSION

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03

Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100

Duration of ESE: 03 hrs

COURSE DESCRIPTION:

This course starts from fundamental concept such as constants of overhead transmission line and the performance of transmission lines. The design of transmission lines is both electrical and mechanical. Design of EHVAC and HVDC transmission and power has been described. Power system control and methods of compensation are also discussed. Latter part of this deals with the design of distribution systems including their economics.

DESIRABLE AWARENESS/SKILLS:

Knowledge of Power system and switchgear protection

COURSE OBJECTIVES:

The objectives of course are to

1. qualitatively compare AC and DC transmission system with all aspects
2. understand the need of EHV AC transmission and various issues related with it
3. judge the need of reactive power management,
4. know the stability of AC and DC systems
5. analyze faults, protections, harmonic considerations, grounding system in EHVAC

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. differentiate between AC and DC transmission system
2. know the issues related to EHV AC transmission
3. understand the devices used for reactive power management
4. analyze problems in stability of AC and DC systems
5. simulate problems in protection , faults in modern EHVAC systems

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	1	2	2
PO-b	2	1	1	3	2
PO-c	3	2	3	2	3
PO-d	2	2	3	2	3
PO-e	2	2	2	2	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE III-C EE453: EXTRA HIGH VOLTAGE AC TRANSMISSION

Teaching Scheme: 03L+0T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Necessity of EHV AC Transmission: Advantages and problems, power handling capacity and line losses, mechanical considerations, resistance of conductors. Surface voltage gradient on conductors, electrostatic field of EHV, Lines properties of bundled conductors, bundle spacing and bundle radius. Capacity and line Loss, measurement of electrostatic fields. Electromagnetic interference.

Line and Ground Reactive Parameters: Line inductance and capacitances , sequence inductances and capacitances, modes of propagation, ground return. Electrostatics, field of sphere gap, field of line changes and properties, charge, potential relations for multi-conductors, surface voltage gradient on conductors, distribution of voltage gradient on sub-conductors of bundle, examples

Corona Effects: Power loss and audible noise (AN), corona loss formulae , charge voltage diagram, generation characteristics, limits and measurements, relation between 1-phase and 3-phase levels. Radio interference (RI), corona pulses generation, properties, limits, frequency spectrum, modes of propagation, excitation function, measurement of RI, RIV and excitation functions, examples.

Electro Static Field: calculation of electrostatic field of EHV/AC lines, effect on humans, animals and plants, electrostatic induction in un-energised circuit of double-circuit line, electromagnetic interference **Voltage control:** Power circle diagram and its use, voltage control using synchronous condensers, cascade connection of shunt and series compensation , sub synchronous resonance in series capacitor compensated lines, static VAR compensating system., examples.

Travelling-Wave Theory: Travelling wave expression and solution- source of excitation- terminal conditions- open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed lines generalized constants-No load voltage conditions and charging current.

Text Books

1. “Extra High Voltage AC Transmission Engineering”, R. D. Begamudre, Wiley Eastern Limited
2. “HVAC and DC Transmission”, S. Rao, New Age International Pvt Ltd, Dhanapat Rai and sons, New Delhi

Reference Book

1. “Elements of Electrical Power Transmission”, Turan Gonen, TMH, New Delhi

ELECTIVE III-E EE453: POWER QUALITY AND MITIGATION ISSUES

Teaching Scheme: 03L+ 0T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The fundamental quality of power systems through has not degraded. What has changed is the today's society is a heavy user of solid state power devices. The subject discusses the various types of power quality problems that can protect equipment. Further these problems not always easy to identify subject also explores this and how to monitor it.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power system and voltage control

COURSE OBJECTIVES:

The objectives of course are to

a. learn to distinguish between the various categories of power quality problems.
b. understand the root of the power quality problems in industry and their impact on performance and economics.
c. learn to apply appropriate solution techniques for power quality mitigation based on the type of problem.
d. introduce the importance of grounding in power quality.
e. introduce power distribution protection techniques and its impact on voltage quality.

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. distinguish between the various categories of power quality problems.
2. understand power quality problems in industry and its impact on performance and economics.
3. try to find appropriate solution techniques for power quality mitigation based on the type of problem.
4. know the importance of grounding in power quality.
5 solve problems related to quality voltage in power systems

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	2	2	-
PO-b	2	1	2	3	-
PO-c	3	2	3	2	3
PO-d	2	2	2	2	3
PO-e	2	2	-	2	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE III-E EE453: POWER QUALITY AND MITIGATION ISSUES

Teaching Scheme: 03L+ 0T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Electric Power Quality: Definition; Power Quality evaluation procedures; Terms and definitions: transients, long duration voltage variations, short duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuation; sources of sags and interruptions, solutions at the end user level.

Transient Over-voltages: Sources of transient over voltages, devises for overvoltage protection, switching transient problems with loads, computer tools for transient analysis.

