# DEPARTMENT OF ELECTRICAL ENGINEERING
## Madan Mohan Malaviya University of Technology, Gorakhpur
## Syllabus for B. Tech.

**Vision:**

**To develop intellectual potentials with excellence in electrical engineering & technology for the global needs.**

**Mission:**

- Empowering students with state-of-art knowledge, technological skills & ethics.
- Provide research environment for sustainable technical growth in the area of power and energy.
- Providing effective solutions for industries through research and consultancy.
- Exposure to standard electrical safety measures and practices.
- Encourage new and non-conventional energy technology for sustainable development and environmental stewardship.

**Programme Educational Objectives (PEO)**

**PEO-1:** To provide technical knowledge in electrical engineering to excel in electrical utility & services.

**PEO-2:** To nurture the students to become successful engineer with administrative acumen to ethically handle the critical situations timely.

**PEO-3:** To prepare and motivate the students for higher education, research and continuous learning in multi-disciplinary areas with innovative ideas for sustainable development.

**Programs Outcomes (POs):**

Students will demonstrate the ability to-

PO-1: Apply the knowledge of mathematics, science and Engineering in all aspects of Electrical Engineering.

PO-2: To formulate the techniques of using appropriate tools to analyze and/or fabricate electrical systems.

PO-3: Design of different parts of electrical machines, drives &power system network.

PO-4: Align with and upgrade to higher learning and research activities.

PO-5: Model real life problems using different hardware and software platforms, both offline and in real-time.

PO-6: Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources.

PO-7: Develop the awareness about non-conventional sources of energy for sustainable development.

PO-8: Promote the good practices of electrical engineering with high ethical values.

PO-9: Work in a team and comprehend his/her scope of work, deliverables and issues in which help is needed by other members of the team.

PO-10: To communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.

PO-11: To be familiar with project management problems and basic financial principles for a multi-disciplinary work such as biomedical instrumentation.

PO-12: A recognition of the need for identifying contemporary issues due to changing technical scenario and an ability to engage in life-long learning to update himself/herself.

**BEE- 01 PRINCIPLES OF ELECTRICAL ENGINEERING**

**Course category** **:** Department Core (DC)
**Pre- requisites** **:** Physics and Math (10+2)
**Contact hours/week** **:** Lecture: 3, Tutorial: 1, Practical:2
**Number of Credits** **:** 5
**Course Assessment Methods** **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One Major Theory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to understand the basic concepts of network and circuit.
2. To solve the basic electrical circuits.
3. Familiarity with the basic concepts of AC circuits.
4. Introductory concept of measurement, instrumentation, working & performances of different kind of measuring instruments (PMMC, MI).
5. Able solve magnetic circuits.
6. Able to analyze three phase circuits.
7. Introduction and application to different electrical machines.

**Topic Covered**

**UNIT I**

**D C Circuit Analysis and Network Theorems:** **9**

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation Kirchhoff's laws; Loop and nodal methods of

analysis; Star-delta transformation Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

**UNIT II**

**Steady- State Analysis of Single Phase AC Circuits: 9**

AC fundamentals: Sinusoidal, square and triangular waveforms – Average and effective values, Form and peak factors, Concept of phasor, phasor representation of sinusoidally varying voltage and current, Analysis of series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit

Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, Three-phase power and its measurement

**UNIT III**

**Measuring Instruments, Magnetic Circuit & 1 phase Transformers: 9**

Types of instruments, Construction and working principles of PMMC and Moving Iron type voltmeters & ammeters, Use of shunts and multipliers.

Magnetic circuit, concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis and eddy current losses.

Single Phase Transformer: Principle of operation, Construction, EMF equation, Power losses, Efficiency, Introduction to auto transformer.

**UNIT IV**

**Electrical Machines: 9**

Concept of electromechanical energy conversion DC machines: Types, EMF equation of generators and torque equation of motor, Characteristics and applications of DC Generators & motors

Three Phase Induction Motor: Types, Principle of operation, Torque-slip characteristics, Applications

Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications.

Three Phase Synchronous Machines: Principle of operation of alternator, emf equation, Principle of operation and starting of synchronous motor, their applications.

**Text Books:**

1."Principles of Electrical Engineering", V. Del Toro,; Prentice Hall International
2."Basic Electrical Engineering", D P Kothari, I.J. Nagarath; Tata McGraw Hill
3."Basic Electrical Engineering", S N Singh; Prentice Hall International
4."Fundamentals of Electrical Engineering" B Dwivedi, A Tripathi; Wiley India
5."Electrical and Electronics Technology", Edward Hughes; Pearson

## PRINCIPLES OF ELECTRICAL ENGINEERING LABORATORY

1. Verification of Kirchhoff's law
2. Verification of Norton's theorem
3. Verification of Thevenin's theorem
4. Verification of Series R-L-C circuit
5. Verification of Parallel R-L-C circuit

6. Measurement of Power and Power factor of three phase inductive load by two wattmeter method
7. To draw the magnetization characteristics of separately excited dc motor.
8. To perform the external load characteristics of dc shunt motor.
9. To perform O.C. and S.C. test of a single phase transformer

## BEE-02 ELECTRICAL CIRCUIT ANALYSIS

**Course category** : Department Core(DC)
**Pre- requisites** : Physics and Math(10+2)
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :2
**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One Major Theory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course .

1. Able to understand the basic concepts of network and circuit.
2. To solve the basic electrical circuits.
3. Familiarity with the basic concepts of AC circuits.
4. Able to analyze the transient behavior of the circuit.
5. Able solve magnetic circuits.
6. Able to analyze three phase circuits.
7. Need of earthing of equipment's with safety issues.

**Topic Covered**

**UNIT-I**

**D C Circuit Analysis and Network Theorems: 9**

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation Kirchhoff's laws; Loop and nodal methods of analysis; Star-delta transformation Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem

**UNIT- II**

**Analysis of Single Phase AC Circuits: 9**

Complex quantities, the operator J, Representation of vectors, forms of expression of complex quantities, complex expression of voltage , current and impedance, addition and subtraction of Steady State , AC fundamentals, Sinusoidal, square and triangular waveforms, Average and effective values, Form and peak factors, Concept of phasors, phasor representation of sinusoidally varying voltage and current, Analysis of series, parallel and series parallel RLC Circuits,Resonance in series and parallel circuits, bandwidth and quality factor; Apparent, active & reactive powers, Power factor, Causes and problems of low power factor, Concept of power factor improvement.

**UNIT- III**

**Transient State Analysis: 9**

Transient response of series RL circuit with alternating voltage source, Transient Response Analysis of series RC circuit, Transient Response Analysis of series RLC circuit.
Non sinusoidal waves: generation of non- sinusoidal waves, Fourier analysis, constants in Fourier series, Effective values of complex wave, power and power factor.
Need of Earthing of equipment and devices, important electrical safety issues

**UNIT-IV**
**Three Phase AC Circuits**: **9**
Three phase system its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, Three phase power.
**Magnetic Circuit:** Magnetic circuit concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis and eddy current losses, Mutual coupling with dot convention, Magnetic circuit calculations,Mutual inductance coupling coefficient.

