# B. Tech. Degree

in

# ELECTRICAL AND ELECTRONICS ENGINEERING

**SYLLABUS**
**FOR**
**CREDIT BASED CURRICULUM**
**(For students admitted in 2013-14)**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**
**NATIONAL INSTITUTE OF TECHNOLOGY**
**TIRUCHIRAPPALLI – 620 015**
**TAMIL NADU, INDIA**

# CURRICULUM

The total minimum credits required for completing the B.Tech. programme in Electrical and Electronics Engineering is **182** (45 + (137))

### SEMESTER III

| CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|
| MA205 | TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS | 3 | 0 | 0 | 3 |
| EE201 | DC MACHINES AND TRANSFORMERS | 3 | 1 | 0 | 4 |
| EE203 | CIRCUIT THEORY | 3 | 1 | 0 | 4 |
| EE205 | ELECTRON DEVICES | 3 | 0 | 0 | 3 |
| EE207 | DIGITAL ELECTRONICS | 3 | 0 | 0 | 3 |
| ME231 | THERMODYNAMICS AND MECHANICS OF FLUIDS | 3 | 1 | 0 | 4 |
| EE209 | DC MACHINES AND TRANSFORMERS LABORATORY | 0 | 0 | 3 | 2 |
| EE211 | CIRCUITS AND DEVICES LABORATORY | 0 | 0 | 3 | 2 |
| | TOTAL | 19 | 2 | 6 | 25 |

### SEMESTER IV

| CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|
| MA202 | NUMERICAL METHODS | 3 | 0 | 0 | 3 |
| EE202 | AC MACHINES | 3 | 1 | 0 | 4 |
| EE204 | TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY | 3 | 0 | 0 | 3 |
| EE206 | NETWORKS AND LINEAR SYSTEMS | 3 | 1 | 0 | 4 |
| EE208 | MEASUREMENTS AND INSTRUMENTATION | 3 | 0 | 0 | 3 |
| EE210 | ANALOG ELECTRONIC CIRCUITS | 3 | 0 | 0 | 3 |
| EE212 | SYNCHRONOUS AND INDUCTION MACHINES LABORATORY | 0 | 0 | 3 | 2 |
| EE214 | ELECTRONIC CIRCUITS LABORATORY | 0 | 0 | 3 | 2 |
| | TOTAL | 18 | 2 | 6 | 24 |

## SEMESTER V

| CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|
| EE301 | POWER SYSTEM ANALYSIS | 3 | 1 | 0 | 4 |
| EE303 | CONTROL SYSTEMS | 3 | 0 | 0 | 3 |
| EE305 | LINEAR INTEGRATED CIRCUITS | 3 | 0 | 0 | 3 |
| EE307 | DATA STRUCTURES AND ALGORITHMS | 3 | 0 | 0 | 3 |
| EC319 | COMMUNICATION SYSTEMS | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 1 | 3 | 0 | 0 | 3 |
| EE309 | INTEGRATED CIRCUITS LABORATORY | 0 | 0 | 3 | 2 |
| EE311 | DATA STRUCTURES LABORATORY | 0 | 0 | 3 | 2 |
| | TOTAL | 18 | 1 | 6 | 23 |

## SEMESTER VI

| CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|
| EE302 | POWER ELECTRONICS | 3 | 0 | 0 | 3 |
| EE304 | POWER SYSTEM PROTECTION AND SWITCHGEAR | 3 | 0 | 0 | 3 |
| EE306 | MICROPROCESSORS AND MICROCONTROLLERS | 3 | 0 | 0 | 3 |
| EE308 | VLSI DESIGN | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 2 | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 3 | 3 | 0 | 0 | 3 |
| EE310 | POWER ELECTRONICS LABORATORY | 0 | 0 | 3 | 2 |
| EE312 | MICRO-COMPUTING AND VLSI DESIGN LABORATORY | 0 | 0 | 3 | 2 |
| -- | INDUSTRIAL LECTURES | 0 | 0 | 0 | 1 |
| -- | INTERNSHIP / INDUSTRIAL TRAINING / ACADEMIC ATTACHMENT [#] (2 to 3 months duration during summer vacation) | 0 | 0 | 0 | 2 |
| | TOTAL | 18 | 0 | 6 | 25 |

[#] To be evaluated at the beginning of VII semester by assessing the report and conducting seminar presentations.

## SEMESTER VII

| CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|
| MB491 | MANAGEMENT CONCEPTS AND PRACTICES | 3 | 0 | 0 | 3 |
| EE401 | POWER SYSTEM ECONOMICS AND CONTROL TECHNIQUES | 3 | 0 | 0 | 3 |
| EE403 | WIND AND SOLAR ELECTRICAL SYSTEMS | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 4 | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 5* | 3 | 0 | 0 | 3 |
| EE405 | CONTROL AND RENEWABLE ENERGY SYSTEMS LABORATORY | 0 | 0 | 3 | 2 |
| EE407 | POWER SYSTEMS SIMULATION LABORATORY | 0 | 0 | 3 | 2 |
| EE447 | COMPREHENSIVE EXAMINATION | - | - | - | 3 |
| | TOTAL | 15 | 0 | 6 | 22 |

## SEMESTER VIII

| CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|
| HM402 | PROFESSIONAL ETHICS AND VALUES | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 6 | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 7* | 3 | 0 | 0 | 3 |
| -- | ELECTIVE 8* | 3 | 0 | 0 | 3 |
| EE498 | PROJECT WORK | 0 | 0 | 15 | 6 |
| | TOTAL | 12 | 0 | 15 | 18 |

* GLOBAL ELECTIVES ALSO

## LIST OF ELECTIVES

| GROUP 1 (ELECTRICAL POWER STREAM) | | | | | |
|---|---|---|---|---|---|
| **CODE** | **COURSE OF STUDY** | **L** | **T** | **P** | **C** |
| EE001 | POWER GENERATION SYSTEMS | 3 | 0 | 0 | 3 |
| EE002 | DESIGN OF ELECTRICAL APPARATUS | 3 | 0 | 0 | 3 |
| EE003 | STATIC RELAYS | 3 | 0 | 0 | 3 |
| EE004 | EHV AC AND DC TRANSMISSION | 3 | 0 | 0 | 3 |
| EE005 | FUNDAMENTALS OF FACTS | 3 | 0 | 0 | 3 |
| EE006 | UTILIZATION OF ELECTRICAL ENERGY | 3 | 0 | 0 | 3 |
| EE007 | SPECIAL ELECTRICAL MACHINES | 3 | 0 | 0 | 3 |
| EE008 | ELECTRICAL SAFETY | 3 | 0 | 0 | 3 |
| EE009 | COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT | 3 | 0 | 0 | 3 |
| EE081 | SOLID STATE DRIVES | 3 | 0 | 0 | 3 |
| EE082 | POWER SYSTEM DYNAMICS | 3 | 0 | 0 | 3 |
| EE083 | POWER SYSTEM RESTRUCTURING | 3 | 0 | 0 | 3 |
| EE084 | POWER SWITCHING CONVERTERS | 3 | 0 | 0 | 3 |
| EE085 | MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS | 3 | 0 | 0 | 3 |
| EE086 | VEHICULAR ELECTRIC POWER SYSTEMS | 3 | 0 | 0 | 3 |
| EE087 | DISTRIBUTION SYSTEM AUTOMATION | 3 | 0 | 0 | 3 |
| **GROUP 2 (ELECTRONICS AND COMPUTER STREAM)** | | | | | |
| EE021 | COMPUTER ARCHITECTURE | 3 | 0 | 0 | 3 |
| EE022 | COMPUTER NETWORKS | 3 | 0 | 0 | 3 |
| EE023 | OPERATING SYSTEMS | 3 | 0 | 0 | 3 |
| EE024 | DESIGN WITH PIC MICROCONTROLLERS | 3 | 0 | 0 | 3 |
| EE025 | EMBEDDED SYSTEM DESIGN | 3 | 0 | 0 | 3 |
| EE026 | DIGITAL SIGNAL PROCESSING | 3 | 0 | 0 | 3 |
| EE027 | DIGITAL SYSTEM DESIGN AND HDLS | 3 | 0 | 0 | 3 |
| EE028 | LOW POWER MICROCONTROLLER | 3 | 0 | 0 | 3 |
| EE088 | AIRCRAFT ELECTRONIC SYSTEMS | 3 | 0 | 0 | 3 |
| EE089 | APPLIED SIGNAL PROCESSING | 3 | 0 | 0 | 3 |

| GROUP 3 (Common to Group 1 and 2) | | | | | |
|---|---|---|---|---|---|
| EE041 | ARTIFICIAL NEURAL NETWORKS | 3 | 0 | 0 | 3 |
| EE042 | FUZZY SYSTEMS AND GENETIC ALGORITHMS | 3 | 0 | 0 | 3 |
| EE043 | INDUSTRIAL AUTOMATION | 3 | 0 | 0 | 3 |
| EE044 | OPERATION RESEARCH | 3 | 0 | 0 | 3 |
| EE090 | MODERN CONTROL SYSTEMS | 3 | 0 | 0 | 3 |
| EE091 | DIGITAL CONTROL SYSTEMS | 3 | 0 | 0 | 3 |
| EE092 | NON-LINEAR CONTROL SYSTEMS | 3 | 0 | 0 | 3 |

## LIST OF ADVANCED LEVEL COURSES FOR B.Tech. HONOURS

i. For the students with consistent academic record of GPA ≥ 8.5 from I to IV semesters, and applied for B.Tech Honours.
ii. Can opt to study any 3 of the listed advanced level courses from V semester
iii. In 7$^{th}$ semester, B.Tech Honours students are permitted to take one M.Tech. (Power Systems/Power Electronics) core course offered during that semester.

| LIST OF ADVANCED LEVEL COURSES FOR B.Tech. HONOURS | | | | | |
|---|---|---|---|---|---|
| **CODE** | **COURSE OF STUDY** | **L** | **T** | **P** | **C** |
| EE081 | SOLID STATE DRIVES | 3 | 0 | 0 | 3 |
| EE082 | POWER SYSTEM DYNAMICS | 3 | 0 | 0 | 3 |
| EE083 | POWER SYSTEM RESTRUCTURING | 3 | 0 | 0 | 3 |
| EE084 | POWER SWITCHING CONVERTERS | 3 | 0 | 0 | 3 |
| EE085 | MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS | 3 | 0 | 0 | 3 |
| EE086 | VEHICULAR ELECTRIC POWER SYSTEMS | 3 | 0 | 0 | 3 |
| EE087 | DISTRIBUTION SYSTEM AUTOMATION | 3 | 0 | 0 | 3 |
| EE088 | AIRCRAFT ELECTRONIC SYSTEMS | 3 | 0 | 0 | 3 |
| EE089 | APPLIED SIGNAL PROCESSING | 3 | 0 | 0 | 3 |
| EE090 | MODERN CONTROL SYSTEMS | 3 | 0 | 0 | 3 |
| EE091 | DIGITAL CONTROL SYSTEMS | 3 | 0 | 0 | 3 |
| EE092 | NON-LINEAR CONTROL SYSTEMS | 3 | 0 | 0 | 3 |

## COURSES OFFERED TO OTHER DEPARTMENTS

| DEPT. | CODE | COURSE OF STUDY | L | T | P | C |
|---|---|---|---|---|---|---|
| MECHANICAL | EE223 | APPLIED ELECTRICAL ENGINEERING | 2 | 0 | 1 | 3 |
| CHEMICAL | EE227 | APPLIED ELECTRICAL AND ELECTRONICS ENGINEERING | 3 | 0 | 0 | 3 |
| CHEMICAL | EE221 | ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY | 0 | 0 | 2 | 2 |
| PRODUCTION | EE225 | APPLIED ELECTRONICS | 3 | 0 | 0 | 3 |
| PRODUCTION | EE242 | ELECTRICAL AND CONTROL SYSTEM ENGINEERING | 3 | 0 | 0 | 3 |
| PRODUCTION | EE224 | ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY | 0 | 0 | 1 | 1 |
| MME | EE220 | ELECTRICAL TECHNOLOGY | 2 | 0 | 1 | 3 |

| **MA205 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives:** To study the application of transform techniques to solve linear ordinary and partial differential equations and to solve boundary value problems by using Fourier series

**Prerequisites:** Knowledge of Integral Calculus, Ordinary differential equations, Complex variables

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem-Periodic functions – Application to ordinary differential equations and simultaneous equations with constant coefficients and integral equations

Fourier series – Dirichlet's conditions - Half range Fourier cosine and sine series - Parseval's relation - Fourier series in complex form - Harmonic analysis

Fourier transforms - Fourier cosine and sine transforms - inverse transforms - convolution theorem and Parseval's identity for Fourier transforms - Finite cosine and sine transforms

Formation of partial differential equations eliminating arbitrary constants and functions - solution of first order equations - four standard types - Lagrange's equation - homogeneous and non-homogeneous type of second order linear differential equation with constant coefficients

One-dimensional wave equation and one-dimensional heat flow equation - method of separation of variables - Fourier series solution

**Text Books:**

1. *Veerarajan, T., 'Engineering mathematics', Tata McGraw-Hill (Education) India Pvt.Ltd, 2006.*

**Reference Books:**

1. *Venkataraman, M.K., 'Engineering Mathematics Vol.4', National publishing company, 2004.*
2. *Grewal.B.S. 'Higher Engineering Mathematics', Khanna Publishers, 2000.*

**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Understand the basics of transformation techniques.
2. Apply the transform techniques for solving ordinary differential equations and partial differential equations.

## EE201 DC MACHINES AND TRANSFORMERS

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Course Objectives:** This course aims to equip the students with a basic understanding of DC machines and Transformer fundamentals, machine parts and help to gain the skills for operating DC machines and Transformers . The course also equips students with ability to understand and analyze the equivalent circuits of DC machines and Transformers.

**Prerequisites:** Engineering Physics and Basic Electrical Engineering

Principles of Energy conversion – basic magnetic circuit analysis Faradays law of electromagnetic induction – singly and doubly excited magnetic field systems – torque production in rotating machines and general analysis of electro mechanical system.

DC Generator – construction, principle of operation – emf equation – types Characteristics commutation - armature reaction.

DC motor – principle of operation – torque equation – types – electrical & mechanical characteristic–starting – speed control – various testing – braking.

Transformers – principle of operation – types – basic construction – equivalent circuit - regulation and efficiency – auto transformer.

Three phase transformer connection-Scott connection – all day efficiency - Sumpner's test - parallel operation of transformers

**Text Books:**

1. *Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.*
2. *Nagrath, I.J.and Kothari, D.P., 'Electrical Machines',Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.*

**Reference Books:**

1. *Arthur Eugene Fitzgerald and Charles Kingsley, 'Electric Machinery', Tata McGraw Hill Education Publications, 6th Edition, 2002.*
2. *Vincent Del Toro, 'Electrical Engineering Fundamentals', 2nd Edition, Prentice hall Publications, 2003.*
3. *Parkar Smith, N.N., 'Problems in Electrical Engineering', 9th Edition, CBS Publishers and Distributers, 1984.*

**COURSE OUTCOMES:**

Upon the completion of the course, The student will be able to

1. Understand the constructional details and principle of operation of DC machines and Transformers.
2. Analyze the performance of the DC Machines under various operating conditions using their various characteristics.
3. Evaluate the performance of Transformers using phasor diagrams and equivalent circuits.
4. Select appropriate DC motor as well as to choose an appropriate method of speed control for any industrial application

## EE203 CIRCUIT THEORY

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Course Objectives:** To provide the key concepts and tools in a logical sequence to analyze and understand electrical and electronic circuits.

**Prerequisites:** Higher secondary mathematical concepts such as solution of ordinary differential equations, calculus, matrix algebra and elementary concepts of physics such as electricity and magnetism

Fundamental concepts of R, L and C elements, DC circuits, series and parallel circuits - loop and nodal analysis, A.C circuits - complex impedance - phasor diagram, real and reactive power - loop and nodal analysis applied to AC circuits.

Voltage source –current source transformations, Various Network theorems and applications to dc and ac circuits, star-delta transformations.

Resonance in series and parallel circuits, self and mutual inductances, coefficient of coupling - dot convention - analysis of coupled circuits.

Three - phase star and delta circuits with balanced and unbalanced loads power measurements - power factor calculations.

Time response of RL, RC and RLC circuits for step and sinusoidal inputs.

**Text Books:**


1. *Hayt, W. H, Kemmerly J. E. & Durbin, 'Engineering Circuit Analysis', McGraw Hill Publications, 8th Edition, 2013.*
2. *Charles K. Alexander, Matthew N. O. Sadiku, 'Fundamentals of Electric Circuits', McGraw-Hill Publications, 3rd Edition, 2007.*


**Reference Books:**


1. *Joseph. A. Edminister, 'Electric Circuits - Schaum's outline series', McGraw Hill Publications, 6th Edition, 2003.*
2. *Robins & Miller, 'Circuit Analysis Theory and Practice', Delmar Publishers, 5th Edition, 2012.*


**COURSE OUTCOMES:**

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

1. Understand the technical representation of common electrical systems.
2. Analyze and compute the time domain behavior of linear (AC and DC) electric circuits with single or multiple power sources.
3. Compute the performance of AC Networks (1 port) which may be 1-phase or 3-phase using phasor analysis.
4. Understand flow of real and reactive power components in AC systems.
5. Analyze simple electro-magnetic circuits.