Fundamentals of Harmonics: Harmonic distortion, power system quantities under non-sinusoidal conditions, harmonic indices, harmonic sources from industrial loads, effects of harmonic distortion, devices for controlling harmonic distortion, standards on harmonics.

Power Quality Monitoring: Monitoring considerations, historical perspective of power quality measuring instruments, power quality measurement equipment, application of intelligent systems, power quality monitoring standards.

Modelling of Networks and components under non-sinusoidal conditions: Transmission and distribution systems, resonance, shunt capacitors, transformers, electric machines, ground systems.

State Estimation applied to Power Quality Assessment: State estimation, Least square state estimators, Kalman filters, artificial neural networks.

Text Books

1. "Electrical Power Systems Quality", Roger C. Dugan, McGraw-Hill Publication,
2. "Electric Power Quality", G.T.Heydt, Stars in a Circle Publications

Reference Book

1. J. "Power System Quality Assessment", Arrillaga, N.R.Watson, John Willey & Sons

ELECTIVE IV-A EE454: ADVANCED ELECTRIC DRIVES

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

With nearly two-thirds of global electricity consumed by electric motors, their proper control represents appreciable energy savings. The efficient use of electric drives also has far-reaching applications in such areas as factory automation (robotics), clean transportation (hybrid-electric vehicles), and renewable (wind and solar) energy resource management. Advanced Electric Drives utilizes a physics-based approach to explain the fundamental concepts of modern electric drive control and its operation under dynamic conditions. Advanced Electric Drives is an invaluable resource to facilitate an understanding of the analysis, control, and modelling of electric machines. The subject explores this.

DESIRABLE AWARENESS/SKILLS:

Knowledge of electrical machines, mathematics

COURSE OBJECTIVES:

The objectives of course are to

a. analyze d-q axis behaviour of drives
b. differentiate between flux and direct control of induction motor
c. compare operation motor for PMAC/PMDC
d. select proper BLDC / SRM and its rating according to the application.
e. model BLDC and SRM drive for application.

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. understand various controls of modern advanced electric drive
2. discriminate and select sine wave and square wave EMF based BLDC
3. suitably select proper BLDC / SRM and its rating according to the application
4. select suitable drive for BLDC AND SRM
5. simulate BLDC and SRM drive

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	2	2	2
PO-b	2	1	2	3	1
PO-c	3	2	3	2	3
PO-d	2	3	2	2	2
PO-e	-	2	-	-	-

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE IV-A EE454: ADVANCED ELECTRIC DRIVES

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Power Converters for AC drives: PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three-level inverter, different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self commutated devices. Control of CSI, H bridge as a 4-Q drive.

Induction Motor Drives: Voltage fed inverter control-v/f control, vector control, direct torque and flux control(DTC).

Synchronous Motor Drives: Open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Permanent Magnet Motor Drives: Definitions and types of brushless motor, classification and applications, commutation, PMSM, self starting and inverter driven, operation of 3-phase brushless DC motor: EMF waveform, torque and EMF constants, speed/torque characteristic.

Square Wave and Sine Wave Drives of Brushless Permanent Magnet Motors: Magnetic circuit analysis on open-circuit, torque and winding inductances and armature reaction, motors with 120° and 180° magnet arcs: commutation torque, and reactance, sine wave motor with practical windings, circle diagram and torque/speed characteristic, torque per ampere and kVA/kW of square wave and sine wave motors.

Introduction and Design of Switched Reluctance Motor (SRM): Principle of operation of the switched reluctance motor, SRM configurations, derivation of output equation, selection of dimensions, steady-state performance and analytic derivation of SRM characteristics, method of inductance calculation, calculation of average and instantaneous torque.

Switched Reluctance Motor Drive Converters for SRM drives, converter configurations, comparison of power converters, control of SRM drive, closed-loop, speed-controlled SRM drive, torque control, acoustic noise and its control in SRMs, sensor less operation of SRM Drives, applications

DSP based motion control: Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

Text books:

1. "Modern Power Electronics and AC Drives", B. K. Bose, Pearson Education, Asia, 2003
2. "Analysis of Electric Machinery and Drive Systems" P.C. Krause, O.Wasynczuk, S. D. Sudhoff, 2nd edition, IEEE press, A John Wiley & Sons, Inc Publications
3. "Design of Brushless Permanent Magnet Machines", J.R. Hendershot and T.J.E. Miller, Motor Design Books, 2010

Reference Books:

1. "DSP based Electromechanical Motion Control", H. A. Taliyat, S. Campbell CRC press
2. "Permanent Magnet Synchronous and Brushless DC motor Drives", R. Krishnan, CRC Press, 2009
3. "Brushless Permanent-Magnet Motor Design", D. C. Hanselman, Mc Graw-Hill, Inc, 1994.
4. "Switched Reluctance Motors and their Control", T. J. E MillerMagna Physics, Calendran Press, 1993

ELECTIVE IV-B EE454: RESTRUCTURED POWER SYSTEMS

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03

Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100

Duration of ESE : 03 hrs

COURSE DESCRIPTION:

"What is deregulation or restructuring of an industry?" Deregulation is about removing control over the prices with introduction of market players in the sector. There are certain conditions that create a conducive environment for the competition to work. These conditions need to be satisfied while deregulating or restructuring a system. The subject discusses all about these aspects.