**REFERENCES:**

1. K. S. Suresh Kumar :Electrical Circuit Analysis . Pearson, 2013
2. Lawrence P. Huelsman 'Basic Circuit Theory", 3rd ed. PHI
3. T.K. Nagsakar& M.S. Sukhija ' Basic Electrical Engg'., OXFORD, 2nd ed
4. SamarjitGhosh, 'Network Theory: Analysis and Synthesis' PHI


## ELECTRICAL CIRCUIT ANALYSIS LABORATORY

**List of Experiments**
1. Verification of Kirchhoff's law
2. Verification of Norton's theorem
3. Verification of Thevenin's theorem
4. Verification of Superposition theorem
5. Verification of Series R-L-C circuit
6. Verification of Parallel R-L-C circuit
7. Study of R-L-C series resonant circuit
8. Study of R-L-C Parallel resonant circuit

## BEE -11 BASIC SYSTEM ANALYSIS

**Course category** **:** Department Core (DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** **:** Lecture: 3, Tutorial: 1,Practical :0
**Number of Credits** **:** 4
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing

this course

1. Analyze as well as synthesize Continuous and discrete signals.
2. Classify and identify different signals
3. Familiarity with continuous and discrete models and their representation.
4. Acquire the knowledge of analogous electrical systems of different non- electrical systems.
5. Application of Laplace, Z and Fourier Transform
6. Modeling through State variable analysis

**Topic Covered**

**UNIT I**

**Introduction to continuous time signals and systems: 9**

Basic continuous time signals, unit step, unit ramp, unit impulse and periodic signals with their mathematical representation and characteristics. Introduction to various types of systems.

**Analogous System:**

Linear mechanical elements, force-voltage and force-current analogy, modeling of mechanical and electro-mechanical systems: Analysis of first and second order linear systems by classical method.

**UNITII**

**Fourier Transform Analysis: 9**

Exponential form and Trigonometric form of Fourier series, Fourier symmetry, Fourier Integral and Fourier Transform. Transform of common functions and periodic wave forms: Applications of Fourier Transform to network analysis.

**Laplace Transform Analysis :**

Review of Laplace Transform , Laplace Transform of periodic functions, Initial and Final Value Theorems, Inverse Laplace Transform , Convolution Theorem, Superposition Integral , Application of Laplace Transform to analysis of networks, waveform synthesis and Laplace Transform of complex waveforms

**UNIT III**

**State Variable Analysis: 9**

Introduction, State Space representation of linear systems, Transfer Function and state Variables , State Transition Matrix, Solution of state equations for homogeneous and non-homogeneous systems , Applications of State-Variable technique to the analysis of linear systems.

**UNIT IV**

**Z-Transform Analysis : 9**

Concept of Z-Transform, Z-Transform of common functions, Inverse ZTransform, Initial and Final Value theorems , Applications to solution of difference equations, Pulse Transfer Function

**Text Books:**

1. David K.Cheng; “Analysis of Linear System”, Narosa Publishing Co.
2. ME Van-Valkenberg; “ Network Analysis”, Prentice Hall of India
3. C.L.Wadhwa, “Network Analysis and Synthesis”, New Age International Publishers,2007.

4. SamarajitGhosh, “Network Theory: Analysis and Synthesis” Prentice Hall of India, 2008

**Reference Books:**

5. ChoudharyD.Roy, “Network & Systems”, Wiley Eastern Ltd.
6. Donald E.Scott, “Introduction to circuit Analysis” Mc. Graw Hill
7. B.P. Lathi, “Linear Systems & Signals” Oxford University Press, 2008.
8. I.J. Nagrath, S.N. Saran, R. Ranjan and S.Kumar, “Singnals and Systems, “Tata Mc. Graw Hill, 2001.
9. Taan S. Elali&Mohd. A. Karim, “Continuous Signals and Systems with MATLAB” 2nd Edition,CRCPress.

## BEE- 12 ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS

**Course category** **:** Department Core (DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** : Lecture: 3, Tutorial: 1,Practical: 2
**Number of Credits** **:** 5
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Basic concept of measurement, instrumentation, working & performances of different kind of measuring instruments
2. Ability to analyze performance characteristics of measuring instruments.
3. Ability to know, working principle & Performances of AC Bridges.
4. Ability to understand construction, principle of operation, working and applications of waveform analyzers and spectrum analyzers.
5. Ability to understand construction, principle of operation, working and applications of harmonic distortion analyzers.
6. Ability to understand construction, principle of operation, working and measurements of Cathode Ray Oscilloscope (CRO).

**Topic Covered**

**UNIT-I**

**Fundamentals of Measurement Systems** **9**

Philosophy of measurement,methods of measurements,classification of measurement system,functional elements of measurement, units, dimensions & standards, static performance characteristics, errors analysis, loading effect of instrument, uncertainty in compound quantity, histogram, deviation, dispersion, standard deviations, variance, Gaussian's distribution curve analysis.

**UNIT II**

**Analog Measurement of Electrical Quantities** **9**

Types of measuring instruments, secondary instruments, essentials components of instruments, design of sprigs, pivot & jewels, Ammeters & Voltmeters; moving coil, moving iron, electrodynamic, electrostatic, rectifier & thermocouple type, Measurement of power,

wattmeter, Measurement of energy, induction type energy meter, errors & remedies in wattmeter and energy meter, frequency meters.

**UNIT III**

**Instrument Transformers & A.C. Bridges 9**

Instrument Transformer (CT &PT) and their applications in the extension of instrument range, Different methods of measuring low, medium and high resistances**,** measurement of inductance & capacitance with the help of AC Bridges.

**UNIT IV**

**Magnetic Measurement & Digital Measurement of Electrical Quantities 9**

Flux meter**,** determination of hysteresis loop, measurement of iron losses**.** Concept of digital measurement, block diagram study of digital voltmeters (DVM), Spectrum analyzers, Wave Analyzer and Harmonics distortion analyzer; Basic CRO circuit (Block Diagram), Cathode ray tube (CRT) & its components **,** application of CRO in measurement, Lissajous Pattern.

**Text Books:**

1. E.W. Golding & F.C. Widdis, "Electrical Measurement &Measuring Instrument", A.W. Wheeler& Co. Pvt. Ltd. India.
2. A.K. Sawhney, "Electrical & Electronic Measurement & Instrument", DhanpatRai& Sons India .

**Reference Books:**

3. E.O. Decblin, "Measurement System – Application & design", McGraw Hill.
4.Forest K. Harries,"ElectricalMeasurement",Willey Eastern Pvt. Ltd. India .
5. M.B. Stout ,"Basic Electrical Measurement" Prentice hall of India,India.
6. W.D.Cooper," Electronic Instrument & Measurement Technique " Prentice Hall International.
7. B.C. Nakra&K.Chaudhry, "Instrumentation, Measurement and Analysis", Tata McGraw Hill
2nd Edition.
8. J.B. Gupta, "Electrical Measurements and Measuring Instruments", S.K. Kataria& Sons

## ELECTRICAL MEASUREMENT LAB

**List of Experiments**

1. Calibration of ac voltmeter and ac ammeter.
2. Calibration of single of induction type energy meter with the help of wattmeter.
3. Extension of range instruments using CT & PT.
4. Determination of iron loss using Lloyd Fisher's square method.
5. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
6. Measurement of power and power factor of a load using three voltmeter method.
7. Measurement of low resistance by Kelvin's double bridge.
8. Study of Maxwell's inductance bridge.
9. Study of Schering bridge.
10. Study of Hay's bridge.