## EE205 ELECTRON DEVICES

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To educate on the construction and working of common electronic devices and to prepare for application areas.

**Prerequisites:** Semiconductor materials

Semi-conductors - charge carriers, electrons and holes in intrinsic and extrinsic semi-conductors – Hall effect

Diodes – PN junction – current equation – junction capacitance - breakdown characteristics, Zener, tunnel, Schottky diodes

Bipolar junction transistors – Characteristics – analysis of CB, CE, CC amplifier configurations

Unipolar devices – FET, MOSFET, UJT and Opto-Electronic devices – theory and characteristics

Rectifiers and switched mode power supplies – theory and design, filter circuits, applications

**Text Books:**


1. *David, A.Bell, 'Electronic Devices and Circuits', PHI, 5th Edition, 2008.*
2. *Millman and Halkias, 'Electronic Devices and Circuits', McGraw-Hill International student Edition, 5th Reprint 1993.*


**Reference Books:**


1. *Allen Mottershead, 'Electronic Devices and Circuits-An Introduction', PHI, 18th Reprint, 2006.*
2. *Albert Malvino and David J Bates, 'Electronic Principles', McGraw Hill, 7th Edition, 2007.*


**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Understanding the semiconductor physics of the intrinsic, p and n materials and various devices and characteristics.
2. Analyze simple diode circuits under DC and AC excitation.
3. Analyze and design simple amplifier circuits using BJT in CE,CC and CB configurations
4. Understand the analysis and salient features of CE, CC & CB amplifier circuits.
5. Understand the construction and characteristics of FET, MOSFET and UJT

## EE207 DIGITAL ELECTRONICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** This subject exposes the students to digital fundamentals

**Prerequisites:** Basics of Electron Devices

Review of number systems, binary codes, error detection and correction codes. Digital Logic Families – Introduction to RTL, DTL, TTL, ECL and MOSL families – wired and operation, characteristics of digital logic family – comparison of different logic families

Combinational logic - representation of logic functions – SOP andPOS forms K-map representations – minimization using K maps - simplification and implementation of combinational logic – multiplexers and demultiplexers – code converters, adders, subtractors.

Sequential logic- SR, JK, D and T flip flops – level triggering and edge triggering –counters – asynchronous and synchronous type – Modulo counters – Shift registers – Ring counters.

Synchronous Sequential Logic circuits-state table and excitation tables-state diagrams-Moore and Melay models-design of counters-analysis of synchronous sequential logic circuits-state reduction and state assignment.

Asynchronous sequential logic circuits-Transition table, flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – introduction to design –implication table-hazards-programmable logic array and devices.

**Text Books:**

1. *Morris Mano.M, 'Digital logic and computer design', Prentice Hall of India, 3rd Edition, 2005.*
2. *Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2002.*

**Reference Books:**

1. *Tocci R.J.,Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 2014.*
2. *Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', The McGraw Hill, 7th edition, 2010.*

**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Interpret, convert and represent different number systems
2. Manipulate and examine Boolean algebra, logic operations, Boolean functions and their simplification
3. Design and analyze combinational and sequential logic circuits

## ME231 THERMODYNAMICS AND MECHANICS OF FLUIDS

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Course Objectives:**

- To achieve an understanding of principles of thermodynamics and to be able to use it in accounting for the bulk behavior of the simple physical systems.
- To provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, Properties of pure substances
- To enlighten the basic concepts of air standard cycles
- To provide basic awareness about fluid properties and its flow
- To impart knowledge about hydraulic machines

**Prerequisites:** Concepts and principles dealing with thermodynamic cycles, thermodynamic relations and generalized charts, mixtures of fluids, chemical reactions, chemical and phase equilibrium, thermodynamic aspects of fluid flow.
Basic knowledge of mathematics.

Basic concepts: Thermodynamic equilibrium, quasi-static process, zeroth law, work and heat interactions, first law for a cycle and a process, steady flow processes, second law statements, reversibility, Carnot theorem, Clausius inequality, entropy principle.

Heat engines: Otto, diesel and dual cycles, Brayton cycle with regeneration, inter cooling reheat, Joule-Thompson effect, Rankine cycle, reheat and regenerative cycle, properties of ideal gas, Stirling and Ericson cycles

Available energy: Availability and irreversibility, properties of pure substances, phase equilibrium diagrams.

Classification of fluids and their physical properties, Fluid statics, manometers, pressure on submerged bodies. Basics of fluid properties - Vapour Pressure – Pressure at a point its variation – Measurement with Piezo meter, manometers and gauges - Continuity equation in one dimension – Bernoulli's equation – Venturi meters and Orificie meters

Pumps – General principles of displacement and Centrifugal pumps – Efficiency and Performance Curves of Pumps – Cavitation in Pumps – Turbines – Efficiency – Governing of turbines

**Text Books:**


1. *Gordan Van Wylen, Richard Sonntag., 'Fundamentals of Classical Thermodynamics', John Wiley and Sons, 1994*
2. *Yunus A.Cengel and Michel A.Boles, 'Thermodynamics: An Engineering Approach', McGraw-Hill Higher Education, 2006*
3. *T.R.Banga and S.C.Sharma, 'Hydraulic Machines', Khanna Publishers, 2004*


**Reference Books:**


1. *Kothandaraman. C.P., `A Course in Thermodynamics and Heat Engines', Dhanpat, Rai and Sons, 1992.*
2. *Nag, P.K., `Engineering Thermodynamics', Tata McGraw Hill, 1997.*
3. *R.K.Rajput, 'Thermal Engineering', Laxmi publications, 2006.*
4. *Nagarathnam, S. 'Fluid Mechanics', Khanna Publishers, New Delhi, 1995.*
5. *Dr.R.K.Bansal ,'A text book of Fluid Mechanics and hydraulic machines' ,Laxmi Publications(P) Ltd,2005*


**COURSE OUTCOMES:**

Upon the completion of the course, the students will be able to

1. Understand the fundamentals of first and second laws of thermodynamics and their application to a wide range of systems.
2. Familiarize with calculations of the efficiencies of heat engines and other engineering devices.
3. Familiarize the construction and principles governing the form of simple and complex one-component phase diagrams such as pressure-temperature , volume-temperature & and pressure-volume and the steam tables in the analysis of engineering devices and systems.
4. Calculate various fluid flow parameters
5. Determine the optimum working conditions for hydraulic machines

## EE 209 DC MACHINES AND TRANSFORMERS LABORATORY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 2 |

**Course Objectives:** The main objective of the course is to give the students an insight into the constructional details of the dc machines and transformers with a view of better understanding of their working principles. The course also equips the students to test and evaluate the performance of various dc machines and single phase transformers by conducting appropriate experiments.

**Prerequisites:** Basic knowledge in electric circuit analysis, constructional details and operational principles of various dc machines and transformers.

### List of Experiments

A demonstration of the static and rotational electrical machines (constructional details) is ought to be done in an introductory class.

1. Open circuit and load characteristics of DC shunt/compound generator
2. Swinburne's test and Speed control of DC shunt motor
3. Load test on DC shunt motor
4. Load test on DC series motor
5. Open circuit and short circuit test on single phase transformer
6. Load test on single phase transformer
7. Sumpner's test
8. Parallel operation of single phase transformer
9. Electrical braking in DC shunt motor
10. Three phase transformer connections

Mini-project

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Interpret the constructional details of the DC machines and Transformers and also understand the significance of different connections of three phase transformers
2. Estimate or test the performance of any DC machine (shunt, series or compound) and single phase transformer, by conducting suitable experiments and report the results.
3. Experiment and analyze, the various speed control and braking techniques for dc motors
4. Develop simulation models and prototype modules in view of implementing any control technique upon dc motors and single phase transformers for various applications

## EE211 CIRCUITS AND DEVICES LABORATORY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 2 |

**Course Objectives:**

- To understand and analyze the basic theorems of Circuit theory
- Understand and analyze series & parallel circuits and measurement of single and three phase power.
- Understand and analyze different applications of diode and characteristics of Transistor.

**Prerequisites:** Basic electrical and electronics elements (R, L, C, diode, Transistor)

### List of Experiments

1. Verification of Thevenin's and Maximum Power Transfer Theorem.
2. Verification of KCL, KVL and Super Position Theorem.
3. Basic operation of AC R-L-C Series & Parallel Circuit
4. Measurement of Power and Power Factor in Single Phase AC circuits
5. Verification of Resonance in Electrical Circuit.
6. Verification of 3-Phase Star & Delta Connection.
7. Design of full wave Rectifiers (Centre –tapped and Bridge).
8. Design of Clipping and Clamping circuits
9. Volt-ampere characteristics of rectifier diode and Zener diodes as a voltage regulator circuit.
10. Characteristics of CE configuration of BJT

### COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Verify the network theorems and operation of typical electrical and electronic circuits.
2. Choose the appropriate equipment for measuring electrical quantities and verify the same for different circuits.
3. Prepare the technical report on the experiments carried.

## MA202 NUMERICAL METHODS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To learn numerical methods and apply to engineering problems

**Prerequisites:** Knowledge of Calculus and Differential Equations

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Doolittle method - Cholesky's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigen value and eigenvector

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method -Order of convergence of these methods - Horner's method - Graeffe's method - Birge-Vieta method - Bairstow's method

Curve fitting - Method of least squares and group averages – Least square approximation of functions - solution of linear difference equations with constant coefficients

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and $2^{nd}$ order equations - Multistep methods - Milne's and Adams' methods

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one dimensional wave equation

**Text Books:**

1. *Kandasamy, P., Thilagavathy ,K.,and Gunavathy,S., 'Numerical Methods', Chand and Co.,2007.*
2. *Jain, M.K., Iyengar, S.R.,and Jain,R.K., 'Numerical Methods for Scientific and Engineering Computation', Wiley Eastern,1992*

**Reference Books:**

1. *Gerald,C.F., and Wheatley, P.O., 'Applied Numerical Analysis', M/s. Addison Wesley, 1994.*

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

1. Understand the various methods of solving linear and non-linear equations.
2. Solve ordinary differential equations numerically.
3. Apply the knowledge to real life engineering problems.

## EE202 AC MACHINES

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Course Objectives:** This course provides a basic understanding of AC machinery fundamentals, machine parts and helps to gain the skills for operating AC machines. The course also equips students with ability to understand and analyse the phasor diagrams and equivalent circuits of AC Induction and Synchronous Machines.

**Prerequisites:** DC Machines and Transformers

Alternators – construction, principle and types - armature reaction - load characteristics – voltage regulation - two reaction theory.

Synchronous motors - Synchronous machines on infinite bus bars - phasor diagram - V and inverted V curves - current - Hunting and its suppression - starting methods.

Polyphase induction motors - construction, principle and types - equivalent circuit – circle diagram - starting and speed control - Induction generators.

Single phase induction motors - construction, principle and types - double revolving field theory – equivalent circuit.

Permanent magnet brushless motors – construction, principle and types – principle of operation – phasor diagram - torque equation.

**Text Books:**


1. *Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.*
2. *Nagrath, I.J.and Kothari, D.P., 'Electrical Machines', Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.*
3. *M. G. Say, 'Performance and design of Alternating Current Machines', John Wiley and Sons Publications, 3rd Edition ,1983.*


**Reference Books:**


1. *Arthur Eugene Fitzgerald and Charles Kingsley, 'Electric Machinery', Tata McGraw Hill Education Publications, 6th Edition, 2002.*
2. *Miller, T.J.E., 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press- Oxford, 1989.*
3. *Parkar Smith, N.N., 'Problems in Electrical Engineering', CBS Publishers and Distributers, 9th Edition, 1984.*


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Understand the constructional details and principle of operation of AC Induction and Synchronous Machines.
2. Understand and appraise the principle of operation and performance of PMBLDC machines.
3. Analyze the performance of the AC Induction and Synchronous Machines using the phasor diagrams and equivalent circuits.
4. Select appropriate AC machine for any application and appraise its significance

| **EE204 TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Identify major components of power transmission and distribution systems.
- Describe the principle of operation of transmission and distribution equipment.
- Know and appreciate the key factors in equipment specification and network design.

**Prerequisites:** Ordinary differential equation , Partial differential equation, Basic of voltage, current, power and elements like R, L & C.

Transmission line parameters – Resistance, Inductance and Capacitance calculations – single phase and three phase lines – double circuit lines – effect of earth on transmission line capacitance

Performance of transmission lines – Regulation and efficiency – Tuned power lines, Power flow through a transmission line – Power circle diagrams, Introduction to Transmission loss and Formation of corona – critical voltages – effect on line performance

Mechanical design of overhead lines – Line supports – Insulators, Voltage distribution in suspension insulators – Testing of insulators – string efficiency – Stress and sag calculation – effects of wind and ice loading

Underground cables – Comparison with overhead line – Types of cables – insulation resistance – potential gradient – capacitance of single core and three core cables No change

Distribution systems – General aspects – Kelvin's Law – A.C distribution – single phase and three phase – Techniques of voltage control and power factor improvement – Introduction to Distribution loss – Recent trends in transmission and distribution systems

**Text Books:**


1. *D. P. Kothari and IJ Nagrath, 'Power System Engineering', Tata Mcgraw – Hill, 2nd Edition, 2008.*
2. *Gupta B.R.,' Power system Analysis & Design', S. Chand and Company Ltd., 5th Edition, 2001.*
3. *Singh S N, 'Electric Power Generation Transmission and distribution', PHI India, 2nd Edition,2008*


**Reference Books:**


1. 1. *Turan Gonen*, '*Electric Power Distribution system Engineering', CRC Press INC, 2nd Edition 2007.*


**Useful web links:**

1. http://nptel.ac.in/video.php?subjectId=108102047

**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Understand the major components of Transmission and Distribution Systems (TDS) and its practical significance
2. Good Knowledge of various equipment specifications and design for TDS
3. Awareness of latest technologies in the field of electrical transmission and distribution

## EE206 NETWORKS AND LINEAR SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Course Objectives:** To emphasize the relationship between the conceptual understanding and problem-solving approach for (i) analyzing the electric circuit/system excited with non-sinusoidal and non-periodic source,(ii) one-port and two- port networks, (iii) system modeling and simplifications, (iv) transfer function, state- space analysis and z-transform analysis.

**Prerequisites:** Knowledge on differential and integral calculus, Fourier series, Fourier transform and Laplace transform are essential.

Frequency response-Fourier series-Harmonic analysis of simple circuits – Fourier integral-Fourier transforms – application to simple circuits.

Classification of signals – representation in terms of elementary signals - impulse functions - Time response of circuits - complex frequency - poles and zeros - frequency response from pole- zero configuration– Driving point impedances - two-port networks.

Differential equation for of translational and rotational systems-transfer function modeling for simple electrical and mechanical systems-open loop and closed loop systems - block diagram representation-Block diagram algebra-signal flow graph- Mason's gain formula.

Concepts of state and state variables – state space modeling for simple electrical and mechanical systems – state transition matrix - solution of state equations.

Introduction to discrete time system – difference equations – z-transforms – inverse z-transforms for typical signals – pulse transfer function – solution of difference equation – stability analysis.

**Text Books:**


1. *D. Roy Choudhury, 'Networks and Systems', New Age International Publications, 1st Edition, 2013.*
2. *James W. Nilsson and Susan A. Riedel, 'Electric Circuits', Pearson Education Publications, 9th Edition, 2011.*
3. *F.F.Kuo,'Network Analysis and Synthesis', John Wiley Inc Publications, 1966*


**References:**


1. *Cheng.D. K, 'Analysis of Linear System', Addision Wesley Publications, 1988.*
2. *William D. Stanley, 'Network Analysis with Applications', Pearson Education Publications, 2009.*
3. *Hayt, W. H, Kemmerly J. E. & Durbin, 'Engineering Circuit Analysis', McGraw Hill Publications, 8th Edition, 2013.*


**COURSE OUTCOMES:**

Upon completion of this course, students will

1. Understand the significance of Fourier series and Fourier Transform and apply them for typical electrical systems.
2. Apply Laplace Transform for typical circuits and be able to determine the two-port network parameters.
3. Model the systems in transfer function and state-space domains and analyze the system using these models.
4. Apply Z-transforms for the analysis of discrete time systems.

**pply Z transforms for the analysis of discrete time system**

## EE208 MEASUREMENTS AND INSTRUMENTATION

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To understand the basic operation of different measuring instruments and thereby able to choose appropriate instruments for measuring different parameters.

**Prerequisites:** Basics of electrical laws and theorems, basic knowhow about operational amplifiers.

Measurements – Errors & classification, Measurement of voltage & current- permanent magnet moving coil and moving iron meters, Digital voltmeters and automation, guarding techniques.

Measurement of power and energy - dynamometer and induction instruments, kVAh and kVARh meters, maximum demand indicators, digital multi-meters. Instrument transformers – Current and Potential transformers. Spectrum Analyzers, Data & Logic Analyzers.

Measurement of resistance, inductance and capacitance using dc and ac bridges, Transducers – Position transducers, force transducers, peizo-electric transducers, Hall effect transducers. Temperature measurement.