DESIRABLE AWARENESS/SKILLS:

Knowledge of power systems, generation, transmission and distribution

COURSE OBJECTIVES:

The objectives of course are to

a. apply this knowledge of science, mathematics, and engineering principles for solving problems
b. identify, electrical engineering problems in the broad area like power systems
c. formulate and solve electrical engineering problems in the broad area like power systems and its economics.
d. know the different software tools in the domain of power system simulations
e. exhibit management principles and function as a member of a multidisciplinary team

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. necessity of restructuring , deregulation power system
2. solve problems on cost of generation
3. understand global power system problems
4. knowledge of contemporary issues pricing in power sector
5. understand problems in security of de-regulation

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	2	2	-
PO-b	2	1	2	3	-
PO-c	3	2	3	2	-
PO-d	2	3	2	2	-
PO-e	-	2	-	-	-

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE IV-B EE454: RESTRUCTURED POWER SYSTEMS

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE : 03 hrs

Introduction: Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, de-regulation, components of deregulated system, advantages of competitive system

Deregulation of Power Sector: Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trade model, multilateral trade model. Competitive electricity market: Independent system operator activities in pool market, wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market power and its mitigation techniques, bilateral trading, ancillary services.

Transmission Pricing: Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, Postage stamp method, Contract Path method, Boundary flow method, MW-mile method, MVA-mile method, Comparison of different methods.

Congestion Management: Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.

Ancillary Services and System Security in Deregulation: Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Text Books

1. "Power System Restructuring and Deregulation", Loi Lei Lai, John Wiley & Sons Ltd.
2. "Restructured Power Systems, Operation, Trading and Volatility "Mohammad Shahidehpour, M. Alomoush, CRC Press

Reference Books

1. "Fundamentals of Power System Economics", Daniel Kirschen, Goran Strbac, John Wiely & Sons Ltd. 2004
2. "Operation of restructured power systems", Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, Kluwer Academic Pub., 2001
3. "Power system Economics: Designing Markets for Electricity", Steven Stoft, John Wiley and Sons, 2002
4. "Making Competition Work in Electricity", Sally Hunt, John Wiely & Sons, Inc., 2002

ELECTIVE IV-C EE454: HIGH VOLTAGE ENGINEERING

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

The demand for generation and transmission of large amount of electric power today necessitates in transmission at extra- high voltages. Electrical engineering students are expected to possess knowledge of high voltage techniques. The subject is not in-depth but explores the knowledge of insulating material, properties, breakdown phenomena in solid, liquid and gases. It also provides the platform to understand the generation and measurement of high voltage.

DESIRABLE AWARENESS/SKILLS:

Knowledge of electrical measurement and instrumentation

COURSE OBJECTIVES:

The objectives of course are to

a. understand breakdown phenomenon in case of solid, liquid and gaseous insulating medium
b. familiarize with various methods of generation of high voltages
c. familiarize with various methods of measurement of high voltages
d. understand over voltage phenomenon & concepts of insulation co-ordination
e. understand importance of testing of power apparatus

COURSE OUTCOMES

Students will be able to

1. understand the breakdown phenomenon in case of various insulating materials
2. understand the concepts of generation of high voltages & currents
3. understand the causes and protection from over-voltages and the concept of insulation co-ordination
4. explain the direct and indirect testing methods
5. exhibit safe working practices in laboratories

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	2	2	1
PO-b	2	1	2	3	1
PO-c	3	2	3	2	2
PO-d	2	3	2	2	2
PO-e	3	2	-	-	2

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE IV-C EE454: HIGH VOLTAGE ENGINEERING

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Breakdown in gases, liquids and solids: Conduction & break down in gases, Ionization process & current growth, Townsend's criterion for break down, Determination of alpha & gamma co-efficient, Streamer theory of breakdown in gases, Paschen's law, Breakdown in non-uniform field and corona discharge, Conduction & break down in pure liquid & commercial liquid, Breakdown in solid dielectrics.

Lightning and Switching Over Voltage Protection: Lightning strokes to lines and towers mechanism and characteristics Generation of lightning surges, Natural causes for over voltages, Lightning phenomenon, over voltages due to switching surges, system faults & other abnormal conditions, Protection of transmission lines from lightning, lightning arrestors, insulation co-ordination of HV and EHV power system,.