11. Study of Anderson's bridge.
12. Study of Owen's bridge.

**BEE – 13 ELECTRO-MECHANICAL ENERGY CONVERSION –I**

**Course category** : Department Core (DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** **:** Lecture: 3, Tutorial: 1,Practical: 2
**Number of Credits** : 5
**Course Assessment methods** **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to learn basic concept of design, working & performances of DC Machines (Generator & Motor).
2. Ability to solve theoretical & numerical problems related with DC Machines (Generator & Motor).
3. Ability to know constructional details, working principle & Performances of Single Phase & 3 phase transformer.
4. Ability to understand electro-mechanical energy conversion process of rotating electrical machines in singly exited & doubly excited magnetic system.

**Topic Covered**
**UNIT -I**
**Principles of Electro-mechanical Energy Conversion – 9**
Introduction, Flow of Energy in Electromechanical Devices, Energy in magnetic systems, singly Excited Systems; Doubly excited Systems; derivation of mechanical force, mechanical energy and torque in magnetic field system, generated EMF in electrical machines

**UNIT II**
**D.C. Machines-I- 9**
Construction of DC Machines, parts of dc machine, armature winding, types of dc generators, Emf and torque equation ,Armature Reaction, Commutation process, Inter pole and Compensating Windings, Performance Characteristics of D.C. generators under no load and loaded conditions.

**UNITIII**
**D.C. Machine-II 9**
DC motors, operating characteristics of D.C. motors ,back EMF and torque equation, necessity of starters , types of starter, Speed control of D.C. motors, Field Control , armature control and voltage control , losses, Efficiency and various Testing on D.C motors.

**UNITIV**
**Transformer: 9**

Construction& working of single phase transformer, types of transformer, equivalent circuit models, efficiency, voltage regulation, various testing methods, Single phase auto transformers, efficiency, merits & demerits and applications of auto transformer. Construction & various connection diagrams of three phase transformers, phasor groups, parallel operation of three phase transformers, harmonics in transformers, three winding transformers.

**Text Books:**

1 I.J. Nagrath&D.P.Kothari," Electrical Machines", Tata McGraw Hill
2 Ashfaq Husain," Electrical Machines", DhanpatRai& Sons
3U.A Bakshi and M.V Bakshi, "Electromechanical Energy Conversion-I", Technical Publication Pune ,
4 B.R. Gupta &VandanaSinghal, "Fundamentals of Electrical Machines, New International.

**Reference Books:**

1. Irving L.Kosow, "Electric Machine and Tranformers", Prentice Hall of India.
2. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
3. P.S.Bimbhra, "Electrical Machinery", Khanna Publisher

## ELECTROMECHANICAL ENERGY CONVERSION- I LAB

**List of Experiments**

**Note: Minimum eight experiments are to be performed from the following list:**

1. To obtain magnetization characteristics of a d.c. shunt generator
2. To obtain load characteristics of a d.c. shunt generator.
3. To obtain efficiency of a dc shunt machine using Swinburn's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine
5. To obtain speed-torque characteristics of a dc shunt motor and series motor.
6. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control
7. To obtain speed control of dc separately excited motor using Ward-Leonard.
8. To study polarity and ratio test of single phase and 3-phase transformers
9. To obtain equivalent circuit, efficiency and voltage regulation of a single transformer using open circuit and short Circuit test.
10. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
11. Study of 3-phase to 2-phase conversion by Scott connection.

## BEE -14 NETWORK ANALYSIS AND SYNTHESIS

**Course category** : Department Core (DC)
**Pre- requisites** : Electrical Circuits and Analysis
**Contact hours/week** : Lecture: 3, Tutorial: 1,Practical: 2
**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing

this course

1. Able to solve the circuits through graph theory.
2. Able to understand the concept of transfer function & time response analysis.
3. Able to analyze a two port network.
4. Able to synthesis a network.
5. Able to understand the basic concepts of filter.

**UNITI**

**Introduction to Graph Theory: 9**

Graph of a Network, definitions, tree, co tree , link, basic loop and basic cut set, Incidence matrix, cut set matrix, Tie set matrix Duality, Loop and Nodal methods of analysis.

**UNITII:**

**Network Functions: 9**

Concept of Complex frequency , Transform Impedances Network functions of one port and two port networks, concept of poles and zeros, properties of driving point and transfer functions, time response and stability from pole zero plot.

**UNIT III**

**Two Port Networks**: **9**

Characterization of LTI two port networks ZY, ABCD and h parameters, reciprocity and symmetry. Inter-relationships between the parameters, inter-connections of two port networks, Ladder and Lattice networks& Π Representation.

**UNIT IV**

**Network Synthesis: 9**

Positive real function; definition and properties; properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point immittance functions using Foster and Cauer first and second forms.

**Filters:**

Image parameters and characteristics impedance, passive and active filter fundamentals, low pass, high-pass, (constant K type) filters, and introduction to active filters.

**Text Books:**


1. M.E. Van Valkenburg, “Network Analysis”, Prentice Hall of India
2. A.Chakrabarti, “Circuit Theory” DhanpatRai& Co.
3. C.L Wadhwa, “Network Analysis and Synthesis” New Age International Publishers, 2007.
4. D.RoyChoudhary, “Networks and Systems” Wiley Eastern Ltd.
5. Donald E. Scott: “An Introduction to Circuit analysis: A System Approach” McGraw Hill


**Reference Books:**


6. M.E. Van Valkenburg, “An Introduction to Modern Network Synthesis”, Wiley Eastern Ltd.
7. N.C. Jagan and C. Lakshminarayana, “Network Analysis” B.S. Publications, 2008.
8. K.S. Suresh Kumar, “Electric Circuits and Networks” Pearson Education, 2009.
9. A Ramakalyan, “Linear Circuits: Analysis and Synthesis” Oxford University Press, 2005.

## NETWORK ANALYSIS LAB

**List of Experiments:**

1. Verification of Superposition Theorem.
2. Verification of Thevenin's Theorem.
3. Verification of Norton's theorem.
4. Verification of Maximum power transfer theorem.
5. Verification of Reciprocity Theorem.
6. Star Delta Transformation
7. Power Factor Improvement
8. To plot frequency response of a series resonant circuit.
9. To plot frequency response of a parallel resonant circuit.
10. To measure input impedance and output impedance of a given two port network.
11. To design a Π attenuator which attenuate given signal to the desired level.