Signal sources – Oscillators, Function generator & pulse generators. Oscilloscopes - CRO, Digital storage and Analog storage Oscilloscope, Digital Phosphor Oscilloscopes. Analog & Digital Recorders and printers.

Signal conditioners – Instrumentation amplifiers, voltage – current converters, voltage-frequency converters, analog multiplexers and de-multiplexers. Instruments Used in Computer Controlled Instrumentation, Microprocessor Based Measurements, Case Studies in Instrumentation.

**Text Books:**


1. *K. Sawhney, 'A Course in Electrical and Electronic Measurements and Instrumentation', Dhanpat Rai & Co., 1st Edition, 2012.*
2. *Bouwens A. J., 'Digital Instrumentation', Tata McGraw Hill Publications, 16th reprint (2008).*
3. *Kalsi H.S, 'Electronic Instrumentation', Tata McGraw-Hill Education, 3rd Edition, 2010.*


**References:**


1. *Deobelin, 'Measurements Systems', Tata McGraw Hill Publications, 2nd Edition, 2010.*
2. *W. D. Cooper, 'Electronic Instrumentation and Measurement Techniques', Prentice Hall of India Publications, 1st Edition, 2009.*
3. *Rangan C.S., 'Instruments Devices and System', Tata McGraw Hill Publications, 2nd Edition, 2009.*


### COURSE OUTCOMES:

Upon completion of the course, the students would be able to

1. Describe the working principle of different measuring instruments.
2. Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.
3. Correlate the significance of different measuring instruments, recorders and oscilloscopes.
4. Develop a micro-processor based measuring unit for any practical application

## EE210 ANALOG ELECTRONIC CIRCUITS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To give a comprehensive exposure to all types of amplifiers and oscillators constructed with discrete components such as BJTs and FETs. This help to develop a strong basis for building liner and digital integrated circuits.

**Prerequisites:** Basic knowledge on electronic devices and circuit theory

Small signal amplifiers - biasing circuits of BJT and FET transistors, analysis and design of BJT and FET amplifiers, chopper stabilized amplifiers

Large signal amplifiers – analysis and design of class A and class B power amplifiers, class C and class D amplifiers, thermal considerations, tuned amplifiers

Feedback amplifiers – gain with feedback - effect of feedback on gain stability, distortion, bandwidth, input and output impedances ; topologies of feedback amplifiers

Oscillators – Barkhausen criterion for oscillation - Hartley & Colpitts oscillators - phase shift, Wien bridge and crystal oscillators - 1lap oscillator – oscillator amplitude stabilization

Pulse circuits – attenuators – RC integrator and differentiator circuits – diode clampers and clippers – multivibrators - Schmitt Trigger- UJT Oscillator

**Text Books:**


1. *Jacob Millman, 'Micro electronics', McGraw Hill, 2nd Edition, reprinted 2009.*
2. *David A bell, 'Fundamentals of electronic devices and circuits', Oxford University Press, Incorporated, 25-Jun-2009.*
3. *Thomas L. Floyd, David M. Buchla, 'Electronic Fundamentals', Pearson Prentice Hall, 7th Edition, 2010.*


**Reference Books:**


1. *Allen Mottershead, 'Electronic Devices and Circuits-An Introduction', PHI, 18th Reprint, 2006.*
2. *Robert.L.Boylestad, 'Electronic Devices and Circuit Theory', Pearson, 10th Edition, 2009.*
3. *Sedra Smith, 'Microelectronic Circuits', Oxford university Press, 6th Edition, 2010.*


**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Understand the working of different types of amplifier, oscillator and multivibrator circuits.
2. Design BJT and FET amplifier and oscillator circuits.
3. Analyze transistorized amplifier and oscillator circuits.
4. Understand the applications of different types of amplifier, oscillator, attenuators and multivibrator circuits.

| **EE212 SYNCHRONOUS AND INDUCTION MACHINES LABORATORY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 0 | 0 | 3 | 2 |

**Course Objectives:** The main objective of the course is to give the students an insight into the constructional details of the induction and synchronous machines with a view of better understanding of their working principles. The course also equips the students to test and evaluate the performance of induction and synchronous machines by conducting appropriate experiments

**Prerequisites:** Basic knowledge in electric circuit analysis, constructional details and operational principles of induction and synchronous machines.

**List of Experiments**

A demonstration of the static and rotational electrical machines (constructional details) is ought to be done in an introductory class.

1. Load test on 3 phase induction motor
2. No load and blocked rotor test on 3 phase induction motor
3. Load test on grid connected induction generator
4. Load test on self-excited induction generator
5. Load test on single phase induction motor
6. Regulation of three phase alternator by E.M.F and M.M.F methods
7. Load test on three phase alternator
8. Synchronisation of three phase alternator with infinite bus bar
9. V and inverted V-curves of synchronous motor
10. Speed Control on three phase induction motor

Mini project

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Estimate or test the performance of induction and synchronous machines by conducting suitable experiments and report the results.
2. Experiment and analyze the speed control techniques for three phase induction motors.
3. Evaluate the different modes of operating the induction generators and justify their usage in wind power generation.
4. Experiment synchronization of alternators and power exchange with the grid to get convinced with their usage at conventional power generation stations
5. Develop simulation models and prototype modules in view of implementing any control technique upon single phase and three phase induction motors for various applications

## EE214 ELECTRONIC CIRCUITS LABORATORY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 2 |

**Course Objectives:** Design of amplifiers and other electronic systems to satisfy specifications .Gain, Bandwidth, Feedback and Stability are some of the design concepts needed.

**Prerequisites:** Electron Devices, Electronic Circuits, Circuits and Devices Laboratory.

### List of Experiments

1. Frequency analysis of Common emitter amplifier
2. Measurement of input/output impedance of Common collector amplifier
3. Design and verification of characteristics of RC oscillators
4. Design and characterisation of Monostable multivibrator
5. Design and Characterisation of Astable multivibrator
6. Characteristics of UJT and applications of UJT oscillator
7. Frequency analysis of FET Amplifier
8. Frequency response of series voltage negative feedback Amplifier
9. Square waveform generation using transistor based Schmitt trigger
10. Design and characterisation of Bistable Multivibrator

Mini -Project

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Design a complete electronic circuit using a top-down approach which starts from specifications.
2. Design and analyze electronic circuits using BJT and FET.
3. Design and characterization of electronic circuits using UJT.
4. Waveform generation circuit design using electronic devices.
5. Prepare the technical report and provide solutions to real time problems.

## EE301 POWER SYSTEM ANALYSIS

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Course Objectives:** To model various power system components and carry out load flow, short circuit and stability studies

**Prerequisites:** Linear Algebra , Partial Differential Equations, Knowledge in circuit theory, Transmission and Distribution

Modeling of power system components - single line diagram –per unit quantities – bus impedance and admittance matrix

Power flow analysis methods - Gauss- Seidel, Newton-Raphson and Fast decoupled methods of load flow analysis

Fault studies - Symmetrical fault analysis, Analysis through impedance matrix, Current limiting reactors

Fault analysis - Unsymmetrical short circuit analysis- LG, LL, LLG; Fault parameter calculations – Open circuit faults

Stability studies - Steady state and transient stability – Swing equation - Equal area criterion – multi-machine stability analysis

**Text Books:**


1. *John .J.Grainger & Stevenson.W.D., ' Power System Analysis', McGraw Hill, 1st Edition 2003.*
2. *D P Kothari, I J Nagrath 'Modern Power System Analysis', 3rd Edition, 2011.*
3. *Hadi Saadat, 'Power System Analysis ', Tata McGraw - Hill Education, 2nd Edition, 2002.*


**Reference Books:**


1. *J. Duncan Glover, M.S.Sarma & Thomas J. overbye, 'Power system analysis and design', 5th Edition, 2011.*
2. *J.C.Das, 'Power System Analysis', Short-Circuit Load Flow and Harmonics', 1st Edition, 2002.*
3. *Arthur R. Bergen, 'Power System Analysis', Peterson Education India, 2nd Edition, 2009.*


**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Carry out load flow study of a practical system
2. Simulate and analyze fault
3. Study the stability of power systems

## EE303 CONTROL SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To equip the students with the fundamental concepts in control systems

**Prerequisites:** Laplace Transform , Complex Analysis

Test signals - Response of second order systems – time domain specifications - generalised error series - Frequency domain specifications - polar plots - Bode plots.

Stability Analysis - Routh-Hurwitz criterion - Nyquist criterion - Stability of systems with transportation lag - gain margin and phase margin.

Root Locus Technique – Definitions - Root locus diagram - Rules of constructions of root loci - Effect of pole zero additions on the root loci - root contours.

Gain adjustments for the desired $M_p$ – constant M and N loci - Nichols Chart - Compensator design by Bode and Root locus techniques - PID controller design.

Control system components - error detectors - potentiometers and synchros - a.c and d.c servomotors - stepper motors -tacho generators – Proportional, integral and derivative controllers.

**Text Books:**


1. *Katsuhiko Ogata, 'Modern Control Engineering', Pearson Education Publishers, 5th Edition, 2010.*
2. *Nagrath I.J. and Gopal M, 'Control Systems Engineering', New Age International Publications, 5th Edition, 2010.*


**Reference Books:**


1. *Richard C. Dorf and Robert H. Bishop. 'Modern control systems', Pearson Prentice Hall Publications, 12th Edition, 2010.*
2. *Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, 'Feedback control of Dynamic Systems', Pearson Education India Publications, 6th Edition, 2008.*
3. *Benjamin C.Kuo and Farid Golnaraghi, 'Automatic Control Systems', John Wiley & Sons Publications, 8th Edition, 2002.*


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Understand the concepts of closed loop control systems.
2. Analyse the stability of closed loop systems.
3. Apply the control techniques to any electrical systems.
4. Design the classical controllers such as P, PI etc for electrical systems.

## EE305 LINEAR INTEGRATED CIRCUITS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To provide in-depth instructions on the characteristics and applications of operational amplifiers, timers and voltage regulators

**Prerequisites:** Basics of analog and digital Electronic

Block diagram of a typical op-amp - characteristics of ideal and practical op amp - parameters of op-amp – inverting and non-inverting amplifier configurations - frequency response - circuit stability

DC and AC amplifiers - summing amplifier - difference amplifier - voltage follower- differentiator - integrator - clamper - clipper – filters

Oscillators, sine wave, square wave, triangular wave, saw tooth wave generation, Schmitt trigger, window detector

Analog to digital, digital to analog, sample and hold circuits. voltage controlled oscillator, phase locked loop – operating principles , applications of PLL

IC555 Timer, monostable and astable modes of operation ; voltage regulators - fixed voltage regulators, adjustable voltage regulators - switching regulators

**Text Books:**

1. *Gayakwad R.A., 'Op-amps & Linear Integrated Circuits', Prentice Hall of India, New Delhi, 4th edition, 2009.*
2. *Roy Choudhury and Shail Jain, 'Linear Integrated Circuits', 4th Edition, New Age International Publishers, 2010.*

**Reference Books:**

1. *Sergio Franco,' Design with operational amplifiers and Analog Integrated circuits', Tata McGraw Hill, 3rd Edition, 2002.*
2. *Sedra Smith, 'Microelectronic Circuits', Oxford University Press, 6th Edition, 2009.*

**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Describe the various ideal and practical characteristics of an OPAMP
2. Develop simple OPAMP based circuits
3. Implement various signal generating circuits.
4. Analyze and design various types of ADCs and DACs
5. Analyze and construct various application circuits using 555 timer

## EE307 DATA STRUCTURES AND ALGORITHMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To obtain knowledge on data structures and their usage in an algorithmic perspective.

**Prerequisites:** Basic knowledge on computers

Algorithms – Algorithmic Notation, Statements and Control Structures, Operations and Expressions, Functions, Procedures, Time and Space requirement Analysis. Information- nature, storage and transmission of information, Primitive Data structures.

Linear Data structures and their sequential storage representation – arrays, structures and array of structures, stacks, queues; their storage representation and applications. Strings – storage representation and string manipulation applications.

Linear Data structures and their linked storage representation – pointers, linked allocation- single, double and circular linked list and their applications.

Nonlinear data structures – Trees, storage representation and operation on binary trees, application of trees; Graphs- representations and applications of graphs.

Sorting and searching – Selection Sort – Bubble Sort – Merge Sort – Tree Sort – Partition-Exchange Sort. Searching – Sequential Searching – Binary Searching- Search trees, Hash-Table methods - File Structures - External Storage Devices, Record Organization, File types and their structure.

**Text Books:**


1. *Debasis Smanata, 'Classic Data Structures', 2nd edition, PHI learning, 2009.*
2. *Adam Drozdek-Duquesne, 'Data Structures and Algorithms in C++', Thomson Press, 2nd edition India Ltd., 2006*
3. *Mark Allen Weiss, 'Data Structures and Algorithm Analysis in C++', Pearson, 4th edition, 2013.*


**Reference Books:**


1. *Michael T. Goodrich, Roberto Tamassia, David M. Mount, 'Data Structures and Algorithms in C++', 2nd edition, Wiley, 2011.*
2. *John R.Hubbard, 'Schaum's outline of theory and problem of data structure with C++', McGraw-Hill, New Delhi, 2000.*
3. *Jean Paul Tremblay and Paul.G.Sorenson, 'An Introduction to Data Structures with Applications', Tata McGraw Hill, 2nd Edition, 2008.*


**COURSE OUTCOMES:**

Upon completion of this course , students will have

1. Knowledge on algorithmic notations and concepts
2. Clear understanding of the primitive data structures and their applications
3. Familiarity of linked linear and non-linear data structures and operations on such data structures
4. The awareness of various sorting, searching algorithms and file structures
5. The ability to design and develop menu driven application programs.

## EC319 COMMUNICATION SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To develop a fundamental understanding on communication systems with emphasis on analog and digital modulation techniques
- To get introduced the basics of error control coding techniques

**Prerequisites:** Signals and Systems, Digital Electronics

Analog Modulation - Principles of Amplitude Modulation, single and double side band - suppressed carrier system and frequency modulation - varactor diode and reactance modulator - AM detectors - FM discriminators - AM and FM transmitters and receivers

Digital communication - Sampling theorem - pulse modulation techniques - PAM, PWM and PPM concepts - PCM encoder and decoder - Data transmission using analog carriers (FSK, PSK, QPSK, MSK &QAM)

Synchronous & Asynchronous transmission - error control techniques – protocols - data communication, link oriented, asynchronous

Modern Communication Systems – Microwaves - optical communication system - Satellite communication system - Mobile communication system

Principles of television engineering - Requirements and standards - need for scanning - types of camera tubes and picture tubes - B/W and colour systems - PAL - CCTV - Cable TV

**Text Books:**

1. *Simon Haykins, 'Communication Systems', John Wiley, 3rd Edition, 1995.*
2. *D.Roddy & J.Coolen, 'Electronic Communications', Prentice Hall of India, 4th Edition, 1999.*
3. *Kennedy G, 'Electronic Communication System', McGraw Hill, 1987.*

**Reference Books:**

1. *Gulati R R, 'Modern Television Engineering', New Age International Pvt. Ltd, 2nd Edition, 2002.*
2. *Shulin Daniel, 'Error Control Coding', Pearson, 2nd Edition, 2011.*

**COURSE OUTCOMES:**

Upon completion of the course

1. Students are able to apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2. Students are able to apply the knowledge of digital electronics and understand the error control coding techniques.
3. Students are able to summarize different types of communication systems and its requirements.
4. Students are able to design and analyse the performance of communication systems.

| **EE309 INTEGRATED CIRCUITS LABORATORY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **0** | **0** | **3** | **2** |

**Course Objectives:** To enrich the students' knowledge on practical circuit design using analog and digital ICs.

**Prerequisites:** Basics of Electronic Devices and Circuits

**List of Experiments**

1. Understanding of OPAMP Imperfections
2. Application of OPAMP in closed loop
3. Application of OPAMP in open loop
4. Design of Analog filters using OPAMP
5. Output verification of Analog to Digital Converter
6. Output verification of Digital to Analog converter
7. Design of Multivibrators using 555 Timer
8. Design of combinational logic circuits
9. Design of sequential logic circuits
10. Design of Code converter with seven segment display

Mini project

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Understand the non-ideal behavior of Op-amp.
2. Analyze and prepare the technical report on the experiments carried out.
3. Design application oriented circuits using Op-amp and 555 timer ICs.
4. Create and demonstrate live project using ICs.

## EE311 DATA STRUCTURES LABORATORY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 2 |

**Course Objectives:** To have a better understanding of the different types of data and data structures; storage structures, representations and operations on these data structures.

**Prerequisites:** Programming in C/C++/any language

### List of Experiments

1. Functions and parameter passing
2. Arrays, Structures and string operations
3. Stack and queue operations
4. Single linked lists: linear and circular
5. Double linked lists: linear, circular and restricted deques
6. Linked list Applications
7. Trees and tree traversals
8. Applications of trees
9. Sorting Searching techniques
10. Mini Project: Developing menu driven program for specific applications

**COURSE OUTCOMES:**

Upon completion of the course, the students will

1. Have a clear understanding of the various data structures, their storage structures and operations on these data structures
2. Be able to identify the suitable data structure for implementation based on given input data and the required output.
3. Be able to design algorithms to perform operations like insertion, deletion, search and sort on various data structures
4. Be able to develop programs for a specific application

## EE302 POWER ELECTRONICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** This course aims to equip the students with a basic understanding of modern power semiconductor devices, various important topologies of power converter circuits for specific types of applications. The course also equips students with an ability to understand and analyze non-linear circuits involving power electronic converters.