Generation of High voltage and Currents: Generation of high voltage & currents, Generation of high DC voltages and high alternating voltages, impulse voltages, Generation of impulse voltage and current. Classification of high voltage laboratories, testing facilities provided in high voltage laboratories, grounding of impulse testing laboratories.

Measurement of High Voltages and Currents: Methods of measurement of peak voltage and high direct current , Measurement of high, High alternating voltages, & impulse voltages, Measurement of high direct currents, High alternating currents & high impulse currents, Dielectric loss and capacitance measurements, ratio frequency & partial discharge measurements.

Testing of EHV Line Insulation: Basic technology, testing of insulator bushing, cables, transformer, surge diverters and threshold current, capacitance of long objects, Electromagnetic interference, EHV line insulation design based upon transient over voltages High Voltage Testing of Power Apparatus.

Text Books:

1. "High Voltage Engineering", M. S. Naidu, V. Kamaraju, Tata McGraw –Hill publications.
2. "High Voltage Engineering fundamentals", E. Kuffel, W.S. Zaengl, J. Kuffel, Butterworth – Heinemann publishers.

Reference Books:

1. "High Voltage Test Techniques", D. kind, K. Feser, Vieweg, SBA publications.
2. "High Voltage Engineering- Theory & Practices", M. Khalifa, Dekker publications

ELECTIVE IV-D EE454: ILLUMINATION ENGINEERING

Teaching Scheme: 03L+0T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Light by definition connotes Electromagnetic radiation that has a wavelength. In fact in the prehistoric days, all human activities were coordinated with Sunrise and Sunset. Today, in principle activities are carried out round the clock. All this is made possible because of Artificial Lighting systems. The lighting systems comprise of a source employing any physical phenomenon among Incandescence, Electrolumniescence or Flourescence. Trend these days is to employ, modern electronic controls together with energy efficient lamps. The subject discusses all about this.

DESIRABLE AWARENESS/SKILLS:

Knowledge of basic electrical engineering, physics, chemistry

COURSE OBJECTIVES:

The objectives of course are to

a. select proper light source for the given lighting application
b. design a lighting scheme for interior and exterior lighting
c. propose and design energy efficient lighting scheme with suitable stand by source
d. understand how to use data sheets of illumination levels of various light sources
e. solve based on indoor/exterior lighting

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. select proper light source for the given lighting application
2. design a lighting scheme for interior and exterior lighting
3 propose and design energy efficient lighting scheme with suitable stand by source
4 compare light sources based on illumination levels
5 know concepts in outdoor lighting

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	2	2	2
PO-b	2	1	2	3	2
PO-c	3	2	3	2	3
PO-d	2	3	2	2	2
PO-e	3	3	3	-	3

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE IV-D EE454: ILLUMINATION ENGINEERING

Teaching Scheme: 03L+0T Total 03 **Credits**: 03
Examination Scheme: 15 ISE1+15 ISE2+10 ISA+60 ESE **Total Marks:** 100
Duration of ESE: 03 hrs

Importance of Lighting in Human Life: Optical systems of human eye, dependence of human activities on light, performance characteristics of human visual system. Artificial lighting as substitute to natural light, ability to control natural light, construction and working principles of spectro-radiometer, spectrophotometer and colorimeter. Retro reflection & its application. Colorimetric-Different colour specification systems and their limitations. Measurement of CRI, CRI of radiation due to multiple sources. Pigment colour and mixing of pigments in paint industries

Light Source: Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, LEDs characteristics, features and applications, LASERS, characteristics, features and applications, non-lighting lamps, Induction lamps. Optical fibre, its construction as a light guide, features and application

Photometric Control of Light Sources and their Quantification: Luminaries design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, ingress protection code, luminaries standard. Indian standard recommendations.

Factors of Good Lighting Design: Indoor Lighting Design: Zonal cavity method for general lighting design, coefficient of Utilization determination for zonal cavities and different shaped ceilings. Using COU (coefficient of utilization), using beam angles and polar diagrams, glare calculations. Typical applications: office, educational facility, theatre, residential, hospital. Indian Standard recommendation for indoor lighting, selection criteria for selection of lamps and luminaries, design consideration and design procedure. (Problems on COV, beam angles and polar diagrams). Designing problem and solution and designing documentation. Exterior lighting system- Road lighting system and highway lighting system.

Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaries selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. Energy efficient lighting: Comparison between different light sources, comparison between different control gears, overcoming problems in energy efficient lighting, payback calculation, life cycle costing, (problems on payback calculations, life cycle costing). Solar lighting: day lighting, photovoltaic lighting.

Text Books :

1. " Illumination Engineering- from Edison's Lamp to the Laser", Joseph B. MurdochMacmillan Publishing company, New York, 1985.
2. "Introduction to light emitting diode technology and applications," Gilbert Held, CRC Press, 2009.
3. " Light emitting diodes", E. Fred Schubart, Cambridge University Press, 2006

Reference Books:

1. "BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", ManakBhavan, New Delhi.
2. "Handbook of Industrial Lighting", Butterworths and Stanley L. Lyons Butterworth and Co. Publishers Ltd., 1981.