## BEE -15 INTRODUCTION TO MICROPROCESSORS

**Course category** : Department Core (DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** **:** Lecture: 3, Tutorial: 1,Practical: 2
**Number of Credits** **:** 5
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Acquire the introductory knowledge of Digital Computer, microprocessor internal architecture and microprocessor development system.
2.Student gains knowledge on Intel 8085 microprocessor detailed internal architecture along with its assembly language programming.
3.Student gains knowledge on Intel 8086 microprocessor detailed internal architecture, instruction set and interrupts.
4.Student gains knowledge on DMA controller, programmed I/O, interrupt controller and programmable timer/counter interface of Intel's 8-bit and 16-bit microprocessors.
5.With the above knowledge the students will be able to understand advanced microprocessors and microcontroller systems

**Topic Covered**

**UNIT I**

**Introduction to Digital Computer and Microprocessor: 9**

**Digital Computers:** General architecture and brief description of elements, instruction execution, instruction format, and instruction set, addressing modes, programming system, higher lever languages.

**Buses and CPU Timings:** Bus size and signals, machine cycle timing diagram, instruction timing, processor timing.

**Microprocessor and Microprocessor Development Systems:** Evolution of Microprocessor, Microprocessor architecture and its operations, memory, inputs-outputs (I/Os), data transfer

schemes interfacing devices, architecture advancements of microprocessors, typical microprocessor development system.

**UNIT II**

**8-bit Microprocessors: 9**

**8085 microprocessor:** pin configuration, internal architecture. Timing & Signals: control and status, interrupt: ALU, machine cycles,

**Addressing Modes:** Register addressing, direct addressing; register indirect addressing, immediate addressing, and implicit addressing.

Instruction format, op-codes, mnemonics, no. of bytes, RTL, variants, no. of machine cycles and T states, addressing modes.

**Instruction Classification:** Data transfer, arithmetic operations, logical operations, branchingoperation, machine control; Writing assembly Language programs, Assembler directives.

**UNIT III**

**16-bit Microprocessors: 9**

**Architecture:** Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes.

**Instruction Set of 8086**

Addressing Modes**:** Instruction format: Discussion on instruction Set: Groups: data transfer, arithmetic , logic string, branch control transfer, processor control.

**Interrupts:** Hardware and software interrupts, responses and types.

**UNIT IV**

**Peripheral Interfacing: 9**

I/O programming: Programmed I/O, Interrupt Driven I/O, DMA I/O interface: serial and parallel communication, memory I/O mapped I/Os. Peripheral Devices: 8237 DMA controller, 8255- Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259 programmable Interrupt Controller.

**Text Books:**

1. Gaonkar, Ramesh S, “Microprocessor Architecture, programming and applications with the 8085” Pen ram International Publishing 5th Ed.
2. Uffenbeck, John, “Microcomputers and Microprocessors” PHI/ 3rd Edition.
3. Ray, A.K. &Burchandi, K.M., “Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing” Tata Mc. Graw Hill.
4. Krishna Kant, “Microprocessors and Microcontrollers” PHI Learning.

**Reference Books:**

5. Brey, Barry B. “INTEL Microprocessors” Prentice Hall (India)
6. Aditya P. Mathur, “Introduction to Microprocessor” Tata McGraw Hill
7. M. Rafiquzzaman, “Microprocessors- Theory and applications” PHI
8. B. Ram, “Advanced Microprocessor & Interfacing” Tata McGraw Hill
9. Renu Singh &B.P.Singh, “Microprocessor and Interfacing and applications” New Age International
10. Hall D.V., “Microprocessors Interfacing” Tata McGraw Hill
11. Liu and Gibson G.A., “Microcomputer Systems: The 8086/8088 Family” Prentice Hall (India)

## MICROPROCESSORS LAB

**List of Experiments:**

1.To become familiar with 8085 microprocessor training kit and execute following programs on microprocessor kit.

- Add two 8 bit numbers stored in register B & C store result in register D.
- Subtract 8 bit data stored at memory location 4021h from data stored at memory location 4020h. Store result at memory location 4022h.
- To perform OR operation between accumulator and register B. Store result in register C.

2. To become familiar with 8085 microprocessor simulator and simulate following programs using simulator

- Write a program to interchange content of register B and C
- Subtract content of register E from register B.
- Complement content of accumulator and display result on output port PORT2.
- Perform logical OR operation between register B and C, logical AND operation between accumulator and register B.

3. Write a program to transfer set of data from memory location 2050-205Fh to 2060-206Fh

4. Write a program to find smallest number from given set of data stored at location 2040h to 205Fh

5. Write a program to find negative numbers in given set of data stored at the location 2050h to 205Fh

6. Write program to arrange an array of data in ascending order

7. Write a program to multiply two 8 bit numbers stored at the location 2100 and 2101. Store result at memory location 2102h

8. Write program to divide 16 bit number stored at memory location 2100h and 2101h by 8 bit number stored at memory location 2102h. Store quotient in memory locations 2110h and 2111h, remainder at memory location 2112h.

9. Write a program to separate out (unpack) two digit BCD number and pack (combine) two digit BCD number into one.

10. Write a program to convert hexadecimal number into equivalent BCD number

11. Write a program to check parity of data stored at memory location 2100. Move content EEh to register B, if parity is even and 00h if parity is Odd.

12. Write and execute program to display count value 0 to 9 onthe seven segment display using standard subroutine for display output.

13. Write program to use vector interrupt (VI) RST 7.5 to switch from up counter to down counter.

14. Write program to flash message "EC LAB" on address and data field of display.

15. To interface Programmable peripheral interface (PPI) IC-8255 with 8085 Microprocessor in Mode 0.

16. To generate square wave on port pin PC7 of 8255 in BSR mode.

## BEE- 16 ELECTROMECHANICAL ENRGY CONVERSION

**Course category** : Department Core (DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** **:** Lecture: 3, Tutorial :1 , Practical :2

**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts DC machines with numerical calculation.
2. The concept of Transformer with numerical calculation.
3. The concept of Synchronous machine & IM with numerical calculation.

**Topic Covered**

**UNIT I**

**DC Machines: 9**

Construction of DC Machines, Armature winding, EMF and torque equation, Armature Reaction,Commutation, Interpoles and Compensating Windings, Performance Characteristics of D.C. generators, Performance Characteristics of D.C. motors,Starting of D.C. motors ; 3point and 4 point starters, Speed control of D.C. motors: Field Control , armature control and Voltage Control (Ward Lenonard method); Efficiency and Testing of D.C. machines (Hopkinson's and Swinburn's Test).

**UNIT II**

**Transformers: 9**

Principle of operation, Construction, Phasor diagram, efficiency and voltage regulation of 1-phase transformer, O.C. and S.C. tests, Sumpner's test, polarity test. Single phase and three phase auto transformers, volt-amp, relation, efficiency, merits & demerits and applications, three phase to 2 phase, 6 phase or 12 phase connections, and their applications.

**UNIT III**

**Induction Motors: 9**

Constructional features of 3-phase induction motor, Rotating magnetic field, Principle of operation, Phasor diagram, equivalent circuit, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, efficiency, Starting, Speed Control (with and without EMF injection in rotor circuit.) Constructional features and working of 1-phase induction motor, Double revolving field theory, Equivalent circuit, No load and blocked rotor tests, starting methods.

**UNIT IV**

**Synchoronous Machines: 9**

Constructional features and working of 3-phase Alternator, Armature winding, EMF Equation, Winding coefficients, equivalent circuit and phasor diagram, Armature reaction, O. C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier's Triangle Method, Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating Characteristics, Starting methods of 3-phase synchronous motor, Effect of varying field current at different loads, V- Curves.