**Prerequisites:** Electron devices, Circuit theory, Electrical machines.

Power Semiconductor Devices –power diodes, power transistors, SCRs, TRIAC, GTO, power MOSFETs, IGBTs-Principles of operation, characteristics, ratings, protection and gate drive circuits.

Controlled rectifiers- single- phase and three-phase- power factor improvement (qualitative treatment)-dual converters.

DC-DC converters- Buck, Boost, Buck-Boost types with circuit configuration and analysis.

DC-AC converters-1-phase/3- phase, VSI, CSI, frequency and voltage control.

AC-AC converters- single/three phase controllers, phase control, PWM AC voltage controller, Principle of ON-OFF control and cyclo-converters. Introduction to Matrix converters

**Text Books:**


1. *Rashid, M.H, 'Power Electronics - Circuits, Devices and Applications', Prentice Hall Publications, 3rd Edition, 2003.*
2. *M.D.Singh and K.B.Khanchandani, 'Power Electronics', Tata McGraw Hills Publishing Company Limited, 2nd Edition, 2006.*
3. *Ned Mohan, Tore M. Undeland, William P. Robbins, 'Power Electronics', John Wiley & Sons Publications , 3rd edition, 2006.*


**Reference Books:**


1. *Vedam Subramaniam, 'Power Electronics', New Age International (P) Ltd Publishers, 2001.*
2. *Philip T. Krein, 'Elements of Power Electronics', Oxford University Press, 1st Edition, 2012.*
3. *V.R.Moorthi, 'Power Electronics- Devices, Circuits and Industrial Applications', Oxford University Press, 1st Edition, 2005.*


**COURSE OUTCOMES:**

Upon completion of the course

1. The student will be able to understand the principle of operation of commonly employed power electronic converters.
2. The student will be capable of analyzing non-linear circuits with several power electronic switches.
3. The student will be equipped to take up advanced courses in Power Electronics and its application areas.

## EE304 POWER SYSTEM PROTECTION AND SWITCHGEAR

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To give a broad coverage on all types of protective relays, circuit breakers and provide a strong background for working in a practical power system protection system.

**Prerequisites:** Fundamentals in power system analysis and short circuit studies

Relays – General classification, Principle of operation, types, characteristics, Torque equation, Relaying Schemes, Relay Co- ordination.

Apparatus and line protection – Line Protection – Distance, Differential protection and Carrier current protection. Generator protection – protection against abnormal condition, stator and Rotor protection. Transformer Protection – Incipient fault – Differential protection, Feeder and Bus bar protection.

Protection against over voltages – Causes of over voltage Ground wires, Surge absorbers and diverters. Earthling - types. Insulation coordination.

Theory of arcing and arc quenching circuit breakers types – rating and comparison, RRRV, Resistor switching and capacitor switching.

Static relays – Digital relays - Microprocessor based relays – Apparatus and line protection – Basics of Numerical relays.

**Text Books:**


1. *Badri Ram and Vishwakarma, D.N., 'Power System Protection and Switchgear', Tata- McGraw Hill publishing company Ltd., 2nd Edition, 2011.*
2. *Ravindranath B., and Chander, N., 'Power Systems Protection and Switch Gear', Wiley Eastern Ltd., 1st Edition, 1977.*


**Reference Books:**


1. *Sunil S.Rao, 'Protective Switch Gear', Khanna Publishers, New Delhi, 13th Edition, 2008.*
2. *Y. G. Paithangar, 'Fundamentals of power system protection', PHI Learning Private Limited, 2nd Edition, 2010.*


**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Classify and describe the working of various relaying schemes
2. Identify and implement an appropriate relaying schemes for different power apparatus
3. Illustrate the function of various CBs and related switching issues
4. Describe the causes of overvoltage and protection against overvoltage

## EE306 MICROPROCESSORS AND MICROCONTROLLERS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To gain knowledge on the architecture of 8085 microprocessors and 8051 micro controller, their programming and associated peripheral interface devices.

**Prerequisites:** Digital Electronics, Electron Devices and Linear Integrated Circuits

8-Bit Microprocessor - 8085 architecture and memory interfacing (RAM & ROM), interfacing I/O devices - instruction set - addressing modes - assembly language programming – interrupts - timing diagram.

8051 Microcontroller - Intel 8051 architecture, memory organization, flags, stack, and special function registers, I/O, ports - connecting external memory, counters and timers, serial data I/O, Interrupts.

Microcontroller instructions - addressing modes, moving data, logical operations, arithmetic operations, jump and call instructions – subroutines - Interrupts and returns.

Microcontroller programming - Assembly Language Programming, timer and counter programming, connection to RS 232 and RS 485, Interrupt programming.

Peripherals and interfacing - Serial and parallel I/O (8251 and 8255), Programmable DMA controller, Programmable interrupt controller, ADC/DAC interfacing.
Case Study:(i)Waveform generation (ii)speed control of DC motor(iii)Stepper motor control (iv)seven segment LED display (v)Firing Pulse generation (vi) Traffic Control Systems etc.

**Text Books:**


1. *Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Applications with 8085', Penram Intl. Publishing, 6th Edition, 2013.*
2. *Kenneth Ayala, 'The 8051 Microcontroller', Cengage Learning Publications, 3rd Edition, 2007.*
3. *Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay 'The 8051 Microcontroller and Embedded Systems using Assembly and C', Prentice Hall Publications, 2nd Edition, 2008.*


**Reference Books:**


1. *Ray A. K., Bhurchandi K. M., 'Advanced Microprocessor and Peripherals', Tata McGraw-Hill Publications, 3rd Edition, 2013.*
2. *Sencer Yeralan, Helen Emery, 'Programming and interfacing the 8051 Microcontroller', Addison-Wesley Publications, 1st Edition, 2000.*
3. *Krishna Kant, 'Microprocessors and Microcontrollers, Architecture, Programming and System Design-8085, 8086, 8051, 8096', Prentice Hall India Ltd Publications, 1st Edition, 2010*


**COURSE OUTCOMES:**

Upon completion of this course, the students will

1. Have a clear understanding of the architecture and instruction set of 8085 and 8051.
2. Be able to interface peripherals and memories with 8085 and 8051
3. Be able to understand the application of 8085 and 8051in waveform generators.

## EE308 VLSI DESIGN

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To enrich the student with the concepts of VLSI devices and its fabrication and also to develop different electronic circuits.

**Prerequisites:** Essentials of Electronic devices, circuits and Digital systems.

MOS characteristics: NMOS characteristics, inverter action – CMOS characteristics, inverter action - models and second order effects of MOS transistors – Current equation – MOSFET Capacitances - MOS as Switch, Diode/ resistor – current source and sink – Current mirror.

CMOS Fabrication – n-well, p-well, twin-tub processes – fabrication steps – crystal growth – photolithography – oxidation – diffusion – Ion implantation – etching – metallization.

CMOS Logic Circuits: Implementation of logic circuits using nMOS and CMOS, Pass transistor and transmission gates – Implementation of combinational circuits – parity generator – magnitude comparator – stick diagram – layout design.

Memory design – SRAM cell – 6T SRAM – DRAM – 1T, 3T, 4T cells CMOS Sequential circuits: Static and Dynamic circuits – True single phase clocked registers – Clocking schemes.

ASIC - Types of ASICs - Design flow – Design Entry – Simulation – Synthesis – Floor planning – Placement – Routing - Circuit extraction – Programmable ASICs.

**Text Books:**

1. *Neil Weste, David Harris, 'CMOS VLSI Design: A Circuits and Systems Perspective', Addison-Wesley, 4th Edition, 2010.*
2. *Debaprasad Das, 'VLSI Design', Oxford University press, 2010.*
3. *Ken Martin, 'Digital Integrated Circuits', Oxford university press, 1999.*

**Reference Books:**

1. *M. J. S. Smith, 'Application Specific Integrated Circuits', Addison Wesley, 1997.*
2. *Uyemura, 'Introduction to VLSI Circuits and Systems', Wiley, 1st Edition, 2012*

**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. To understand the insights of the MOS devices and its characteristics.
2. To appreciate the different VLSI process technologies.
3. To design the CMOS combinational logic circuits and its layout
4. To develop the sequential circuits and clocking schemes
5. To realize the Design flow of Application specific Integrated circuit

| | | L | T | P | C |
|---|---|---|---|---|---|
| **EE310** | **POWER ELECTRONICS LABORATORY** | 0 | 0 | 3 | 2 |

**Course Objectives:** To enable the students to develop hands on experience in analyzing, designing and carrying out experiments on various electrical networks by make use of power electronic components. It aims to familiarize the switching devices, power converters and its applications in various systems for power control.

**Prerequisites:** Circuits and Devices Laboratory.

**List of Experiments**

1. 1-phase Fully Controlled SCR Converter
2. Buck Converter using MOSFET
3. Boost Converter using MOSFET
4. Buck-Boost Converter using IGBT
5. 1-phase Inverter using IGBT.
6. 1-phase step-down Cyclo-converter
7. Speed Control of 1-phase A.C Motor
8. 1-phase Half Controlled SCR Converter
9. Illumination Control of Lamp
10. Speed Control of 1-phase Capacitor Run Fan Motor
11. Characteristics of SCR, IGBT, MOSFET

Mini project

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Understand the characteristics of various switching devices and appreciate its applications in various electrical networks/systems.
2. Analyze and design the operation of power switching converters.
3. Develop practical control circuits for various real time applications.
4. Analyze and prepare the technical report on the experiments carried out.

| **EE312 MICRO-COMPUTING AND VLSI DESIGN LABORATORY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 0 | 0 | 3 | 2 |

**Course Objectives:** To train the students to use micro-processor, micro-controller and FPGA for computational and logical applications. Also this course prepares the students to provide solutions to real-time problems.

**Prerequisites:** Basics of Digital logics and programming skills

**List of Experiments**

1. Arithmetic operations (8/ 16 bit) using 8085.
2. Waveform generation using 8085.
3. Interfacing with 8085 (ADC, DAC)
4. Arithmetic operations (16 bit) using 8051
5. Firing pulse generation using 8051.
6. Interfacing with 8051 (Stepper motor/ DC Motor control).
7. VHDL programming for PWM pulse generation
8. Design and Simulation of Sequence detector circuit using Verilog HDL.
9. Design and FPGA implementation of 4-bit multiplier unit.
10. Layout and physical design of a Mod-N counter unit.

Mini – Project

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Accomplish arithmetic and logical operations with micro-processors, micro-controllers and FPGA
2. Generate firing pulses for various control applications related to electrical machines and power electronics.
3. Illustrate various interfacing techniques related to real time applications, using micro-processors and micro-controllers.
4. Analyze and document the experiments carried out.
5. Design and implement control circuitry using micro-processors and micro-controllers for any engineering and real world problems

## MB491 MANAGEMENT CONCEPTS AND PRACTICES

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To familiarize the students with the concepts of management.
- To facilitate with the basic concepts of marketing.
- To enrich the learners with fundamentals of financial management.
- To select a methodology for technology and production management.
- To impart the importance of Human Resources in the organizational context.

**Prerequisites:** Overview of organisation structure and functions, Basic understanding of technology and operation adopted in the industry, Fundamentals of the capital employed and the risks involved.

Introduction to management, evolution of scientific management, modern management. Principles. Elements of management .Planning, organizing, staffing, directing, coordinating, reporting, budgeting.

Core concepts of marketing. Need, want, demand, product, value, satisfaction, marketing mix- product, price, place, promotion.

Financial management, objectives, scope, techniques of investment analysis, payback period, accounting rate of return, working capital, cost of capital. Sources of financing.

Technology management. Product design. Types of production system. Plant location-factors to be considered. Plant layout. Types of layout. Inventory management.

Significance of HRM. HR planning job evaluation. Recruitment and selection. Placement and induction. Training. Performance appraisal. Compensation. Industrial relations.

**Text Books:**


1. *L.M.Prasad, 'Priciples and Practice of Management', S.Chand & Sons.*
2. *P.Kotler, 'Marketing Management', Pearson, 12th edition, 2005*
3. *P.Chandra, 'Financial Management Theory and Practice', TMH, 3rd edition, 2004*
4. *K.Ashwathappa, 'Human Resources and Personnel Management', TMH, 3rd edition, 2005*
5. *E.S.Buffa & R.K.Sarin, 'Modern Production/Operation Management', Wiley,8th edition, 1994.*


**Reference Books:**


1. *Harlod Koontz and Heinz Weihrich ,'Essentials of Management', Tata Mc Graw-Hill, 1998*
2. *Stephen Robbins, 'Organizational Behaviour', Pearson Education, New Delhi*


**COURSE OUTCOMES:**

Upon completion of this course

1. The learners get equipped with the nuances of management functions
2. The learners understand the framework of a business organization.
3. The learners gain expertise in analyzing the risk and return of an investment.
4. The learners would become better people managers.

| **EE401 POWER SYSTEM ECONOMICS AND CONTROL TECHNIQUES** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives:**
- To understand the economics of power system operation
- To realize the requirements and methods of real and reactive power control in power system
- To recognize the recent advancements in power system operation

**Prerequisites:** Optimization Methods, Operating Principle of Synchronous Machines, Voltage drop and power loss calculation in Transmission lines and Fundamentals of Load flow analysis.

Types of load –components of system loads- load curves – load factor, demand factor, diversity factor, capacity factor, utilization factor, base load and peak load stations- Reserve Capacity and requirements - Load Forecasting-Electrical Tariff-types of tariff

Economic Load Dispatch-characteristics of generation unit, Co-ordination equations with and without transmission loss, General problem formulation and common constraints-Unit Commitment-Constraints in unit commitment- Solution methods

Load frequency control-Generator, Prime mover, Governor & Load models – LFC of a single area and two area systems-Tie line bias control-steady state and transient response- Automatic Voltage Regulator – Exciter and Generator models-steady state and transient response

Reactive power and Voltage control – Load Compensation- power factor correction, voltage regulation, load balancing-Maximum load ability of transmission lines-Line Compensation-Static shunt capacitor/inductor-tap changing transformer, VAR compensators

Recent trends in real time control of power systems - Power system control centers with SCADA/EMS – Restructuring of power system – fundamentals and operational restrictions – Introduction to Smart Grid

**Text Books:**

1. *Allen J. Wood, Bruce F. Wollenberg, 'Power Generation Operation and Control', Wiley India 2nd Edition, 2009.*
2. *Abhijit Chakrabarti & Sunita Halder, 'Power system Analysis-Operation & Control', PHI New Delhi, 3rd Edition, 2010.*

**Reference Books:**

1. *Robert H. Miller, James H. Malinowski, 'Power system operation', Tata McGraw-Hill, 2nd Edition, 2009.*

## COURSE OUTCOMES:

Upon completion of this course , students will be able to

1. Calculate various factors (such as load factor and demand factor, etc.) and interpret different tariff structures
2. Develop generation dispatching schemes for thermal units
3. Apply frequency control schemes on power system
4. Employ reactive power compensation systems
5. Adopt engineering innovations for improved power system operation

## EE403 WIND AND SOLAR ELECTRICAL SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To familiarize the students with basics of solar and wind energy systems and various techniques for the conversion of solar and wind energy into electrical energy.

**Prerequisites:** Basics on solar systems, Electron devices, Electrical machines and Power electronics

Basic characteristics of sunlight – solar spectrum – isolation specifics – irradiance and irradiation - pyranometer - solar energy statics - Solar PV cell – I-V characteristics – P-V characteristics – fill factor-Modeling of solar cell – maximum power point tracking.

PV module – blocking diode and bypass diodes – composite characteristics of PV module – PV array – PV system – PV- powered fan – PV fan with battery backup – PV-powered pumping system – PV powered lighting systems – grid- connected PV systems

Wind source – wind statistics - energy in the wind – turbine power characteristics - aerodynamics - rotor types – parts of wind turbines – braking systems – tower - control and monitoring system.

General characteristics of induction generators – grid-connected and self-excited systems – steady-state equivalent circuit - performance predetermination–permanent magnet alternators – steady-state performance.

Power electronic converters for interfacing wind electric generators – power quality issues - hybrid systems-wind-diesel systems – wind-solar systems.

**Text Books:**

1. *S N Bhadra, S Banerjee and D Kastha, 'Wind Electrical Systems', Oxford University Press, 1st Edition, 2005.*
2. *Chetan Singh Solanki, 'Solar Photovoltaic's: Fundamentals, Technologies and Applications' PHI Learning Publications, 2nd Edition, 2011.*

**References:**

1. *Roger A. Messenger and Jerry Ventre, 'Photovoltaic systems engineering', Taylor and Francis Group Publications, 2nd Edition, 2003.*
2. *M.Godoy Simoes and Felix A. Farret, 'Alternative Energy Systems: Design and Analysis with Induction Generators', CRC press, 2nd, 2008.*
3. *Ion Boldea, 'The electric generators hand book - Variable speed generators', CRC press, 2010.*

**COURSE OUTCOMES:**

Upon completion of this course students will be able to

1. Describe the solar radiation, measurements and characteristics of solar PV cell
2. Develop the model of a PV system and its applications
3. Describe the basic types and mechanical characteristics and model of wind turbine
4. Analyze the electrical characteristics and operation of various wind-driven electrical generators
5. Understand various power electronic converters used for hybrid system

| **EE405 CONTROL AND RENEWABLE ENERGY SYSTEMS LABORATORY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **0** | **0** | **3** | **2** |

**Course Objectives:** To give an insight to the design of various application based controllers and fundamental operation and control of solar PV and induction generators.