ELECTIVE IV-E EE454: ELECTRICAL MACHINE ANALYSIS

Teaching Scheme: 03L+ 0 T Total 03 **Credits**: 03
Examination Scheme: 15ISE1+15ISE2+10ISA+60ESE **Total Marks:** 100
Duration of ESE: 03 hrs

COURSE DESCRIPTION:

Electrical machine analysis is related with mathematical analysis of rotating electrical machines. All electrical rotating machines basically are similar from its construction point of view. But the way in which excitation will be applied make their operation characteristics different. The subject explores all these aspects in detail.

DESIRABLE AWARENESS/SKILLS:

Knowledge of rotating electrical machines, mathematics

COURSE OBJECTIVES:

The objectives of course are to

a. understand generalized machine theory which forms the basis of Machine modelling.
b. understand transformation of variables to develop mathematical model of machines.
c. develop Mathematical modelling and analysis.
d. know the concepts & techniques of speed control of electrical machines which are essential for high performance drives.
e. exposure to the various equivalent circuits and their application to performance analysis of electrical machines.

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to:

1. explain generalized machines theory and Linear Transformations as applied to electrical machines.
2. develop mathematical models of electrical machines.
3. design machines and analysis of their performance as per applications.
4. use tools like MATLAB, SIMULINK, and ANSYS for analysis.
5. suggest the proper drive as per need of industrial applications drive

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4	CO-5
PO-a	1	3	2	2	2
PO-b	2	1	2	3	1
PO-c	3	2	3	2	3
PO-d	2	3	2	2	2
PO-e	-	2	-	-	-

1- Strongly correlated 2 – Moderately correlated 3 – Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

ELECTIVE IV

EE: 454 E ELECTRICAL MACHINE ANALYSIS

Teaching Scheme: 03L Total 03 **Credits** : 03
Examination Scheme: 15ISE1+ 15ISE2+ 10ISA+60ESE **Total Marks :** 100
Duration of ESE : 03 hrs

Basic concepts of Modelling: Basic Principles of Electrical Machine Analysis, Need of modelling, Introduction to modelling of electrical machines, Kron's primitive Machine

Concept of transformation: Commonly used reference frames, change of variables & machine variables and transform variables for arbitrary reference frame. Stationary circuit variables transformed to the arbitrary reference frame, transformation between reference frames, transformation of a balanced set, phasor relationships, balanced steady state, voltage equations.

Modelling of Direct Current Machine: Voltage and torque equations in machine **v**ariables, mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis, Application to D.C. machine for steady state and transient analysis.

Polyphase Induction Machines: Modelling of 3 phase induction motor, voltage and torque equations., equivalent circuit, steady state analysis, dynamic performance during sudden changes in load torque and three phase fault at the machine terminals.

Polyphase Synchronous Machine: Modelling of synchronous machines, voltage and torque equations in stator, rotor and air-gap field reference frames using Parks transformations, voltage and power equation for salient and non-salient alternator. Simplified equations of a synchronous machine with two damper coils, Dynamic performance during sudden changes in load torque. Dynamic performance during a three-phase fault at the machine terminals. Approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque.

Modelling Permanent Magnet Synchronous Machine: Introduction, types of permanent magnet synchronous machines and applications, PMAC & PMDC(BLDC), voltage and torque equations in machine variables, voltage and torque equations in rotor reference frame variables, Block diagram and transfer functions.

Text books:

1. "Analysis of Electric Machinery", P.C. Krause, McGraw Hill, NY, 1987.
2. "The unified Theory of Electrical Machines", C.V. Jones, Butterworth,-London, 1967.

Reference Books

1. "Power System Analysis", Stevenson, McGraw Hill, NY
2. "Computer Aided Power System Operation and Analysis", Dhar R.N., Tata McGraw Hill
3. "The Generalised Theory of Electrical Machines", P.S. BhimbraTata McGraw Hill
4. "Electric Motor Drives – Modelling, Analysis and Control", R. Krishnan, PHI

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EE455: PROJECT AND FINANCE MANAGEMENT

Teaching Scheme: 01L+ 0 T Total 01 **Credits**: 01
Examination Scheme: 50ISA+00ESE **Total Marks :** 50

COURSE DESCRIPTION:

Project Financial Management is a process which brings together planning, budgeting, accounting, financial reporting, internal control, auditing, procurement, disbursement and the physical performance of the project with the aim of managing project resources properly and achieving the project's objectives. Like the concept of Project Management, it is a strategic competency for organizations and can make the difference between a successful project and audit reports. Subject explores ideas in this regard.