**Text Books:**


1. I.J. Nagrath&D.P.Kothari," Electrical Machines", Tata McGraw Hill
2. Husain Ashfaq ," Electrical Machines", DhanpatRai& Sons
3. A.E. Fitggerald, C.KingsleyJr and Umans,"Electric Machinery" 6th Edition McGraw Hill, International Student Edition.
4. B.R. Gupta &VandanaSinghal, "Fundamentals of Electrical Machines, New Age International.
5. Irving L. Kosow, "Electric Machine and Tranformers", Prentice Hall of India.
6. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
7. Bhag S. Guru and Huseyin R. Hizirogulu, "Electric Machinery and Transformers" Oxford University Press, 2001.
8. P.S.Bimbhra, "Electrical Machinery", Khanna Publisher
9. P.S. Bimbhra, " Generalized Theory of Electrical Machines", Khanna Publishers


## ELECTROMECHANICAL ENERGY CONVERSION LAB

**Note: Minimum eight experiments are to be performed from the following list:**

1. To obtain magnetization characteristics of a d.c. shunt generator
2. To obtain load characteristics of a d.c. shunt generator
3. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control.
4. Determine V-curves and inverted V-curves of a three phase synchronous motor.
5. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
6. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test
7. To study polarity and ratio test of single phase and 3-phase transformers
8. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.
1. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
2. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by Synchronous Method

   Determine V-curves and inverted V-curves of a three phase synchronous motor

## BEE - 20 SIMULATION TECHNIQUES

**Course category** : Department Core(DC)
**Pre- requisites** **:** Physics and Math(10+2)
**Contact hours/week** **:** Lecture : 0, Tutorial :0 , Practical :4
**Number of Credits** **:** 2
**Course Assessment methods** : Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Student gains knowledge on MATALAB desktop and its basic functions.
2. Acquire the knowledge of application of numerical technique in MATALAB functions.
3. Students develop the MATALAB programming skill.
4. With the above knowledge/skill students will be able to solve simultaneous linear equations, differential equations etc., applied in the electrical circuit solutions.
5. Learning of MATALAB Toolboxes helps the students able to develop and verify the concepts of various complex electrical engineering problems**.**

Note: Minimum seven experiments out of the following list:

**MATLAB Based Experiments**

1. Solution of linear equations for under damped and over damped cases.
2. Determination of eigen values and eigenvectors of a square matrix.
3. Determination of roots of a polynomial.
4. Determination of polynomial using method of least square curve fitting.
5. Determination of polynomial fit, analyzing residuals, exponential fit and error bounds from thegiven data.
6. Solution of differential equations using 4th order Runge-Kutta method.
7. Solution of differential equation using revised Euler method.
8. Solution of difference equations.
9. Determination of time response of an R-L-C circuit.
10. College may add any three experiments in the above list.

**Text/Reference Books:**

**1.** AlmosGilat, "MATLAB: An Introduction with Applications" Wiley India Ltd., 2004.
**2.** R.P. Singh, "Getting Started with MATLAB" Oxford University Press.

## BEE -26 ELECTRO-MECHANICAL ENERGY CONVERSION – II

**Course category** : Department Core(DC)
**Pre- requisites** **:** Electromechanical Energy Conversion-I
**Contact hours/week** **:** Lecture : 3, Tutorial :1 , Practical :2
**Number of Credits** **:** 5
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to learn basic concept of design, working & performances of three phase AC Machines (Generator & Motor).
2. Ability to solve theoretical & numerical problems related with three phase AC Machines (Generator & Motor).
3. Ability to know constructional details, working principle & Performances of Single Phase AC Machines

4. Ability to understand working, characteristics & applications of Special Electrical Machines(Universal Motor, AC series motor, Hysteresis Motor, Reluctance Motor)

**Topic Covered**

**UNIT-I**

**Synchronous Machine I: 9**

Constructional features, types and working of AC generator, EMF Equation, Armature reaction, O. C. & S. C. tests, Voltage Regulation and calculations of voltage regulation by different methods, Parallel Operation of synchronous generators, synchronization of ac generators, synchronizing power, concept of $X_d$, and $X_q$.

**UNIT-II**

**Synchronous Machine II: 9**

Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating Characteristics, Synchronous Motor**,** power flow and torque equation, Effect of varying field current at different loads, V- Curves, Hunting, damper windings, synchronous condenser, and application of synchronous motor

**UNIT-III**

**Three phase Induction Machine: 9**

Constructional features, Rotating magnetic field, working principle, Phasor diagrams, equivalent circuits, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, losses, efficiency, Starting methods, various speed control techniques, Deep bar and double cage type rotors, Cogging & Crawling effects, Induction generator, applications.

**UNIT-IV**

**Single phase Induction Motor: 9**

Double revolving field theory, Equivalent circuits, No load and blocked rotor tests, Starting methods, types of single phase induction motors, Repulsion motor, Universal motor, A.C. series motor, hysteresis motor

**Text Books:**

1. D.P.Kothari&I.J.Nagrath, "Electric Machines", Tata McGraw Hill
2. AshfaqHussain"Electric Machines" DhanpatRai& Company
3. Fitzerald,A.E.,Kingsley and S.D.Umans"Electric Machinery", MC Graw Hill.

**Reference Books:**

4. P.S.Bimbhra, "Electrical Machinery", Khanna Publisher
5. P.S. Bimbhra, " Generalized Theory of Electrical Machines", Khanna Publishers
6**.** M.G.Say, "Alternating Current Machines",Pitman& Sons

## ELECTRO-MECHANICAL ENERGY CONVERSION – II LAB

**Note: The minimum 8 experiments are to be performed from the following list:**

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.

2. To perform load test on a three phase induction motor and draw: Torque -speed characteristics
3. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit parameters and efficiency.
6. To study of speed control of three phase induction motor by (i) pole changing (ii) Supply voltage and (iii) frequency control method
7. To study speed control of three phase slip ring induction motor by rotor emf injected method .
8. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging by (i) Synchronous Impedance method and (ii) MMF method.
9. To perform V-curves and inverted V-curves of a three phase synchronous motor.
10. To determine $X_d$and$X_q$ of a three phase salient pole synchronous machine using the slip test and draw the power-angle characteristics.
11. To study synchronization of an alternator with the infinite bus by using: dark lamp method (ii) twobright and one dark lamp method.
13. To study speed-torque characteristics of three phase slip ring induction motor and effects ofadditional resistance, or capacitance in the rotor circuit.
14. To study VSI based slip power recovery scheme of three phase induction motor
15. To study performances of three phase Induction Generator.

**BEE- 27 POWER SYSTEM-1**

**Course category** **:** Department Core(DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** **:** Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** **:** 4
**Course Assessment** **:** Continuous assessment through tutorials, assignments**,**
**methods**Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing
this course
The student will be able to demonstrate:
1. Basic Layout of power system.
2. The concept of supply system
3. The analysis of O/H Transmission lines
4. The understanding of EHVAC & HVDC Transmission lines.
5. The Corona, insulator, neutral grounding & mechanical design of Transmission line.