**Prerequisites:** Fundamentals of control systems, electronics and machines

**List of Experiments**

1. Stabilization of Inverted pendulum on a cart system using PID controller
2. Closed – loop control of Ball and Beam system
3. Speed control of a BLDC motor drive
4. Water-level controller with data acquisition system
5. Closed-loop temperature control system
6. Identifying and measuring parameters of solar PV module in the field
7. Efficiency measurement of stand-alone PV System
8. I-V characteristics of Solar cell under different illumination and temperature condition
9. Rotor resistance control of WRIG
10. Voltage control of SEIG

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able

1. To design and implement a suitable controller for a practical system.
2. Estimate or test the performance of a solar PV system and induction generators under different operating conditions.
3. Develop simulation models and prototype modules in view of implementing any control technique upon any renewable energy applications.
4. Analyze and prepare the technical report on the experiments carried out.

## EE407 POWER SYSTEMS SIMULATION LABORATORY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 2 |

**Course Objectives:** To enhance the analyzing and problem solving skills of the students in the area of power system and power electronics through computer programming and simulation.

**Prerequisites:** Fundamentals of power system , Fundamentals of power electronics

### List of Experiments

1. Real and Reactive Power Computation
2. Transmission Line Parameter Calculation
3. Power Circle Diagrams
4. Bus Admittance Matrix Formulation
5. Graph Theory Matrices
6. Load Flow Analysis
7. Z bus Formation
8. Short Circuit Analysis
9. Simulation of AC DC Converters
10. Power Electronic Applications in Power Systems

Mini project

### COURSE OUTCOMES:

Upon completion of the course students will be able to

1. Develop computer programs for power system studies
2. Design, simulate and analyze power electronics circuits using simulation packages.
3. Prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner

## HM 402 PROFESSIONAL ETHICS AND HUMAN VALUES

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Identify the core values that shape the ethical behavior of an engineer
- To create an awareness on professional ethics and Human Values
- To appreciate the rights of others

**Prerequisites:** Nil

Morals, Values and Ethics - Integrity - work Ethic - Service Learning - Civic Virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Co-operation - Commitment - Empathy - Self-Confidence - Character - Spirituality - The role of engineers in modern society - social expectations.

Sense of 'Engineering Ethics' - Variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of Professional Roles & Professionalism - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Engineering as experimentation - engineers as responsible experimenters - Research ethics -Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.

Safety and risk - assessment of safety and risk - Riysis - Risk benefit analysis and reducing risk - Govt. Regulator's approach to risks - the three mile island and Chernobyl case studies & Bhopal - Threat of Nuclear power, depletion of ozone, greenery effects - Collegiality and loyalty - respect for authority - collective bargaining - Confidentiality - conflicts of interest - occupation crime - professional rights - employees' rights - Intellectual Property rights (IPR) - discrimination.

Multinational corporations - Business ethics - Environmental ethics - computer ethics - Role in Technological Development - Weapons development engineers as managers - consulting engineers - engineers as expert witnesses and advisors - Honesty - leadership - sample code of conduct ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management Institution of electronics and telecommunication engineers (IETE), India, etc.,.

**Text Books:**


1. *Mika martin and Roland Scinger, 'Ethics in Engineering', Pearson Education/Prentice Hall, New York 1996.*
2. *Govindarajan M, Natarajan S, Senthil Kumar V.S, 'Engineering Ethics', Prentice Hall of India, New Delhi, 2004.*
3. *Charles D. Fleddermann, 'Ethics in Engineering', Pearson Education/Prentice Hall, New Jerssy, 2004 (Indian Reprint)*


**Reference Books:**


1. *Charles E Harris, Michael S. Protchard and Michael J Rabins, 'Engineering Ethics - Concept and Case', Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available)*
2. *'Concepts and Cases', Thompson Learning (2000)*
3. *John R Boatright, 'Ethics and Conduct of Business', Pearson Education, New Delhi, 2003.*
4. *Edmund G Seebauer and Robert L Barry, 'Fundamentals of Ethics for Scientists and Engineers', Oxford University of Press, Oxford, 2001.*


**COURSE OUTCOMES:**

Upon completion of this course, students should have

1. Understood the core values that shape the ethical behaviour of an engineer
2. Exposed awareness on professional ethics and human values.
3. Known their role in technological development

## EE001 POWER GENERATION SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To understand the working of different types of power generation systems and to realize the necessity for interconnected operation of different power stations.

**Prerequisites:** Basic knowledge about working of alternators and electric power systems

Hydro-electric power plants – selection of site, elements of power plant, classification, water turbines, governor action, hydro-electric generator, plant layout, pumped storage plants.

Thermal Steam power plants – selection of site, elements and operational circuits of the power plant, turbo-alternators, plant layout, steam turbines, controls and auxiliaries.

Nuclear power plants – selection of site, nuclear reaction – fission process and chain reaction, constituents of power plant and layout, nuclear reactor – working, classification, control, shielding and waste disposal.

Renewable power plants – Solar power generation – Photo-voltaic and solar thermal generation – solar concentrators, Wind power generation – types of wind mills, wind generators, tidal, biomass, geothermal and magneto-hydro dynamic power generation, micro-hydel power plants, fuel cells and diesel and gas power plants.

Combined operation of power plants – plant selection, choice of size and number of generator units, interconnected systems, real and reactive power exchange among interconnected systems. Major electrical equipment in power plants, DC systems in power plants, station control - switch yard and control room. Economic considerations – types of costs, tariff and consumers.

**Text Books:**

1. *Chakrabarti A., Soni M.L., Gupta P.V., and Bhatnagar U.S., 'A text book on Power Systems Engg.', Dhanpat Rai and Sons, New Delhi, 2nd revised edition, 2010.*
2. *J.B.Gupta, 'A course in Power Systems', S.K.Kataria and sons, reprint 2010-2011.*

**Reference Books:**

1. *Wadhwa, C.L., 'Generation Distribution and Utilisation of Electrical Energy', New Age International publishers, 3rd edition, 2010.*
2. *Deshpande M.V, `Elements of Electrical Power systems Design', Pitman, New Delhi, PHI Learning Private Limited, 1st edition, 2009.*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to:-

1. Appreciate the different types of tariff, consumers and different types of power generation plants
2. Determine the significance of various components of the power generation plants
3. Correlate the importance of interconnected operation of different power generation systems
4. Plan an appropriate scheduling of electric power to satisfy the demand constraint

## EE002 DESIGN OF ELECTRICAL APPARATUS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** This course offers the preliminary instructions and techniques to design the main dimensions and other major part of the transformer and DC and AC rotating machines. The course also provides the students with an ability to understand the step by step procedure for the complete design of electrical machines.

**Prerequisites:** DC Machines and Transformers , AC Machines

General concepts in the design of rotating machines-output equation-Magnetic and electric loadings-Common design features of all rotating machines-Conducting, insulating and magnetic materials used in electrical apparatus-mmf calculation for the magnetic circuit of rotating machines-Leakage reactance calculation.

Armature winding –output equation-Choice of specific loadings-Choice of poles-design of conductors, winding, slot, air gap, field poles and field coils, commutator and brush-Predetermination of efficiency, temperature rise and open circuit characteristics from design data(qualitative treatment only)

Output equation-Design of core and coils for single phase and three phase transformers-Design of tank and cooling tubes-Predetermination of circuit parameters, magnetising current, losses, efficiency, temperature rise and regulation from design data (qualitative treatment only)

Output equation-Choice of specific loadings-Design of stator-Design of squirrel cage and slip ring rotors-Stator and rotor winding designs-Predetermination of circuit parameters, magnetising current, efficiency and temperature rise from design data (qualitative treatment only).

Constructional features of synchronous machines-SCR-Output equation-specific loadings-Main dimensions-Stator design-Design of salient pole field coil.

**Text Books:**

1. *Sawhney, A.K.,'A course in Electrical Machines Design', Dhanpat Rai and sons Publications, 4th edition, 2010.*

**References:**

1. *Sen, S.K.,'Principles of Electrical Machine Design with computer Programmes', Oxford and I.B.H Publishing Co.Pvt.Ltd, 2nd edition, 2006.*
2. *Rai, H.M.,'Principles of Electrical Machines Design', Sathya Prakash Publications, 3rd edition, 1994.*

**COURSE OUTCOMES:**

Upon completion of this course**,**

1. The student will be able to understand the design of main dimensions and other major part of the transformer and DC and AC rotating machines.
2. The student will be capable of evaluating the procedure for the design of main dimensions and other major part of the transformer and DC and AC rotating machines.
3. The student will be equipped to apply in-depth knowledge related to the design of electrical machines.

## EE003 STATIC RELAYS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To emphasize on various type and implementation of relays using solid-state circuits and microprocessors.

**Prerequisites:** Fundamentals on Power system protection, Analog electronics, Digital electronics and Microprocessor

Power system protection and its requirements – conventional Vs static relays - steady state and transient performance of signal deriving elements, signal mixing techniques and measuring techniques.

Over current protection - instantaneous over current relay – directional over current relay – applications – differential relays - generator and transmission line protection.

Static relay circuits for generator loss of field, under frequency, distance, impedance, reactance, mho and special characteristics - reverse power relays

Static relay circuits for carrier protection and testing of relays - Static relay circuits - tripping circuits using thyristor.

Microprocessor/Microcontroller based Relays-Hardware and software for the measurements of voltage, current, frequency and phase angle- implementation of over current, directional, impedance and mho relays.

**Text Books:**

1. *Madhava Rao T.S., 'Power System Protection - Static Relays', McGraw Hill, New Delhi,2nd Edition, 21st reprinted, 2008***.**

**Reference Books:**

1. *Ram.B. `Fundamentals of Microprocessors and Microcomputers', M/s. Dhanpat Rai & sons, New Delhi, 2011.*
2. *Van.C.Warrington, 'Protective Relays - Their Theory and Practice', Vols. I & II, Chapman & Hall Ltd. London, 2nd Edition, 1994.*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Distinguish between the conventional electro-mechanical relays and static relays
2. Design various electronic circuits to implement various relaying functions
3. Implement microprocessor based relays

## EE004 EHV AC AND DC TRANSMISSION

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand and analyze the HVAC and HVDC transmission systems.
- To plan an appropriate transmission system between two destinations based on the load requirement and anticipated technical performance of power transmission

**Prerequisites:** As a pre-requisite to this course the students should have completed a fundamental course on Transmission and Distribution and Power Electronics.

Design aspects of HVAC – conductor, tower, insulator and substation structure design, mechanical design - sag-tension calculations, design of EHVAC lines based on steady state limits and transient over voltages - design of extra HV cables - XLPE cables and gas insulated cables.

Real and reactive power flows in HVAC systems – reactive power compensation, FACTS devices in EHV Transmission, short circuit level & real power transfer capacity. Stability- voltage stability and control. Theory of travelling and stationary waves, radio interference, television interference, audible noise and corona.

Introduction to HVDC transmission - Bridge converters – rectifier and inverter operation, equivalent circuit representation, power reversal, desired features of control and actual control characteristics.

Basic HVDC controllers, converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over voltage protection, HVDC cables

Harmonics in HVDC - characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters, active and reactive power exchange in converters and recent trend in HVDC transmission – Hybrid HVDC and Off-shore wind power evacuation through HVDC, introduction to Wide Area Monitoring Systems.

**Text Books:**

1. *S.Rao, 'EHV-AC, HVDC Transmission and Distribution Engineering', Khanna publishers, 3rd edition, 2012.*
2. *Rakosh Das Begamudre, 'Extra High Voltage AC Transmission Engineering', New Age International publishers, 3rd edition, 2009.*

**Reference Books:**

1. *Padiyar K.R., 'HVDC transmission systems', New Age International publishers, 2nd revised edition, 2012.*

**Useful web links:**

1. *http://nptel.iitm.ac.in/courses/108104013*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Distinguish between the usage of EHVAC and HVDC transmission systems.
2. Judge when and where to use EHAV / HVDC transmission systems in practice.
3. Design implementation circuitry for various controllers used in HVDC transmission systems
4. Plan an appropriate electric power transmission system between two destinations to satisfy the pre-defined load requirement without compromising the technical performance.

## EE005 FUNDAMENTALS OF FACTS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To familiarize the students with the basic concepts, different types, scope and applications of FACTS controllers in power transmission.

**Prerequisites:** Power Electronics, Electrical Machines and Power systems.

Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations, FACTS controllers.

Principles of shunt compensation – Variable Impedance type & switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

Principles of static series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC), TJE.

Principles of operation-Steady state model and characteristics of a static voltage regulators and phase shifters-power circuit configurations.

UPFC-Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.

**Text Books:**

1. *Hingorani, L. Gyugyi, 'Concepts and Technology of flexible AC transmission system', Standard Publishers Distributors, 1st Edition, 2011.*
2. *R.M. Mathur and R.K. Varma, 'Thyristor-Based FACTS Controllers for Electrical Transmission Systems', Wiley India Pvt. Limited Publications, 1st Edition, 2011*.

**References:**

1. *K. R. Padiyar, 'FACTS Controllers in Power Transmission and Distribution', New Age International Publications, 1st Edition, 2009.*

**COURSE OUTCOMES:**

Upon completion of the course, the students shall be able to

1. Understand various control issues, for the purpose of identifying the scope and for selection of specific FACTS controllers.
2. Apply the concepts in solving problems of simple power systems with FACTS controllers.
3. Design simple FACTS controllers

## EE006 UTILIZATION OF ELECTRICAL ENERGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To design illumination systems, choose appropriate motors for any drive application, to debug a domestic refrigerator circuit and to design battery charging circuitry for specific applications.

**Prerequisites:** Basics of circuit theory, operational characteristics of various dc and ac motors.

Illumination – Terminology, Laws of illumination, Photometry, lighting calculations. Electric lamps – Different types of lamps, LED lighting and Energy efficient lamps. Design of lighting schemes - factory lighting - flood lighting – street lighting.

Refrigeration- Domestic refrigerator and water coolers. Air-Conditioning - Various types of air conditioning system and their applications, smart air conditioning units. Energy Efficient motors: Standard motor efficiency, need for more efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor.

Domestic utilization of electrical energy – House wiring. Induction based appliances, Online and OFF line UPS, Batteries. Power quality aspects – nonlinear and domestic loads. Earthing – domestic, industrial and sub-station.

Electric Heating- Types of heating and applications, Electric furnaces - Resistance, inductance and Arc Furnaces, Electric welding and sources of welding, Electrolytic processes – electro-metallurgy and electro-plating.

Traction system – power supply, traction drives, electric braking, tractive effort calculations and speed-time characteristics. Locomotives and train - recent trend in electric traction.

**Text Books:**


1. *Dr. Uppal S.L. and Prof. S. Rao, 'Electrical Power Systems', Khanna publishers, New Delhi, 2009.*
2. *Gupta, J.B., 'Utilisation of Electrical Energy and Electric Traction', S.K.Kataria and sons, 10th Edition, 1990.*
3. *Rajput R.K.,'Utilisation of Electrical Power', Laxmi publications, 1st Edition, 2007.*


**Reference Books:**


1. *N.V.Suryanarayana, 'Utilisation of Electrical Power', New Age International publishers, Reprinted 2005.*
2. *C.L.Wadhwa, 'Generation Distribution and Utilization of Electrical Energy', New Age International publishers, 4th edition, 2011.*
3. *Energy Efficiency in Electrical Utilities, BEE guide book, 2010.*


**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Develop a clear idea on various Illumination techniques and hence design lighting scheme for specific applications
2. Identify an appropriate method of heating for any particular industrial application
3. Evaluate domestic wiring connection and debug any faults occurred
4. Construct an electric connection for any domestic appliance like refrigerator as well as to design a battery charging circuit for a specific household application.
5. Realize the appropriate type of electric supply system as well as to evaluate the performance of a traction unit.

## EE007 SPECIAL ELECTRICAL MACHINES

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To expose the students to the construction, principle of operation and performance of special electrical machines as an extension to the study of basic electrical machines.

**Prerequisites:** Fundamentals of DC and AC machines

Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance and Hybrid Motors – SYNREL Motors – Voltage and Torque Equations - Phasor diagram - Characteristics.

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi-stack configurations – Torque equations – Modes of excitations – Characteristics – Drive circuits – Microprocessor control of stepping motors – Closed loop control.

Constructional features – Rotary and Linear SRMs - Principle of operation – Torque production – Steady state performance prediction- Analytical method -Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Closed loop control of SRM - Characteristics.

Permanent Magnet materials – Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation - Power controllers – Motor characteristics and control.

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature reaction MMF – Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements.