DESIRABLE AWARENESS/SKILLS:

Knowledge of humanities,

COURSE OBJECTIVES:

The objective of s course are to

a. terminologies in project management application in real world
b. role and responsibilities of the project manager
c. estimate the project (cost and time)
d. managing conflict and motivating

COURSE OUTCOMES:

On the successful completion of this course, student shall be able to:

1. understand the processes in project management
2. learn importance of team building and resource allocation
3. know concepts of project and finance management
4. use PMS software

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4
PO-a	1	1	1	2
PO-b	1	1	1	2
PO-d	2	2	2	2
PO-f	3	-	-	2

1- Strongly correlated 2 – Moderately correlated 3–Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE455: PROJECT AND FINANCE MANAGEMENT

Teaching Scheme: 01L+ 0 T Total 01 **Credits**: 01
Examination Scheme: 50ISA+00ESE **Total Marks :** 50

Basics of Project Management*:* Introduction, need for project management, project management knowledge areas and processes, project life cycle, project manager, phases of project management life cycle. Project management processes, impact of delays in project completions, essentials of project management philosophy, project management principles.

Project Identification and Selection*:* Project Identification Process, project initiation, pre-feasibility study, project break-even point Project Planning: Need of Project Planning, project life cycle, Responsibility and team work, work breakdown structure, organisational structure and organisational issues, organisational structure. Roles and responsibilities of project leader, leadership styles for project managers, conflict resolution, team management and diversity management, change management

Project Quality Management and Value Engineering: Quality concepts, value engineering project management information system:(PMIS), Planning, Design of PMIS, Purchasing and contracting for projects: Purchase cycle, contract management, procurement process.

Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the projects. Purpose of project execution and Control, steps for closing the project, Project Management Software*:* Introduction, Advantages of Using Project Management Software, Common Features Available In Most of the Project Management Software, Illustration Case Studies in Project Management

Financial Management: Meanings and definitions, goals of financial management, interface between finance and other business functions. Financial Planning: Benefits, steps in financial planning, factors affecting financial planning. Requirements of a firm, capitalisation, time value of money, rationale, future value, present value.

Text Books:

1. "Elements of Project management", K Nagarajan, New Age International, 1.6.2005
2 "Financial Management, Theory and Practice", Prasanna Chandra , TMH, 7th, edition.

Reference Books:

1. " Modern Project Management", R. C. Mishra, TMH.
2. "Financial Management, Principles and Practice", Sudhindra Bhatt, 2nd edition,

The laboratory work should consist of assignment/ case studies based on theory syllabus of EE455.

Note :

Guide lines for ISA: Internal Sessional Assessment shall support for regular performance of minimum 05 assignments, ppt's and case studies, etc. In addition; it shall be based on knowledge/skill acquired and record submitted by student.

EE 456: ENTERPRENEURSHIP DEVELOPMENTLABORATORY

Teaching Scheme: 02Pr Total 02 **Credits**: 01
Examination Scheme: 50ICA+00ESE **Total Marks:** 50

COURSE DESCRIPTION:

Entrepreneurship is undertaken by entrepreneurs. In most cases the success of a business depends on the capability of the owner or the manager or both. Most of the qualities needed for successful entrepreneurship must be learned. The subject discusses about it.

DESIRABLE AWARENESS/SKILLS:

Knowledge of humanities, management

COURSE OBJECTIVES:

The objective of course are to

a. understand need of entrepreneurship
b. know challenges to entrepreneurs
c. know how to get financial assistance
d. support systems of entrepreneurs

COURSE OUTCOMES:

On the successful completion of this course student will able to learn

1. meaning of entrepreneurship
2. understand challenges to entrepreneurs
3. understand role of entrepreneurs
4. know the institutions giving financial support

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4
PO-a	2	1	2	3
PO-b	1	1	2	3
PO-d	2	2	2	-
PO-f	3	-	-	-

1- Strongly correlated 2 – Moderately correlated 3–Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE: 456 ENTREPRENEURSHIP DEVELOPMENT LABORATORY

Teaching Scheme: 02 Pr+ 0 T Total 01 **Credits** : 01
Examination Scheme: 50ICA + 0ESE **Total Marks:** 50

Introduction to Entrepreneurship: Introduction, Concept of entrepreneurship: Significance of entrepreneurship, Theories of entrepreneurship, Models of entrepreneurship development Definition of entrepreneur: Traits and characteristics of successful entrepreneur, Functions of an entrepreneur , Types of entrepreneurs, Factors influencing entrepreneur, Professional vs. family entrepreneurs, Entrepreneurial leaders vs. managers, Entrepreneurial process: Entrepreneurial motivation, Entrepreneurial barriers, Women as entrepreneur , Role of woman entrepreneurs in society, Barriers to women entrepreneurs , Myths of entrepreneurship, Problems faced by entrepreneurs and capacity building for Entrepreneurship, Profiles of successful entrepreneurs.