**Topic Covered**
**UNIT I**
**Power System Components:** **9**
Single line Diagram of Power system, Brief description of power system Elements: Synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator
**Supply System:**
Different kinds of supply system and their comparison, choice of transmission voltage
**Transmission Lines:**

Configurations, types of conductors, resistance of line, skin effect, Kelvin's law.Proximity effect

**UNIT II**

**Over Head Transmission Lines: 9**

Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines, Representation and performance of short, medium and long transmission lines, Ferranti effect. Surge impedance loading

**EHV AC and HVDC Transmission:**

Introduction to EHV AC and HVDC transmission and their comparison, use of bundle conductors, kinds of DC links, and incorporation of HVDC into AC system

**UNITIII**

**Corona and Interference: 9**

Phenomenon of corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona and interference. Electrostatic and electromagnetic interference with communication lines

**Overhead line Insulators:**

Type of insulators and their applications, potential distribution over a string of insulators, methods of equalizing the potential, string efficiency

**Insulated cables:**

Type of cables and their construction, dielectric stress, grading of cables, insulation resistance, capacitance of single phase and three phase cables, dielectric loss, heating of cables

**UNITIV**

**Mechanical Design of transmission line: 9**

Catenary curve, calculation of sag & tension, effects of wind and ice loading, sag template, vibration, Dampers

**Electrical Design of Transmission Line:**

Design consideration of EHV transmission lines, choice of voltage, number of circuits, conductor configuration, insulation design, selection of ground wires.

**Neutral grounding:**

Necessity of neutral grounding, various methods of neutral grounding, earthing transformer, grounding practices

**Text Books**

1.W. D. Stevenson, "Element of Power System Analysis", McGraw Hill,
2.C. L. Wadhwa, "Electrical Power Systems" New age international Ltd. Third Edition
3.AsfaqHussain, ""Power System", CBS Publishers and Distributors,
4.B. R. Gupta, "Power System Analysis and Design" Third Edition, S. Chand & Co.
5.M. V. Deshpande, "Electrical Power System Design" Tata McGraw Hill.

**Reference Books**

6.M. V. Deshpandey, “Elements of Power System Design”, Tata McGraw Hill,
7.Soni, Gupta &Bhatnagar, “A Course in Electrical Power”, DhanpatRai& Sons,
8.S. L. Uppal, “Electric Power”, Khanna Publishers
9. S.N. Singh, “Electric Power Generation, Transmission& distribution.” PHI Learning

**BEE-28CONTROL SYSTEM ENGINEERING**

**Course category** **:** Department Core(DC)
**Pre- requisites** **:** Electrical Circuits and Analysis
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :2
**Number of Credits** **:** 5
**Course Assessment methods** **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

The student will be able to demonstrate:

1. Basic Block diagram of control system.
2. The control system components.
3. The analysis of time response.
4. The analysis of frequency response.
5. The Compensator design.

**Topic Covered**

**UNITI**

**Control System Introduction and Mathematical Modelling: 9**

Open loop & closed control; servomechanism; Mathematical modelling of physical systems; Transfer functions, Block diagram algebra, Signal flow graph, Mason’s gain formula, Reduction of parameter variation and effects of disturbance by using negative feedback.

**UNITII**

**Control System Components: 9**

Constructional and working principles of AC & DC servomotors, stepper motor, and synchros, error detectors.Basic control actions: proportional (P), integral (I), derivative (D), and PID controllers.

Concept of Stability: Stability concepts, algebraic criteria, and necessary conditions, Routh-Hurwitz criteria and limitations.

**UNITIII**

**Time Response analysis: 9**

Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants.

Design specifications of second order systems: Derivative error, derivative output, integral error and PID compensations, design considerations for higher order systems, performance indices.Root Locus Technique: The root locus concepts, construction of root loci.

**UNIT-IV**

**Frequency response Analysis: 9**

Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots.

Stability in Frequency Domain: Nyquist stability criterion, assessment of relative stability, gain margin and phase margin, constant M&N circles

**References:**


1. I. J. Nagrath and M. Gopal, "Control System Engineering", 4th Edition, New age International.
2. M. Gopal, "Control Systems: Principles and Design", Tata McGraw-Hill Education, 2002.
3. K. Ogata, "Modern Control Engineering", Pearson Education, 4th Indian reprint.
4. B.C. Kuo and FaridGolnaraghi, "Automatic Control System" Wiley India Ltd, 2008.
5. D.RoyChoudhary, "Modern Control Engineering", Prentice Hall of India.
6. Ajit K. Mandal, "Introduction to Control Engineering" New Age International, 2006.


## CONTROL SYSTEM LABORATORY

**List of Experiments**

3. Study Metaldyne cross-field generator. Determine its transfer function.
4. Determine transfer function of dc generator.Study behavior of dc generator in open loop and closed loop conditions at various loads.
5. Determine transfer function of dc motor. Study behavior of dc motor in open loop and closed loop conditions at various loads.
6. Study DC position control system and determine speed-torque characteristics of ac servomotor.
7. Study AC position control system and determine speed-torque characteristics of ac servomotor.
8. Study PID control using linear simulator unit and determine step input response of first order and second order systems.
9. Study synchros. Determine synchros-transmitter characteristics. Configure synchro-transmitter and synchro-control transformer unit as error detector and obtain output vs input characteristics.
10. Study stepper motor from its characteristics and applications point of view.

**BEE-29INSTRUMENTATION AND PROCESS CONTROL**

**Course category** : Department Core(DC)
**Pre- requisites** : Control System Engineering
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :2
**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Basic concept of instrumentation and its industrial application and working & performances of different kind of measuring instruments.
2. Ability to analyze performance characteristics of measuring instruments.
3. Ability to know, working principle & Performances of different electrical transducers.
4. Ability to understand construction, principle of operation, working and applications of waveform analyzers and spectrum analyzers, CRO and other display devices.
5. Ability to understand principle of operation of telemetry system and data acquisition system.
6. Ability to understand principle of operation of process control system and its various elements

**UNITI**

**Fundamentals of Transducers 9**

Generalized input-output configuration of instrumentation, Dynamic performance characteristics of instruments, order of systems (zero, first, seconds order systems), Transfer functions, Advantages of electrical transducers, definition, description, classification, characteristics, factors affecting the choice of transducers, Sensors & pick-ups.

**UNITII**

**Transducers for Measurement of Non-Electrical Quantities 9**

Introduction to resistive, inductive & capacitive transducers. Transducers for measurement of displacement, velocity, acceleration, force, pressure, temperature, humidity, moisture, flow and liquid level monitoring & control. Piezoelectric, Piezoresitive, Photo voltaic, Hall effect, fiber optic and opto- electronic transducers,

**UNITIII**

**Telemetry, Data Acquisition System, Recorders & Display Devices 9**

General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter, TDM &, FDM.Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system. Display devices, storage oscilloscope, Strip chart & X-Y recorders, magnetic tape & digital tape recorders.

**UNIT-IV**

**Process Control 9**

Principle, elements of process control system, process characteristics, ON-OFF controller, proportional (P), integral (I), Derivative (D), PI, PD and PID control modes.Electronic, Pneumatic & digital controllers.Role of computer instrumentation and process control.