**Text Books:**

1. *T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1993.*
2. *T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1995.*

**Reference Books:**

1. *R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.*
2. *P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus London, 2002.*
3. *T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to understand the construction, principle of operation and performance of

1. Synchronous reluctance motors
2. Stepping motors
3. Switched reluctance motors
4. Permanent magnet brushless D.C. motors
5. Permanent magnet synchronous motors.

## EE008 ELECTRICAL SAFETY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To provide a comprehensive exposure to electrical hazards, various grounding techniques, safety procedures and various electrical maintenance techniques.

**Prerequisites:** Basic science and electrical engineering

Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers and signs, safety tags, locking devices- voltage measuring instruments- proximity and contact testers-safety electrical one line diagram- electrician's safety kit.

General requirements for grounding and bonding- definitions- grounding of electrical equipment- bonding of electrically conducting materials and other equipment- connection of grounding and bonding equipment- system grounding- purpose of system grounding- grounding electrode system- grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment- grounding of low voltage and high voltage systems.

The six step safety methods- pre job briefings- hot -work decision tree-safe switching of power system-lockout-tag out- flash hazard calculation and approach distances- calculating the required level of arc protection-safety equipment , procedure for low, medium and high voltage systems- the one minute safety audit

Electrical safety programme structure, development- company safety team- safety policy- programme implementation- employee electrical safety teams- safety meetings- safety audit- accident prevention- first aid- rescue techniques-accident investigation

Safety related case for electrical maintenance- reliability centered maintenance (RCM) - eight step maintenance programme- frequency of maintenance- maintenance requirement for specific equipment and location- regulatory bodies- national electrical safety code- standard for electrical safety in work place-occupational safety and health administration standards.

**Text Books:**

1. Dennis Neitzel, Al Winfield,'Electrical Safety Handbook', McGraw-Hill Education , 4th Edition,2012.

**Reference Books:**

1. *John Cadick, 'Electrical Safety Handbook', McGraw-Hill School Education Group, 1994.*
2. *Maxwell Adams.J, "Electrical safety- a guide to the causes and prevention of electric hazards",The Institution of Electric Engineers, 1994.*
3. *Ray A. Jones, Jane G. Jones, 'Electrical safety in the workplace', Jones & Bartlett Learning, 2000.*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to:-

1. Describe electrical hazards and safety equipment.
2. Analyze and apply various grounding and bonding techniques.
3. Select appropriate safety method for low, medium and high voltage equipment.
4. Participate in a safety team.
5. carry out proper maintenance of electrical equipment by understanding various standards

| **EE009 COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand and analyze the basic architecture of Digital Relay
- Understand the basics of Phasor Measurement unit (PMU)
- Applications of PMUs in power system

**Prerequisites:** Fourier series, Fourier Transform, Phasors , ADC

Mathematical background to protection algorithms-Finite difference technique-Numerical differentiation-Least Squares Method-Fourier analysis-Fourier analysis of analogue signals- Fourier analysis of discrete signals-Walsh function analysis.

Basic elements of digital protection-Signal conditioning subsystem-Transducers-Surge protection circuits-Analogue filtering-Analog multiplexers-Conversion subsystem-Sampling theorem-Signal aliasing error-Sample and hold circuit-Digital multiplexing-Digital to Analogue Conversion-Analogue to Digital Conversion-Processor-Data and Program memory-Digital relay hardware unit.

Phasor Measurement Unit– Introduction- Phasor representation of sinusoids- Phasor Estimation of Nominal Frequency Signals- Formulas for updating phasors - Nonrecursive updates-Recursive updates- Frequency Estimation.

Phasor Measurement Applications-State Estimation-History- Operator's load flow- weighted least square least square- Linear weighted least squares; Nonlinear weighted least squares- Static state estimation- State estimation with Phasors measurements- linear state estimation.

Adaptive protection- Differential and distance protection of transmission lines- Adaptive out-of-step protection.

**Text Books:**

1. *Arun G. Phadke, James S. Thorp, 'Computer Relaying for Power Systems', A John Wiley and Sons Ltd., Research Studies Press Limited, 2009.*
2. *A.G. Phadke • J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer,2008.*

**Reference Books:**

1. *A.T.Johns and S.K.Salman, 'Digital Protection For Power Systems', Peter Peregrinus Ltd, 1997.*

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

1. Understand the operation of computer relay.
2. Understand the basics of phasor measurement unit.
3. Understand the different applications of PMUs on power system.

## EE081 SOLID STATE DRIVES

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand the basic concept of DC and AC Drives.
- To understand the various control techniques involved with both DC and AC Drives.
- To brief about the working principle of Special Electrical Drives.

**Prerequisites:** Electrical machines, Power Electronics.

Introduction to solid state drives, various components-power converters, motors, loads, coupling mechanisms, Stability of drive.

Modeling of d.c.motor drives. Transfer function and state-space models. Experimental determination of drive parameters. Speed control using ac to dc converters, Input performance parameters, Speed reversal schemes.

Chopper fed d.c.motor drives. Four quadrant operation. Input filters design. Dynamic braking with dc chopper. Type-c chopper fed regenerative braking. Operation with non- receptive lines.

Power converters for induction motor speed control. Harmonic behavior of induction motors-harmonic currents and harmonic torques using per phase equivalent circuit. Stator voltage control schemes. S e c y m
State-space modeling of induction motors. Voltage source-Inverter fed operation. Field oriented control schemes. Current source – inverter drives. Principle of vector control.

**Text Books:**


1. *P.C.Sen, 'Thyristor DC Drives' John Wiley& Sons Publishers, New York, 2008.*
2. *R.Krishnan, 'Electric Motor Drives-Modeling, Analysis, and Control', Pearson Education Publishers, 1st edition, 2003.*
3. *B.K.Bose, 'Modern Power Electronics and AC drives', Pearson Education Publications, 2nd edition, 2005.*


**Reference Books:**


1. *G.K. Dubey, 'Fundamentals of Electrical Drives', Narosa Publishing house, 2nd edition, 2008.*
2. *T. Wildi, 'Electrical Machines Drives and Power Systems', Pearson Education Publications, 6th edition, 2004.*


**COURSE OUTCOMES:**

Upon completion of this course,

1. The student learns the fundamental concepts of power electronic converter fed DC and AC machines.
2. The student can analyze the converter fed motor under different torque/speed conditions.
3. The student will be able to design converter fed drives with existing/new control techniques.

## EE082 POWER SYSTEM DYNAMICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To explain the power system stability problem
- To understand the behavior of synchronous and induction machines during disturbance
- To employ mathematical tools for power system stability analysis

**Prerequisites:** Mathematical Transformations, Fundamentals of Synchronous and asynchronous machines, Principle of load flow and short circuit analysis

Stability considerations – Dynamic modeling requirements- angle stability – equal area criterion- Critical fault clearing time and angle-numerical integration techniques.

Synchronous machines - Park's transformation – flux linkage equations – formulation of normalized equations – state space current model – simplified models of the synchronous machine – turbine, Generator – steady state equations and phasor diagrams.

Dynamics of Synchronous machines - Mechanical relationships – electrical transient relationships – adjustment of machine models – Park's equation in the operational form.

Induction motor equivalent circuits and parameters - free acceleration characteristics – dynamic performance – effect of three phase short circuit and unbalanced faults.

Transient and dynamic stability distinction – linear model of unregulated synchronous machine and its oscillation modes – distribution of power impacts – effects of excitation on stability – supplementary stabilization signals.

**Text Books:**

1. *Krause P.C., 'Analysis of Electric Machinery', McGraw-Hill, 3rd revised Editions, 2013.*
2. *Ramanujam R, 'Power System Dynamics', PHI Learning Pvt. Ltd., New Delhi, 2009.*

**Reference Books:**

1. *Kundur P, 'Power System Stability and Control', McGraw-Hill, New Yark, 1st Edition, 2006.*

**COURSE OUTCOMES:**

Upon completion of the course, the students will have acquired

1. Understanding of the dynamic phenomena of the power system operation
2. Knowledge to employ modeling techniques for investigating the response of system during disturbance.
3. Ability to interpret results coming from the simulation of differential -algebraic systems

## EE083 POWER SYSTEM RESTRUCTURING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To understand the electricity power business and technical issues in a restructured power system in both Indian and world scenario.

**Prerequisites:** Knowledge in power system analysis & Power system generation, transmission and distribution.

Introduction – Market Models – Entities – Key issues in regulated and deregulated power markets; Market equilibrium- Market clearing price- Electricity markets around the world

Operational and planning activities of a Genco - Electricity Pricing and Forecasting -Price Based Unit Commitment Design - Security Constrained Unit Commitment design. – AncillaryServices - Automatic Generation Control (AGC).

Introduction-Components of restructured system-Transmission pricing in Open- access system - Open transmission system operation; Congestion management in Open-access transmission systems- FACTS in congestion management - Open-access Coordination Strategies; Power Wheeling- Transmission Cost Allocation Methods

Open Access Distribution - Changes in Distribution Operations- The Development of Competition – Maintaining Distribution Planning

Power Market Development – Electricity Act, 2003 - Key issues and solution; Developing power exchanges suited to the Indian market - Challenges and synergies in the use of IT in power- Competition- Indian power market- Indian energy exchange- Indian power exchange- Infrastructure model for power exchanges- Congestion Management-Day Ahead Market- Online power trading.

**Text Books:**

1. *Loi Lei Lai, 'Power System Restructuring and Deregulation', John Wiley & son LTD, New York, HRD Edition, 2001.*
2. *Mohammad Shahidehpour, Hatim Yamin,' Market operations in Electric power systems', John Wiley & son LTD, Publication, 2002.*
3. *Lorrin Philipson, H. Lee Willis, 'Understanding Electric Utilities and Deregulation', Taylor & Francis, New York, 2nd Edition, 2006.*

**Reference Books:**

1. *Mohammad S hahidehpour, Muwaffaq Alomoush, 'Restructured Electrical Power Systems'," Marcel Dekker, INC., New York, 1st Edition, 2001.*

**Useful web links**

1. *Indian energy exchange:* http://www.iexindia.com/
2. *Indian power India limited:* http://www.powerexindia.com/
3. *Indian Electricity Regulations:* http://www.cercind.gov.in/

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Explain and differentiate the key issues involved in the regulator and de-regulated power markets.
2. Describe the operational activities in Generation, Transmission and Distribution system in the restructured environment.
3. Illustrate and Solve problems in the de-regulated power System.
4. Explain and analyze the restructuring activities in Indian Power System.

## EE084 POWER SWITCHING CONVERTERS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** This course aims at modelling, analysis and control of various power converter circuits.

**Prerequisites:** Fundamentals of power electronics, Basic Electrical Engineering, Control systems

Basic converter topologies: Buck, Boost, Buck-Boost converter; steady state converter analysis - Equivalent circuit modelling

State space averaging of converters- Transfer function of converters- Design of feedback compensators-voltage and current loop

Design constraints of reactive elements in Power Electronic Systems: Design of inductor, transformer and capacitors for power electronic applications, Input filter requirement.

Isolated converters: forward converter, push-pull converter, fly back converter, half bridge and full bridge converter-operating principles

Soft-switching DC - DC Converters: zero-voltage-switching converters, zero-current switching converters, Multi-resonant converters and Load resonant converters-operating principles

**Text Books:**

1. *Simon Ang, Alejandro Oliva, 'Power Switching Converters', Taylor & Francis, 3rd Edition, 2010.*
2. *Robert W. Erickson, Dragan Maksimovic,, 'Fundamentals of Power Electronics', springer,2nd edition, 2001*

**Reference Books:**

1. *N. Mohan, T. Undeland, and W. Robbins, 'Power Electronics: Converters, Applications, and Design', 2nd edition, John Wiley & Sons, 1995.*
2. *M. Rashid, 'Power Electronics: Circuits, Devices, and Applications', , Prentice Hall, 2nd edition 1993*

**COURSE OUTCOMES:**

Upon completion of this course the students will be able to

1. Understand the classification and operation of different types of DC-DC converters.
2. Analyze the Steady-state operation of DC-DC converter circuits
3. Develop the transfer function of DC-DC converter circuits
4. Design the compensator and reactive elements of DC-DC converter circuits
5. Illustrate different soft switching techniques in DC-DC converter circuits

| **EE085 MODERN OPTIMIZATION TECHNIQUES FOR ELECTRIC POWER SYSTEMS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives:** To learn the concepts and techniques of evolutionary and optimization techniques in power system applications.

**Prerequisites:** Fundamentals of electrical power system

Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-Classical Optimization techniques (Linear and nonlinear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, Particle swarm optimization, Application of fuzzy set theory).

Evolution in nature-Fundamentals of Evolutionary algorithms-Working Principles of Genetic Algorithm-Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation- GA based Economic Dispatch solution-Fuzzy Economic Dispatch including losses- Tabu search algorithm for unit commitment problem-GA for unit commitment-GA based Optimal power flow- GA based state estimation.

Fundamental principle-Velocity Updating-Advanced operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues-Convergence issues- PSO based OPF problem and unit commitment-PSO for reactive power and voltage control-PSO for power system reliability and security.

Simulated annealing algorithm-Tabu search algorithm-SA and TS for unit commitment-Ant colony optimization- Bacteria Foraging optimization.

Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-Economic Emission dispatch using MOGA-Multiobjective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO) –Multiobjective OPF problem.

**Text Books:**

1. *SolimanAbdel Hady,Abdel Aal Hassan Mantawy, "Modern optimization techniques with applications in Electric Power Systems", Springer,2012.*

**Reference Books:**

1. *D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2nd Edition, PHI learning private limited, 2010.*
2. *Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms", John Wiley and Sons, 2008.*
3. *Kalyanmoy Deb, "Optimization for Engineering Design",Prentice hall of India first edition,1988.*

**COURSE OUTCOMES:**

Upon completion of this course the students will be able to

1. Understand the concept of optimization techniques.
2. Apply evolutionary algorithms for unit commitment and economic dispatch problems.
3. Interpret hybrid approach for power system reliability and security.

## EE086 VEHICULAR ELECTRIC POWER SYSTEM

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** This course introduces the fundamental concepts, principles and analysis of hybrid and electric vehicles.

**Prerequisites:** Power Conversion Techniques, Electrical Machines

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Basics of vehicle performance, vehicle power source characterization, transmission characteristics

Introduction to electric components used in hybrid and electric vehicles- Configuration and control of DC Motor drives Induction Motor drives, Permanent Magnet Motor drives, and Switched Reluctance Motor drives- drive system efficiency. Capabilities, Automation system computer facilities.

Energy storage technologies in hybrid vehicles-flywheel, hydraulic, fuel cell and hybrid fuel cell energy storage system-ultra capacitors- comparison- - battery charging control

Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.

Electrical power system in air craft, sea and undersea vehicles, space vehicles-hybrid vehicle control strategies-supporting subsystem

**Text Books:**

1. *Ali Emadi, Mehrdad Ehsani, John M. Miller 'Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles',*

**Reference Books:**

1. *Ion Boldea and S.A Nasar, 'Electric drives', CRC Press, 2005*
2. *Sandeep Dhameja,'Electric Vehicle Battery Systems',*
3. *Chris Mi, M. Abul Masrur, David Wenzhong Gao,*
4. *Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Second Edition*

**COURSE OUTCOMES:**

On completion of the course, the student would be able to

1. Understand the various aspects of hybrid and electric vehicles
2. Plan the selection of electrical machines for hybrid and electric vehicles
3. Select various energy storage technologies for hybrid and electric vehicles
4. Implement energy management techniques for hybrid and electric vehicles
5. Demonstrate the power system of various vehicular system

## EE087 DISTRIBUTION SYSTEM AUTOMATION

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To understand and appreciate the basic control techniques involved in distribution automation and also get introduced to the various communication systems involved in distribution automation. Also the objective of the course is to enable the students capable of analyzing the economics behind the automation of distribution system automation.

**Prerequisites:** Basic knowledge on control systems, communication systems and electric power distribution systems

Introduction to Distribution Automation, Control System Interfaces, Control and Data requirements, Centralized (Vs) Decentralized Control, Distribution Automation System, DAS Hardware, DAS Software, DA Capabilities, Automation system computer facilities.

Layout of substations and feeders, design considerations. Distribution system load flow, optimal siting and sizing of substations, optimal capacitor placement. Distribution system monitoring and control: SCADA, Remote metering and load control strategies, Optimum feeder switching for loss minimization and load control. Distribution system restoration. Distribution system protection and switchgear. Power quality issues. System Reliability Management, Voltage Management and Load Management.

DA Communication Requirements, Communication Reliability, Cost Effectiveness, Data Rate Requirements, Two Way Capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow. Communication Systems used - Distribution line carrier (Power line carrier), Telephone, Cable TV, Radio, AM Broadcast, FM SCA, VHF Radio, UHF Radio, Microwave, Satellite, Fibre Optics, Hybrid Communication Systems.

DA Benefit Categories, Capital Deferred Savings, Operation and Maintenance Savings, Interruption Related Savings, Customer-related Savings, Operational savings, Improved operation, Function Benefits, Potential Benefits for Functions, Function-shared Benefits, Guidelines for Formulation of Estimating Equations.

Economic impacts and Benefit impacts of Automation on Distribution Systems, Integration of benefits into economic evaluation. Development and Evaluation of Alternate plans, Operation and Maintenance Cost Evaluation, Evaluation of Alternatives. Economic Comparison of Alternate Plans, Classification of Expenses and Capital Expenditures, Comparison of revenue requirements of alternative plans, Sensitivity Analysis, Computational Aids. Distribution system restoration. Distribution system protection and switchgear. Power quality issues.