Financial requirements of a new Enterprise: Estimating financial requirements, Estimation of fix capital requirements, Estimation of working capital requirements Identifying the sources of finance– sources of long-term financing: Sources of medium term financing , Sources of short-term financing

Institutions providing financial assistance: Venture capital funding- venture capital funding in the Indian scenario, Venture capital funding process, Importance of financial management, working capital management, Accounting and book keeping, Financial statement, Financial ration analysis

Expansion strategies of an Enterprise: Expanding and enterprise: Expansion through concentration, Expansion through integration, expansion through diversification , Expansion through cooperation, Expansion through internationalization, Expansion through digitalization , Organization life cycle, Strategic. **Challenges for small Enterprises:** Problem faced by small enterprises: Managerial problems, Marketing management, Human resource, Production management, Technological problems Role of central and state governments in promoting small enterprises: Fiscal and tax concessions for small enterprises, Industrial policies for small enterprises, Importance of marketing, Customer relationship management (CRM), Marketing services

Institutional Support for small enterprises and decision support system: Institutions supporting small scale enterprises: Small scale industries (SSI) board, Khadi and village industries commission (KVIC), Micro, small and medium enterprises development organization (MSME-DO), National small industries corporation limited (NSIC), National institute for entrepreneurship and small business development (NIESBUD)‘ Indian institute of entrepreneurship (IIE), State industrial development / Investment Corporation (SIDCs/SIICs), State directorate of Industries (SDIs), District industry centres (DICs) ,Industry associations , Non-Governmental organization Institutions providing financial association: Small industries development bank of India (SIDBI), State financial corporation (SFCs) Technological up gradation and moderation of small enterprises: ISO 9000/14001 certification fee reimbursement scheme

Text books

1. “Entrepreneurship”, Alpana Trehan, Published Dreamtech Press.
2. “Patterns of Entrepreneurship” Jack M. Kaplan, Published, WILEY

Reference Books:

1. “Entrepreneurship Development, Small Business Enterprises”, Poornima M. Charantimath Publisher, Pearson.
2. “Essential of Entrepreneurship and Small Business Management”, Thomas W. Zimmerer & Norman M. Scarborough, Pearson, 4th Edition

The ICA work should consist of assignment/ case studies based on theory syllabus of EE456. The list given below is just a guide line.

EDP lab

1. Performing case studies of minimum two successful entrepreneurs
2. Study of pilot proposal of electrical small/medium firm with government machinery/District Industrial Centre/Banks/Financial firms.
3. Preparation, Submission and Presentation of individual innovative pilot proposal to government machinery/District Industrial Centre/Banks/Financial firms.

Note :

Guide lines for ICA: Internal Continuous Assessment shall support for regular performance of minimum 10 practical's and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student based on practical performed by student. The performance shall be assessed experiment wise using internal continuous assessment format (S10).

EE: 457 ELECTRICAL MACHINE DESIGN LABORATORY

Teaching Scheme: 02Pr Total 02 **Credits**: 01
Examination Scheme: 25ICA+25ESE **Total Marks:** 50
Duration of ESE : 03 hrs

COURSE DESCRIPTION:

The subject explores the practical knowledge of design of transformer and rotating electrical machines. In addition, software can also used for design and drawing of the machines.

DESIRABLE AWARENESS/SKILLS:

Knowledge of electrical machines, transformer

COURSE OBJECTIVES:

The objectives of course are to

a. design starters of dc/ac machine
b. concepts to design transformers
c. understand design of single phase machines
d. know design of reluctance machine

COURSE OUTCOMES:

On the successful completion of this course, student shall be able to:

1. design 3 point starter
2. solve problems on design of 3 phase induction motor
3. determine main dimensions of dc machine
4. learn and analyze different steady state speed control methods for Induction motors, and understand the closed loop block diagrams for different methods.
5. get introduced to modern synchronous motors

RELEVANCE OF COS /POS AND STRENGTH OF CO-RELATION:

PO/CO	CO-1	CO-2	CO-3	CO-4
PO-a	1	1	1	2
PO-b	1	1	1	2
PO-d	2	2	2	2
PO-f	3	-	-	2

1- Strongly correlated 2 – Moderately correlated 3–Weakly correlated

COURSE CONTENT (ON NEXT PAGE)

EE457: ELECTRICAL MACHINE DESIGN LABORATORY

Teaching Scheme: 02Pr Total 02 **Credits** : 01
Examination Scheme: 25ICA+25ESE **Total Marks :** 50
Duration of ESE : 03 hrs

The laboratory work should consist of minimum 10 experiments/drawings based on theory syllabus of EE451. Any five from group A and B. The sample list given below is just a guide line.