**Text Books:**

1. A.K.Sawhney, "Advanced Measurements & Instrumentation", DhanpatRai& Sons
2. B.C. Nakra&K.Chaudhry, "Instrumentation, Measurement and Analysis", Tata McGraw Hill
2nd Edition.
3. Curtis Johns, "Process Control Instrumentation Technology", Prentice Hall

**Reference Books:**

4. E.O. Decblin, "Measurement System – Application & design", McGraw Hill.
5. W.D. Cooper and A.P. Beltried, "Electronics Instrumentation and Measurement Techniques"
Prentice Hall International
6. RajendraPrasad,"Electronic Measurement and Instrumentation Khanna Publisher

7. M.M.S. Anand, "Electronic Instruments and Instrumentation Technology" PHI Learning.

## ELECTRICAL INSTRUMENTATION LAB

**List of Experiments**

1. Measurement of displacement using LVDT.
2. Measurement of displacement using strain gauge based displacement transducer.
3. Measurement of displacement using LDR.
4. Measurement of speed of motor using magnetic pickup &photoelectric pickup.
5. Measurement of speed of motor using stroboscope.
6. Measurement of load using strain gauge based load cell.
7. Measurement of temperature by RTD.
8. Measurement of temperature by thermocouple.
9. Measurement of weight of unknown sample using inductive transducers.
10. Study of P, PI and PID controllers.
11. Study of storage oscilloscope and determination of transient response of RLC circuit.
12. Study of signal conditioning circuit for any transducer
13. Study of data acquisition system using "**Lab View**" software and test all signal points
14. Measurement of sine, triangular, square wave signal of function generator and verify its frequency at 100 Hz tap point using "**Lab View**" software.

## BEE-31 POWER SYSTEM-II

**Course category** **:** Department Core (DC)
**Pre- requisites** : Power System- I
**Contact hours/week** : Lecture: 3, Tutorial: 1 , Practical :2
**Number of Credits** : 5
**Course Assessment methods** **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

The student will be able to demonstrate:

1. The L and C expressions for various configurations and analyze different types of Transmission lines
2. The Traveling wave theory and derive expressions for reflection and refraction coefficients with various terminations of the lines
3. The analysis symmetrical as well as unsymmetrical faults.
4. Load flow analysis.
5. The concept of Power system stability

**Topic Covered**

**UNIT-I**

**Representation of Power System Components**: **9**

Synchronous machines, Transformers,Transmission lines, One line diagram, Impedance and reactance diagram, per unit System

**Symmetrical components, Symmetrical & Unsymmetrical faults:**

Symmetrical Components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks. Transient in R-L series circuit, calculation of 3-phase short circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions

Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance.

Formation of Zbus using singular transformation and algorithm, computer method for short circuit calculations

**Unit-II**

**Load Flows**: **9**

Introduction, bus classifications, nodal admittance matrix ( BUS Y ), development of load flow equations, load flow solution using Gauss Siedel and Newton-Raphson method, approximation to N-R method, line flow equations and fast decoupled method

**Unit-III**

**Power System Stability**: **9**

Stability and Stability limit, Steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion and step-by-step method. Factors affecting steady state and transient stability and methods of improvement

**Unit-IV**

**Traveling Waves**: **9**

Wave equation for uniform Transmission lines, velocity of propagation, surge impedance, reflection and transmission of traveling waves under different line loadings. Bewlay's lattice diagram, protection of equipments and line against traveling waves

**Text Books:**

1. W.D. Stevenson, Jr. " Elements of Power System Analysis", McGraw Hill.
2. C.L. Wadhwa, "Electrical Power System", New Age International.
3. Chakraborthy, Soni,Gupta&Bhatnagar, "Power System Engineering", DhanpatRai& Co.
4. T.K Nagsarkar& M.S. Sukhija, "Power System Analysis" Oxford University Press,2007.

**Reference Books**:

5. L. P. Singh; "Advanced Power System Analysis & Dynamics", New Age International
6. Hadi Sadat; "Power System Analysis", Tata McGraw Hill.
7. D.Das, " Electrical Power Systems" New Age International, 2006.
8. J.D. Glover, M.S. Sharma &T.J.Overbye, "Power System Analysis and Design" Thomson, 2008.
9. P.S.R. Murthy " Power System Analysis" B.S. Publications,2007.
10. Stagg and El-Abiad, "Computer Methods in Power System Analysis" Tata McGraw Hill
11. Kothari &Nagrath, "Modern Power System Analysis" Tata Mc. Graw Hill.

**POWER SYSTEM LAB**

**(A) Hardware Based:**

1. To determine direct axis reactance (xd) and quadrature axis reactance (xq) of a salient pole alternator.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (xd) and sub transient quadrature axisreactance (xq) of an alternator
4. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of analternator at very low excitation
5. To study the IDMT over current relay and determine the time current characteristics
6. To study percentage differential relay
7. To study Impedance, MHO and Reactance type distance relays
8. To determine location of fault in a cable using cable fault locator
9. To study ferranty effect and voltage distribution in H.V. long transmission line usingtransmission line model.
10. To study operation of oil testing set.

**Simulation Based Experiments (using MATLAB or any other software)**

11. To determine transmission line performance.
12. To obtain steady state, transient and sub-transient short circuit currents in an alternator
13. To obtain formation of Y-bus and perform load flow analysis
14. To perform symmetrical fault analysis in a power system
15. To perform unsymmetrical fault analysis in a power system

**Text Books:-**

1. Hasdi Sadat, "Power System Analysis" Tata Mc.Graw Hill.
2. T. K. Nagsarskar& M.S. Sukhija,' Power System Analysis' Oxford University Press.

## BEE-32 POWER ELECTRONICS

**Course category** **:** Department Core (DC)
**Pre- requisites** **:** Digital Electronics and Circuits
**Contact hours/week** **:** Lecture: 3, Tutorial: 1 , Practical :2
**Number of Credits** : 5
**Course Assessment methods** **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

The student will be able to demonstrate:

1. The working & principle of various semiconductor devices.
2. The concept of phase controller converters.
3. The analysis of Inverters in various configurations.
4. The concept of DC-Choppers, AC Voltage Controllers &Cyclo-converters.this course

**Topic Covered**

**UNIT I**

**Power semiconductor Devices:** **9**

Power semiconductor devices their symbols and static characteristics, Characteristics and specifications of switches, types of power electronic circuits Operation, steady state & switch characteristics & switching limits of Power Transistor Operation and steady state characteristics of Power MOSFET and IGBT Thyristor – Operation V- I characteristics, two transistor model, methods of turn-on Operation of GTO, MCT and TRIAC Power Semiconductor Devices (Contd.) Protection of devices. Series and parallel operation of thyristors, Commutation techniques of thyristors.

**UNIT II**

**Phase Controlled Converters:** **9**

Single phase half wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode. Single phase fully controlled and half controlled bridge converters. Performance Parameters Three phase half wave converters Three phase fully controlled and half controlled bridge converters, Effect of source impedance, Single phase and three phase dual converters, Cyclo-Converters Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo-converters, output voltage equation

**UNITIII**

**AC Voltage Controllers:** **9**

Principle of On-Off and phase controls Single phase ac voltage controller with resistive and inductive loads Three phase ac voltage controllers (various configurations and comparison only) Single phase transformer taps changer.