**Text Books:**

1. *Momoh A. Momoh, James A. Momoh., 'Electric Power Distribution, Automation, Protection, and Control', CRC Press, 2007*
2. *Gonen., 'Electric Power Distribution System Engineering', BSP Books, Pvt.* Ltd, 2007

**Reference Books:**

1. *D. Bassett, K. Clinard, J. Grainger, S. Purucker, and D. Ward, 'Tutorial Course: Distribution Automation', IEEE Tutorial Publication 88EH0280-8-PWR, 1988.*
2. *IEEE Working Group on 'Distribution Automation'*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Understand the Distribution Automation Systems and the Control techniques involved.
2. Develop a clear idea on the layout of the substations and feeders and also on the various management techniques viz., load management and voltage management.
3. Identify an appropriate method of communication for any particular distribution system with a view of automation
4. Evaluate the economic aspects of any distribution system with automation

## EE021 COMPUTER ARCHITECTURE

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** This Course will render the basic structure of computers their control design, memory organizations and an introduction to parallel processing

**Prerequisites:** Fundamental of digital systems , Basic programming skills

Computer – Functional units, Addressing modes, Instruction formats, Stacks and Subroutines. Processing Unit - Execution of instructions - Control step sequence.

Control Design - Hardwired control- design - multiplier control unit - CPU control unit and Micro programmed control - micro instructions - Sequencing - prefecting.

Arithmetic and Logic Unit-Fixed point and floatingpoint numbers and operations. Design of arithmetic units.

Memories - cache memories - virtual memories. Input-Output Organization - Data transfer- synchronization- Interrupt handling-I/O interfaces.

Introduction to parallel processing- Generation of computer systems – Parallelism in uniprocessor system – Parallel computer structures- architectural classification schemes.

**Text Books:**


1. *David A. Patterson and John L. Hennessy, 'Computer Organization and Design: The Hardware/Software interface', 4th Edition, Elsevier, 2009.*
2. *Morris Mano.M., 'Computer system Architecture', PHI, New Delhi, 3rd Edition 1993.*
3. *William Stallings, 'Computer Organization and Architecture – Designing for Performance', 8th Edition, Pearson Education, 2010*.


**Reference Books:**


1. *Behrooz Parhami, 'Computer Architecture from up to super computer', Oxford press, reprinted 2014*
2. *John P. Hayes, 'Computer Architecture and Organization', Tata McGraw Hill, 3rd Edition, 1998.*
3. *Carl Hamachar, Zvonko Uranesic, Safwat zaky, ' Computer Organization', Tata McGraw Hill, 6th revised Edition ,2011*


### COURSE OUTCOMES:

Upon completion of this course , students will

1. Describe the general architecture of computers.
2. Be familiar with the history and development of modern computers, the Von Neumann architecture and functional units of the processor such as the register file and arithmetic- logical unit,
3. Understand the major components of a computer including CPU, memory, I/O and storage, how computer hardware has evolved to meet the needs of multi-processing systems, the uses for cache memory, parallelism both in terms of a single processor and multiple processors.
4. Design principles in instruction set design including RISC architectures.
5. Analyze and design computer hardware components.

## EE022 COMPUTER NETWORKS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To know about different network architectures and network protocols, data communications and different IEEE standards.

**Prerequisites:** Basics of Programming, Digital Electronics

Introduction - Architecture, Network hardware and software. Physical layer - Guided transmission media - Cable television.

Data Link Layer - Design issues – Channel allocation problem - Multiple access protocols - Ethernet - Wireless LAN - 802.11 architecture.

Network Layer - Design issues – Routing algorithms - Congestion control algorithms -Quality of Service - Internetworking.

Transport Layer - Transport service - Elements of transport protocols - User Datagram Protocol - Transmission Control Protocol.

Application Layer - DNS - Electronic mail - World Wide Web - Multimedia - Network security.

**Text Books:**


1. *A. S. Tanenbaum, 'Computer Networks', Pearson Education, 4th Edition, 2003*
2. *W. Stallings, 'Data and Computer Communication', Pearson Education, 8th Edition, 2007*
3. *James F.Kurose, Keith W.Ross,'Computer Networking', Pearson Education, 6th Edition, 2012.*


**Reference Books:**


1. *Douglas E.Comer, 'Computer Networks and Internet', Pearson education, 4th Edition, 2008.*
2. *Behrouz A. Foruzan, 'Data Communication and Networking', Tata McGraw Hill, 5th Edition, 2013.*
3. *Larry L. Peterson and Bruce S. Davie, 'Computer Networks - A systems Approach', Harcourt Asia/Morgan Kaufmann, 5th Edition, 2011.*


**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Understand of the fundamental network issues
2. Analyze the significance of the network layers and their functions.
3. Gain knowledge about the basic network protocols.
4. Have a basic understanding of TCP / IP

## EE023 OPERATING SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To learn the various aspects of operating systems such as process management, memory management, and I/O management. This course will outline the importance of operating system components, different views and principles of design and implementation

**Prerequisites:** Fundamental of computer systems, Basic programming skills

Operating system concepts-types of OS and OS structure-Processes-Process model –Process scheduling - Scheduling criteria – Scheduling algorithms – Multiple- processor scheduling – Real time scheduling – Algorithm Evaluation.

The critical- section problem –Synchronization hardware – Semaphores – Classic problems of synchronization –critical regions – Monitors. Deadlock: System model – Deadlock characterization – Methods for handling deadlocks – Deadlock prevention – Deadlock avoidance – Deadlock detection – Recovery from deadlock.

Memory Management: Background – Swapping – Contiguous memory allocation – Paging – Segmentation – Segmentation with paging. Virtual Memory: Background – Demand paging – Process creation – Page replacement – Allocation of frames – Thrashing. Case Study: Memory management in Linux

File-System Interface: File concept – Access methods – Directory structure – File-system mounting – Protection. File-System Implementation: Directory implementation – Allocation methods – Free-space management – efficiency and performance – recovery– log-structured file systems. Case studies: File system in Linux – file system in Windows XP

I/O Systems – I/O Hardware – Application I/O interface – kernel I/O subsystem – streams– performance. Mass-Storage Structure: Diskscheduling – Disk management – Swap-space management – RAID – disk attachment – stable storage – tertiary storage. Introduction to distributed systems. Case study: I/O in Linux

**Text Books:**


1. *Andrew S.Tanenbaum, 'Modern operating systems', Prentice Hall of India, 10th print, 2000.*
2. *J. L. Peterson, 'Operating System Concepts', Addison- Wesley Publishing Company, 2nd Edition, 1985*
3. *A.Silberchatz, P.B.Galvin, 'Operating System Concepts', Addison Wesley, 6th Edition, 2005*


**Reference Books:**


1. *W.Stallings, 'Operating Systems', Prentice Hall, 5th Edition, 2005.*
2. *Harvey M. Deital, 'Operating Systems', 3rd Edition, Pearson Education, 2004.*


**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Describe functions, structures and history of operating systems, various process management concepts including scheduling, synchronization, Deadlocks, concepts of memory management including virtual memory, related to file system interface and implementation, disk management,
2. Be familiar with protection and security mechanisms
3. Be familiar with various types of operating systems including WINDOWS and UNIX.
4. Analyze theory and implementation of processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and file.

## EE024 DESIGN WITH PIC MICROCONTROLLERS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To understand the internal structure and operation of PIC16F876 microcontroller, assembly language programming with MPLAB and PICSTART plus and design methodology for software and hardware applications.

**Prerequisites:** Knowledge on any microprocessor and power electronics may be desirable.

Introduction to PIC microcontrollers-PIC 16F876 microcontroller –device overview-pin diagrams-memory organisation.

Special Function Registers-I/O ports-Timers –Capture/Compare/PWM modules (CCP)-Analog to digital converter module-selection –reset–interrupts-watchdog timer.

Instruction set-instruction description–PIC16F876assembly language programming –simple programs.

Introduction to MPLABIDE and PICSTART plus–Device Programming using MPLAB and PICSTART plus.

Assembly language programming for –Zero crossing detectors-square wave generation–firing pulse generation for typical single-phase converters and inverters- ADC program –hardware demonstration.

**Text Books:**


1. *PIC16F87X datasheet, 28/40- pin 8 bit CMOS flash Microcontrollers, Microchip Technology Inc, 2001.*
2. *Myke Predko, 'Programming and Customizing the PIC Microcontroller', Tata McGraw Hill Publications, 1st Edition, 2007.*
3. *John B. Peatman, 'Design with PIC Microcontrollers', Pearson Education Publications, 1st Edition, 2008.*


**References:**


1. *MPLABIDE Quick start guide Microchip technology Inc., 2007.*
2. *M. D. Singh and K. B. Khanchandani, 'Power Electronics', Tata McGraw Hills Publishing Company Limited, 2nd Edition, 2006.*


**COURSE OUTCOMES:**

Upon completion of this course, students will

1. Understand the architecture of PIC 16F876 microcontroller and its instruction set.
2. Be able to develop assembly language program.
3. Be able to develop the program using MPLAB and download it to the microcontroller chip using suitable developer.
4. Be able to design and generate the firing pulses for typical power electronic circuits

## EE025 EMBEDDED SYSTEM DESIGN

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To enable the leaner to design a system with combination of hardware and Software for specific application.

**Prerequisites:** Basics of processors and controllers

Embedded System Architectures – ARM processor and SHARC processor - architectural design - memory organization - data operation - bus configurations. System on-chip, scalable bus architectures, Design example: Alarm clock, hybrid architectures.

Sensor and Actuator I/O – ADC, DAC, timers, Servos, Relays, stepper motors, H-Bridge, CODECs, FPGA, ASIC, diagnostic port.

Real time operating systems (RTOS) – real time kernel – OS tasks – task states – task scheduling – interrupt processing – clocking communication and synchronization – control blocks – memory requirements and control – kernel services.

Embedded Networks – Distributed Embedded Architecture – Hardware and Software Architectures, Networks for embedded systems– I2C, CAN Bus, Ethernet, Internet, Network–Based design– Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

System Design – Specification, Requirements and Architectural design of PBX systems, Set-top box, Ink-jet printer, Laser printer, Personal digital Assistants.

**Text Books:**

1. *Wayne Wolf, 'Computers as Components: Principles of Embedded Computing System Design', Morgan Kaufman Publishers, 2nd Edition, 2010.*
2. *C.M Krishna, Kang G. Shin, 'Real time systems', Mc-Graw Hill, 1st Edition, 2010.*
3. *GaIski D. Vahid F., Narayan S., 'Specification and Design of Embedded Systems', Prentice Hall, 1st impression ,2007*

**Reference Books:**

1. *Herma K., 'Real Time Systems: Design for Distributed Embedded Applications', Springer, 2nd Edition, 2011.*
2. *WilliamHohl, 'ARM Assembly Language, Fundamentals and Techniques', CRC Press, 2009.*

**COURSE OUTCOMES:**

Upon completion of this course , students will be able to

1. Remember the concepts of process and controllers
2. Apply the concepts for real time applications
3. Create a real time system for particular applications

## EE026 DIGITAL SIGNAL PROCESSING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To explore the basic concepts of digital signal processing in a simple and easy-to-understand manner.

**Prerequisites:** Signals and systems

Linearity shift - invariance - Unit sample response characterization – Convolution summation, causality, linear difference equations with constant coefficients and their solution using Z-transform – System function concept.

Discrete Fourier Transform and its properties – Circular convolution – Linear convolution of two finite length sequences through circular convolution, Sectioned convolutions – Relationship between Z- Transform, Fourier Transform and the Discrete Fourier Transform, Digital filter sampling, Introduction to radix-2 FFT – decimation in time and decimation in frequency radix2 algorithm – FFT Fortran program.

Amplitude and phase response of FIR filters – Linear phase filters – Windowing technique for the design of linear phase FIR filters – Rectangular – Hamming and Kaiser windows – Frequency sampling technique – Introduction to optimal filters.

Properties of IIR digital filters – Design of IIR filters from continuous time filters – Impulse invariance and Bilinear transformation technique – Finite Word Length Effects – Elementary ideas of finite word length effects in digital filters.

Architecture and features of signal processor and motion controller.

**Text Books:**


1. *Oppenheim and Schaffer, 'Discrete time Signal processing', Pearson Education Publications, 3rd edition, 2010.*
2. *Ludemann L. C., 'Fundamentals of Digital Signal Processing', Harper and Row Publications, 1st edition, 1992.*


**Reference Books:**


1. *Rabiner & Gold, 'Theory and applications of Digital signal processing', PHI Learning Publications,1st edition, 2009.*
2. *Hamid A. Toliyat and Steven G. Campbell, 'DSP Based Electro Mechanical Motion Control', CRC Press, 1st edition, 2004.*


**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

1. Understand the operations on digital signals.
2. Analyze the signal processing concepts.
3. Design the systems required for digital signal processing

## EE027 DIGITAL SYSTEM DESIGN AND HDLS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To impart the concepts of Digital systems and hardware description languages.

**Prerequisites:** Essentials of Digital Electronics

Finite State machines - Mealy and Moore, state assignments, design and examples – Asynchronous finite state machines – design and examples – multi-input system controller deisgn.

*Programmable Devices:* Simple and Complex Programmable logic devices (SPLD and CPLDs) , Field Programmable Gate Arrays (FPGAs), Internal components of FPGA, Case study: A CPLD and a 10 million gates type of FPGA.

VHDL- Modeling styles – structural – Behavioral – Dataflow - Design of simple/ complex combinational and sequential circuits using VHDL – Data types – Test bench and simulation. Case study on system design.

Verilog HDL - Modeling styles – structural – Behavioral – Dataflow - Design of simple/ complex combinational and sequential circuits using Verilog – Test bench and simulation – case study on system design.

Fault classes and models – Stuck at faults, Bridging faults - Transition and Intermittent faults. Fault Diagnosis of combination circuits by conventional methods - Path sensitization technique - Boolean different method and Kohavi algorithm

**Text Books:**

1. *William I. Fletcher, 'An Engineering Approach to Digital Design', Prentice Hall, 2009.*
2. *Donald D.Givone, 'Digital principles and design', TMH, 2002.*
3. *Morris Mano, 'Digital Design', PHI, 3rd Edition, 2005.*
4. *J. Bhaskar, 'Verilog HDL Primer', BPB publications, 2000.*

**Reference Books:**

1. *Samuel C.Lee, 'Digital circuits and logic design', PHI, 2001.*

**COURSE OUTCOMES:**

On completion of the course the students would be able to:-

1. To understand the insights of the finite state machines.
2. To appreciate and classify the programmable logic devices and FPGA.
3. To design the logic circuits using VHDL.
4. To develop the systems using Verilog HDL.
5. To test the circuits for different faults.

## EE028 LOW POWER MICROCONTROLLER

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To enrich the student with the concepts of low power microcontroller, its architecture, peripherals and applications.

**Prerequisites:** Essentials of Electronic devices, circuits, Digital systems, Microprocessor basics.

Introduction - Motivation for MSP430microcontrollers – Low Power embedded systems, Main characteristics of a MSP430 microcontroller, Main features of the MSP430X RISC CPU architecture, Address space, Interrupt vector table, Flash/ROM, Information memory (Flash devices only), Boot memory (Flash devices only), RAM, Peripheral Modules, Special Function Registers (SFRs), Central Processing Unit (MSP430 CPU), Arithmetic Logic Unit (ALU), MSP430, CPU registers, Central Processing Unit (MSP430X CPU), MSP430X CPU registers.

Addressing modes & Instruction set- Double operand instructions, Single operand instructions, Program flow control – Jumps, Emulated instructions and programming.

Device Systems and Operating Modes- system reset, system clock, interrupt management, WDT, WDT+, Basic Timer, Capture/Compare blocks, Timer_A Interrupts, Timer_B special features, Real Time Clock (RTC).

On-Chip Peripherals and General Purpose I/O- Hardware multiplier, ADC, DAC, SD16, LCD, DMA, Registers, Interruptible ports, Flashing LED, Blinking the LED, toggle the LED state by pressing the push button, Enable / disable LED blinking by push button.

Communications: Communications system model, Transmission mode, Synchronous and asynchronous serial communications, Serial Peripheral Interface (SPI) communication protocol, MSP430 communications interfaces, Case Studies of applications of MSP430.

**Text Books:**

1. *John H Davies, "MSP430 Microcontroller Basics", Newnes Publications, 2008*
2. *Chris Nagy, "Embedded systems Design using TI MSP430 Series", Newnes, 2003.*

**Reference Books:**

*Teaching MSP430, Manual from Texas Instruments.*

**COURSE OUTCOMES:**

Upon completion of the course the students would be able to

1. Understand the architecture of MSP 430 Microcontroller.
2. Appreciate the different Addressing modes and Instruction set.
3. Identify the device systems and operating modes of MSP 430.
4. Utilize the on-chip peripherals and I/O pins of MSP 430.
5. Construct the applications of MSP 430 and understand the communication interfaces.

## EE088 AIRCRAFT ELECTRONIC SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To inculcate the habit of applying theory in practical electronic systems.