Group A

1. Design of starter for dc motor
2. Design of rotor resistance starter for slip ring induction motor
3. Design 1 phase transformer for given kVA rating
4. Design 3 phase transformer for given kVA rating
5. Design of main dimensions of dc machine
6. Design of 3 phase induction motor
7. Design of synchronous motor/ BLDC/reluctance motor

Group B

Design all above using any software like ANSYS

Note :

Guide lines for ICA: Internal Continuous Assessment shall support for regular performance of minimum 10 practical's and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student based on practical performed. The performance shall be assessed experiment wise using internal continuous assessment format (S10).

Guide lines for ESE: The end semester examination (ESE) for the laboratory course of three hrs duration, shall be based on performance in one of the experiments performed by student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners out of which one examiner shall be out of institute.

EE458: PROJECT- II

Teaching Scheme: 04Pr Total 04 **Credits**: 04
Examination Scheme: 50ICA+100ESE **Total Marks:** 150
Duration of ESE:03hrs

1. Project-I work decided in VII semester shall be continued as Project-II
2. Students should complete implementation of ideas given in synopsis/Abstract, so that project work should be completed before end of semester.
3. Project-II may involve fabrication, design , experimentation , data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability. The stage also includes testing , possible results and report writing
4. Each students project group is required to maintain log book for documenting various activities of Project-II and submit group project report at the end of Semester-VIII in the form of Hard bound.
    a. Title
    b. Abstract
    c. Introduction
    d. Problem identification and project objectives
    e. Literature survey
    f. Case study/Analysis/Design Methodology
    g. Project design and implementation details
    h. Result and conclusion
    i. Future scope
    j. references.

Guide lines for ICA: ICA shall be based on continuous evaluation of students performance throughout semester in project-II and report submitted by the students project group in the form Hard bound. Assessment of the project-II for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given in **Table-D.**

Guide lines for ESE:-In ESE the student may be asked for demonstration and questions on Project. Evaluation will be based on answers given by students in oral examination.

EE459: INDUSTRIAL LECTURES

Teaching Scheme: 01L Total 01 **Credits**: 01
Examination Scheme: 25ICA **Total Marks:** 25

Industrial lectures 01 hr/week are to be arranged to share experiences of eminent industrial Managers/ Engineers/ Entrepreneurs/Scientists/Professors. At least 12 lectures could be arranged for EE459 during semester and test may be conducted based on lectures.

1. There is a need to create avenues for a close academia and industry interaction through all the phases of technology development, starting from conceptualization down to commercialization.

2. List of renowned persons from industry shall be prepared by the committee appointed by Head of the department. After approval from the Principal, minimum five Industrial lectures in alternate week shall be arranged. This shall be delivered by the experts/Officials from Industries/Govt. organizations/ Private Sectors/Public Sectors / R&D Labs covering the various aspects.

3. Topics of Industrial Lectures shall be Technical in nature and should not be the specific contents from the curriculum.

4. Minimum **five** Lectures to be delivered by experts from the industry in alternate weeks.

5. Students shall submit the report based on minimum five lectures giving summary of the lecture delivered.

6. The summary should contain brief resume of the expert, brief information of his organization and brief summary of the lecture in bullet point form.

Guide lines for ICA : Assessment of the Industrial Lecture for award of ICA marks shall be done jointly by departmental committee as per attendance in industrial lecture, report submitted by student and overall performance in semester as per the guidelines given in **Table- D**

Table-D

SN	Name of Student	Attendance (05 Marks per Lecture)	Dept of Understanding (03 Marks per Lecture)	Report Writing	Total
		25	**15**	**10**	**50**

EE460: INDUSTRIAL VISIT

Teaching Scheme: **Credits**: 01
Examination Scheme: 25ICA **Total Marks:** 25

1. Industrial visits for minimum two industries shall be carried out by each student preferably or college shall arrange the industrial visit during the vacation period otherwise during the regular VII semester.

2. The student should obtain appropriate certificates of visit from the concerned organizations just after the visits.

3. Every Student should submit industrial visit report individually at the end of semester-VII (First Term of Final Year)
4. The report should contain information about the following points:

    a. The organization - activities of organization and administrative setup technical personnel and their main duties.

    b. The project/ industry brief description with sketches and salient technical information.

    c. The work / processes observed with specification of materials, products, equipments etc. and role of engineers in that organization.

    d. Suggestions (if any) for improvement in the working of those organizations.

5. The evaluation of the report of technical visits will be made by panel of three teachers appointed by Head of the department based on following points:

Guide lines for ICA: ICA shall be based on knowledge gain by student and Industrial Visit Report submitted by the student in the form of Thermal bound. Assessment of the Industrial Visit for award of ICA marks shall be done jointly by industrial visit coordinators departmental committee based on viva -voce as per the guidelines given in **Table- C**

Table-C

SN	Name of Student	Name of industry	Report writing	Depth of understanding	Total
			15	**10**	**25**