**Prerequisites:** Essentials of Digital Electronics and system design

Basic flight instruments – Electronic flight instrument systems – primary flight display – navigation display – Display processor unit - Electronic attitude and direction indicator (EADI) – Electronic Horizontal situation indicator (EHSI) – Multi-function processor unit.

Electronic centralized aircraft Monitor - Engine indicating and crew alerting system - Flight management system – cockpit layouts.

Electrostatic sensitive devices (ESD) – Different devices and its features - tribo-electric series – handling and transporting ESDs - Electromagnetic compatibility – EMI generation – EMC and avionics equipment – spectrum analysis.

Airframe control and indicating systems - Landing gear - Trailing edge flaps - Control surfaces - Electronic indicating systems – Terrain awareness warning systems

Flight data and cockpit voice recorders - Health and usage monitoring system (HUMS) - Aircraft Communication Addressing and Reporting System - Fly-by-wire (FBW).

**Text Books:**

1. *Mike Tooley, 'Aircraft Digital Electronic and Computer Systems: Principles, Operation and Maintenance', 1st Edition, Elsevier, 2007.*
2. *Mike Tooley and David Wyatt,'Aircraft Electrical and Electronic Systems: Principles, operation and maintenance', Elsevier, 2009.*

**Reference Books:**

*IEEE Guide for Aircraft Electric systems, 1976.*

**COURSE OUTCOMES:**

On completion of the course the students would be able to:-

1. To understand the insights of the flight instruments.
2. To appreciate and classify the monitoring and management systems.
3. To differentiate electrostatic and electromagnetic effects.
4. To list the control and indicating systems in aircraft.
5. To enrich about recording and reporting systems in aircraft.

| | L | T | P | C |
|---|---|---|---|---|
| **EE089 APPLIED SIGNAL PROCESSING** | 3 | 0 | 0 | 3 |

**Course Objectives:** To inculcate the habit of applying theory in practical signal processing in real time systems.

**Prerequisites:** Essentials of signals and systems, signal processing

Speech processing in a cell phone conversation - Linear predictive processing of speech – LP model of speech - LP estimation algorithm - LP processing in practice - Linear predictive coders.

Bits played back in an Audio CD - Delta–sigma modulation - Uniform quantization: Bits vs. SNR - Conventional DACs - Oversampling DACs – Noise shaping - Delta–sigma DACs.

Sound processed in a MP3 player - Sub-band and transform coding - Perfect reconstruction filters- Filter banks and lapped transforms - masking properties of the human ear - Audio coders.

Compression of Digital TV programs for broadcasting - Motion estimation - Motion estimation: The block matching algorithm - specificities of video coding standards.

Acoustic echo cancellation - internet phone – guidance and navigation systems – case studies on other real time systems.

**Text Books:**

1. *Thierry Dutoit · Ferran Marqu´es, 'Applied Signal Processing: A MATLAB-Based Proof of Concept', Springer, 2009.*

**Reference Books:**

1. *Dimitris G. Manolakis and Vinay K. Ingle, 'Applied Digital Signal Processing', Cambridge University press, 2011.*
2. *V. Udayashankara, 'Real time Digital Signal Processing', PHI, 2010.*

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. To appreciate the speech processing technique in cell phones.
2. To understand the bits processed in audio CD.
3. To identify the concepts of sound processed in MP3 player.
4. To determine the compression technique used in Digital TV programs.
5. To enrich about different real time signal processing systems.

## EE041 ARTIFICIAL NEURAL NETWORKS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To learn the fundamentals of ANN and its application to electrical system.

**Prerequisites:** Engineering Mathematics, Introduction to EEE.

Objectives-History-Biological Inspiration- Neuron Model- Single-Input Neuron-Multi- Input Neuron-Network Architectures- A Layer of Neurons-Multiple Layers of Neurons.

Perceptron Architecture- Single-Neuron Perceptron- Multi-Neuron Perceptron- Perceptron Learning Rule- Constructing Learning Rules-Training Multiple-Neuron Perceptron.

Simple Associative Networks-Unsupervised Hebb Rule- Hebb Rule with Decay-Instar Rule- Outstar Rule-Kohonen Rule.

Adaline Network – Madaline Network – Mean Square Error- LMS Algorithm- Back Propagational Neural networks–Hopfield Networks.

Adaptive Filtering-Adaptive Noise Cancellation-Forecasting–Neural control applications–Character recognition.

**Text Books:**

1. *Hagan, Demuth, Beale, 'Neural Network Design', PWS Publishing Company, 1st Edition, 2002.*
2. *Freeman, J.A and Skapura, D.M., 'Neural networks - Algorithms, applications and programming techniques', Addison Wesley Publications, Digitized Reprint(2007), 1991.*

**Reference books:**

1. *Satish Kumar, 'Neural Networks–A classroom approach', Tata McGraw-Hill Publishing Company Limited, 2013*

**COURSE OUTCOMES:**

Upon completion of the course students will be able to

1. Describe the development of artificial neural networks (ANN) and classify various ANN models.
2. Solve and design various ANN models.
3. Apply and construct ANN models to various applications of electrical systems.

## EE042 FUZZY SYSTEMS AND GENETIC ALGORITHMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- This course is designed to expose students to fuzzy methods of analyzing problems which involve incomplete or vague criteria rather than crisp values. The course investigates requirements analysis, logical design, and technical design of components for fuzzy systems development.
- The subject is primarily concerned with the definitions and concepts associated with a fuzzy set, Fuzzy reasoning, Fuzzy design and Fuzzy logic applications. The course also introduces Neuro-Fuzzy systems, Fuzzy Genetic Algorithms.

**Prerequisites:** Fundamentals of control systems.

Different faces of imprecision – inexactness, ambiguity, undecidability, Fuzziness and certainty, Fuzzy sets and crisp sets.

Intersections of Fuzzy sets, Union of Fuzzy sets the complement of Fuzzy sets-Fuzzy reasoning..

Linguistic variables, Fuzzy propositions, Fuzzy compositional rules of inference- Methods of decompositions and defuzzification.

Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts, Applications -Fuzzy controllers – Control and Estimation.

Genetic Algorithms- basic structure-coding steps of GA, convergence characteristics, applications.

**Text Books:**


1. *Z i m m e r m a n n H.J., 'Fuzzy set theory and its applications', Springer pvt Limited, 4th edition, 2012.*
2. *Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', John Wiley & Sons Ltd Publications, 3rd edition, 2010.*
3. *M. Mitchell, 'Introduction to Genetic Algorithms", Indian reprint, MIT press Cambridge, 2nd edition, 2002.*


**References:**


1. *John Yen, Reza Langari, 'Fuzzy Logic, Intelligence, Control & Information', Pearson Education Inc., 1st edition, 2002.*
2. *Zdenko Kovacic, Stjepan Bogdan, 'Fuzzy Controller Design Theory and Applications', CRC Press, 1st edition, 2006.*
3. *Riza C. Berkaan, Sheldon L. Trubatch, 'Fuzzy Systems Design Principles – Building Fuzzy IF THEN Rule Based', IEEE Press,1st edition, 1997.*


**COURSE OUTCOMES:**

Upon the completion of the course, the students will be able to

1. Understand the fundamentals of Fuzzy logic theory.
2. Apply and analyse the concept to existing systems.
3. Design Fuzzy logic Systems for engineering applications

## EE043 INDUSTRIAL AUTOMATION

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** The contents aim to develop the knowledge of the student in the field of automation in industries. This will be compromising knowledge of PLC, DCS and SCADA Systems. They will also get familiar with different industrial standard protocols.

**Prerequisites:** Basic knowledge of Control systems and Electrical and electronics measurement

Introduction to process control: Process Control block Diagram, Control System Evaluation, and Digital Control: Supervisory Control, Direct Digital Control, Networked Control Systems, and Distributed Digital Control. Smart Sensor. Definitions of the terms used to describe process control. Data Acquisition Systems: DAS Hardware, DAS Software. Data Logger.

Controller Principles: Process Characteristics: Process Equation, Process Load, Process Lag, Self-Regulation. Control System parameters: Error, Variable Range, Control parameter Range, Control Lag, Dead Time, Cycling, Controller Modes. Discontinuous Controller Mode: Two Position Mode, Multiposition Mode, Floating Control Mode. Continuous Control Mode: Proportional Control Mode, Integral Control Mode, Derivative Control Mode. Composite Control Modes: PI Control, PD Control, PID Control

Analog Controllers: Introduction, Electronic Controllers: Error Detector, Single Controller Modes, Composite Controller Modes. Pneumatic Controllers: General features, Mode Implementation.

Programmable Logic Controller: Evaluation of PLC, PLC Architecture, Basic Structure. PLC Programming: Ladder Diagram – Ladder diagram symbols, Ladder diagram circuits. PLC Communications and Networking, PLC Selection: I/O quantity and Type, Memory size and type, Programmer Units. PLC Installation, Advantages of using PLCs.

Distributed Control System: Introduction, Overview of Distributed Control System, DCS Software configuration, DCS Communication, DCS Supervisory Computer Tasks, DCS Integration with PLCs and Computers, Features of DCS, Advantages of DCS.

**Text Books:**


1. C.D. Johnson, 'Process Control Instrumentation Technology', PHI, 8th edition, 2013
2. S.K. Singh , 'Computer Aided Process Control', PHI, 2004


**Reference books:**


1. Noel M. Morris., 'Control Engg', McGraw-Hill,4th edition, 1992
2. Thomas E. Kissell, 'Industrial Electronics', PHI, 3rd edition,2003
3. Lukcas M.P., 'Distributed control systems', Van Nostrand Reinhold co, illustrated.
4. Huges T, 'Programmable Controllers', ISA press, 4th edition, 1994.
5. A.K. Ghosh ,'Introduction to Instrumentation & Control', Eastern Economy Edition
6. George C. Barney, 'Intelligent Instrumentation', Prentice Hall India


**COURSE OUTCOMES:**

Upon completion of the subject, students will be able to:

1. Implement low cost automation systems using pneumatic and electrical means.
2. Learn about the modern techniques and devices used for the monitoring and control of manufacturing systems including programming of programmable logic controllers and their interfacing with various sensors and actuators.
3. Design automated assembly system for industrial applications.

## EE044 OPERATION RESEARCH

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To equip students to identify and formulate real life problems using mathematical modeling; devise a solution procedure; analyze and interpret the results; revise for the process based on the actual results

**Prerequisites:** Knowledge of differential and integral calculus, matrix analysis, differential equations and algebraic system of equations

Linear Programming: Basic concepts – Mathematical formulation of L.P.P – Graphical solution – simplex method – Charnes' Big-M method – Two-phase method – Dual simplex method

Dual Theory Transportation and Assignment problems: Dual formulation of primal L.P.P and its solution – Transportation problem – Assignment problem – Travelling salesman problem

Integer programming and CPM-PERT: Gomory's method – Branch and bound technique – Critical path in networks – CPM – Time and Cost aspects in networks - PERT

Queueing Theory and Inventory models: Classification of queues – Poisson arrivals – Exponential service time – M/M/1 and M/M/c models – Inventory control – E.O.Q. with uniform demand, with finite rate of replenishment and with shortage – Buffer stock – Inventory with price breaks – Basic probabilistic models

Dynamic programming: Recursive equation approach – applications to shortest path network, Inventory and production control – solution of LPP by dynamic programming

**Text Books:**

1. *Hamdy A. Taha, 'Operation Research – An Introduction', Person Education,9th Edition, 2014*

**References:**

1. *Gass, S.I., 'Linear Programming: methods and applications', McGraw Hill Ltd,1975.*
2. *Hillier , F.S., and Lieberman, G.J., 'Operation Research', McGraw Hill Ltd, 9th edition,2009.*
3. *Wagner, 'Principles Of Operations Research, With Applications To Managerial Decisions', Prentice Hall , 2nd Edition, 2009.*
4. *Gillet, M.N., 'Introduction to Operation Research', Tata McGraw Hill Education Pvt Ltd, 1st edition,2010*

**COURSE OUTCOMES:**

Upon completing the course, the student will be able to

1. Increase the analytical skill of identifying and solving engineering problems.
2. Optimizing the resources and input-output process.
3. Devising new techniques for the better understanding of real life situation.

## EE090 MODERN CONTROL SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** Apply modern control techniques to electrical systems.

**Prerequisites:** Basic control systems, Linear algebra

Review of state space analysis - state variable systems - controllability and observability - State variable feedback and its effect on controllability and observability-elements of observer theory.

Common types of non- linear phenomena – linearization -singular points- phase plane method - construction of phase trajectories- describing functions.

Basic concepts-derivation of describing functions-stability of non- linear systems by describing function method- Liapunov's method of stability studies- Popov's criterion.

Pole placement technique by state feedback for linear SISO time invariant system–Design of state observers and servo system.

Optimal control, adaptive control, robust control and intelligent control methods-Introduction to distributed control systems.

**Text Books:**


1. *Chi-Tsong Chen, 'Linear System Theory and Design', Oxford University Press, 4th Edition, 2012.*
2. *Khalil H.D., 'Nonlinear Systems', Prentice Hall Publications, 3rd Edition, 2003.*


**Reference books:**


1. *Stanley M. Shiners, 'Modern Control System theory and Design', John Wiley and Sons Publications, 2nd Edition, 1998.*
2. *Ogata K. 'Modern Control Engineering', Prentice Hall Publications, 5th Edition, 2010.*


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

1. Understand the concepts of modern control theory using state- space approach.
2. Compare and analyse the classical control system with modern control system.
3. Develop advanced controllers to the existing system using modern control design techniques.

## EE091 DIGITAL CONTROL SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** To learn the digital control design techniques.

**Prerequisites:** Classical Control Systems, Modern Control systems

Introduction- Comparison between analog and digital control-Importance of digital control-Structure of digital control- Examples of digital control system- Difference equations- Z-transform-MATLAB examples. Frequency response of discrete time systems- Properties of frequency response of discrete time systems-Sampling theorem.

ADC model- DAC model- Transfer function of zero order hold- DAC, Analog Subsystem, and ADC Combination Transfer Function-Closed loop transfer function- Steady state error and its constants (MATLAB commands).

Definitions of stability (Asymptotic stability, exponential stability etc)-stable z-domain pole placement locations- stability conditions-Stability determination (routh array)-Nyquist criterion.

Root locus- root locus design ( p-control, Pi- control, pd)- Z-domain root locus- z-domain root locus design-digital implementation of analog controller design (differencing methods forward and backward)- bilinear transformation-direct z- domain controller design-frequency response design-Finite time response settling time.

Concept of state space method-state space representations of discrete time systems- solving discrete time state space equations- Pulse transfer function matrix- Discretization of continuous state space equations-Liapunov stability analysis( discrete time) Controllability-observability-design Via pole placement-state observers.

**Text Books:**

1. *Kannan M. Moudgalya, 'Digital Control', Wiley Publishers, 1st illustrated edition, 2007.*
2. *M.Gopal, 'Digital Control engineering', New Age International (ltd) Publishers,1st edition reprint(2003),1998.*

**Reference books:**

1. *M. Sam Fadalli, 'Digital Control Engineering Analysis And Design', Elsiever publication, 1st edition, 2012.*
2. *Katsuhiko Ogata, 'Discrete Time Control Systems', Pearson Education Publications,2 nd edition, 2005.*

**COURSE OUTCOMES:**

Upon completion of this course, the students can

1. Understand the fundamental differences between continuous time control and digital control.
2. Analyse the advantages of digital control over the continuous time control.
3. Develop digital controllers explicitly compared to continuous time controller.

## EE092 NON-LINEAR CONTROL SYSTEMS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:** The aim of this course is to introduce the concept of non-linear controller design to the undergraduate student.

**Prerequisites:** Linear Electrical Control systems

Open and closed sets, compact set, dense set, Continuity of functions, Lipschitz condition, smooth functions, Vector space, norm of a vector, normed linear space, inner product space.

Mathematical modeling of simple mechanical and electrical systems, concept of equilibrium points, isolated equilibrium points and limit cycles.

Stability analysis of nonlinear systems – Lyapunov stability, asymptotic stability, relative stability, finite-time stability and exponential stability. Lasalles invariance principle

Feedback linearization- dynamic feedback linearization, flatness and back stepping controllers design

Sliding mode controller design, Lyapunov redesign and energy based controller design

**Text Books:**


1. *Khalil H.K., 'Nonlinear Systems', Prentice Hall, 3rd edition, 2001.*
2. *Vidyasagar M., 'Nonlinear System Analysis', Prentice Hall, 2nd edition, 2002.*


**Reference Books:**


1. *J.-J. E. Slotine and W. Li, 'Applied Nonlinear Control', Prentice Hall, Englewood Cliffs, NJ, 1991.*
2. *Zhihua Qu, 'Robust Control of Nonlinear Uncertain Systems', John Wiley & Sons, Interscience Division, New York, NY, 1998.*
3. *A.Isidori, 'Nonlinear Control Systems', Communications and Control Engineering, Springer-Verlag, Third Edition, 1995.*
4. *H. Nijmeijer and A. J. van der Schaft, 'Nonlinear Dynamical Control Systems', Springer-Verlag, New York, 1990.*


**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

1. Understand the concept of non-linear control system
2. Analyze the stability of non-linear system
3. Design non-linear controller for electrical system