DC-DC Converters: Principles of step-down chopper, step down chopper with R-L load Principle of step-up chopper, and operation with RL load, classification of choppers.

**UNIT IV**

**Inverters**: **9**

Single phase series resonant inverter ,Single phase bridge inverters, Three phase bridge inverters, Voltage control of inverters ,Harmonics reduction techniques ,Single phase and three phase current source inverters

**References:**

1.M.H. Rashid,"Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3Edition,2004.

2.M.D. Singh and K.B.Khanchandani, "Power Electronics"Tata MC Graw Hill, 2005

3. V. R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications" Oxford University Press,2007.

4. P. S. Bimbhra, Power Electronics,Khanna Publisher, New Delhi- 2010

5.Chakrabarti&Rai, "Fundamentals of Power Electronics &Drives"DhanpatRai& Sons

## POWER ELECTRONICS LAB

**List of Experiments**

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without free wheeling diode.

4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converter
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor
9. To study operation of IGBT/MOSFET chopper circuit
10. To study MOSFET/IGBT based single-phase series-resonant inverter.
11. To study MOSFET/IGBT based single-phase bridge inverter

## BEE-33 POWER PLANT ENGINEERING

**Course category** **:** Department Core (DC)
**Pre- requisites** : Power System-I
**Contact hours/week** **:** Lecture: 3, Tutorial: 1,Practical: 0
**Number of Credits** : 4
**Course Assessment methods** **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. The concept of conventional & non-conventional source of energy.
2. The general layout, principle, working & performance of a steam power plant.
3. The general layout, principle, working & performance of a Hydro-electric power plant.
4. The general layout, principle, working & performance of a Diesel power plant.

**Topic Covered**

**UNIT I**

**Introduction:** **9**

Power and energy, sources of energy, fuels, energy stored in water, nuclear energy, wind energy, solar energy, tidal power, thermo-electric power, Geothermal energy Load estimation, load curves, Selection of power plant units, Power plant economics, Effect of plant type on costs, rates

**UNIT II**

**Steam Power Plant:** **9**

Classification of steam power plant, general layout of steam power plant, Power plant boilers, Coal handling system, pulverizers and coal burners, combustion system, ash handling system, Steam turbines, steam condensers, dust collection system, Feed water treatment, Steam turbines, auxiliary systems, governing, reheating, Operation and maintenance of steam power plant, Site selection of a steam power plant.

**UNIT III**

**Hydro-Electric Power Plant:** **9**

General layout, site selection for hydro-electric plant, classifications of hydro-electric power plants, hydro plant auxiliaries, Hydraulic turbines, types of turbines, performance of hydraulic turbines, governing operation, hydro plant control, combined hydro and steam power plants, safety measures and preventive maintenance of hydro-plant, hydro-power development in India

**UNIT IV**

**Diesel Power Plant: 9**

General layout, Components of Diesel power plant, site selection, heat engines, classifications of I.C engines, Performance of diesel power plant, fuel system, lubrication system, air intake system, exhaust system, Comparative study of diesel engine and petrol engine, merits and demerits of diesel power plants, applications of diesel power plant

**References**

1. "Power Plant Engineering" F.T. Morse, Affiliated East-West Press Pvt. Ltd, New Delhi/Madras.
2. "Power Plant Engineering" Mahesh Verma, Metropolitan Book Company Pvt. Ltd. New Delhi.
3. "Power System Engineering" R.K Rajput, Laxmi Publication Ltd. New Delhi
4. Power Plant Engineering by P.K. Nag, Tata McGraw Hill. New Delhi

## BEE -41 ELECTRIC DRIVES

**Course category** : Department Core (DC)
**Pre- requisites** : Power Electronics
**Contact hours/week** : Lecture: 3, Tutorial: 1,Practical: 2
**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Knowledge of electric drive and its parts, significance of power modulator ,electric motors ,sensing units, loads and control units in electric drives, advantages and classification of electric drive, multi quadrant operation of the drive
2. Knowledge of dynamic behavior of motor, transient and steady state behavior of drives
3. Knowledge of thermal model of the drive, classes of motor duties and technique to calculate the rating of the drive for various duty cycles, overloading factor estimation and load equalization.
4. Purpose and types of braking, significance and application of different electrical braking, energy loss during starting and braking
5. Control of separately excited and dc series motor dc drive by single phase and three phase converter, dual converter control of dc drive, applications and limitations of various control, chopper control of dc series and servo motor
6. Static control of dc motor by single phase, three phase and dual converters. chopper control of dc series and servomotor ,idea and effect of supply harmonics

7. Static control of three phase induction motor by CSI,VSI and Cycloconverter. static voltage and frequency control, static rotor resistance control and slip power recovery scheme, selection of motor for particular application
8. Constructional features , working and of switched reluctance and brush less motor, selection of motor for particular services

**Topic Covered**

**UNITI**

**Introduction to Electric Drives: 9**

Electric Drives and its parts, advantages ofelectric drives, Classification of electric drives, Speed-torque conventions and multi-quadrant operations, Constant torque and constant power operation.Types of loadtorque components, nature and classification. Dynamics of motor-load combination; Steady state stability of Electric Drive; Transient stability of electric Drive ,Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty. Load equalization

**UNIT II**

**Braking of Electrical Machines: 9**

Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors, Calculation of acceleration time and energy loss during starting of dc shunt and three phaseinduction motors, methods of reducing energy loss during starting. Energy relations during braking, dynamics during braking.

**UNITIII**

**Power Electronics Control of DC Drives: 9**

Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only), dual converter fed separately excited dc motor drive, rectifier control of dc series motor. Supply harmonics, power factor and ripples in motor current, Chopper control of separately excited dc motor and dc series motor**.**

**UNITIV**

**Power Electronics Control of AC Drives & Special Machine: 9**

Static Voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo – converter based) static rotor resistance and slip power recovery control schemes. Self controlled scheme of synchronous motor drive, Switched Reluctance motor, Brushless dc motor. Selection of motor for particular applications

**Text Books:**

1. G.K. Dubey, “Fundamentals of Electric Drives” Narosa publishing House.
2. S.K.Pillai, “A First Course on Electric Drives” New Age International.

**Reference Books:**

3. M.Chilkin, “Electric Drives”,Mir Publishers, Moscow.
4. Mohammed A. El-Sharkawi, “Fundamentals of Electric Drives”, Thomson Asia, Pvt. Ltd. Singapore.
5. N.K. De and PrashantK.Sen, “Electric Drives”, Prentice Hall of India Ltd.
6. V.Subrahmanyam, “Electric Drives: Concepts and Applications”, Tata McGraw Hill.

## ELECTRIC DRIVES LAB

**Note: - Minimum 10 experiments are to be performed**

**Hard Ware Based Experiments**

1. To study speed control of separately excited dc motor by varying armature
2. Voltage using single-phase fully controlled bridge converter.
3. To study speed control of separately excited dc motor by varying armature
4. Voltage using single phase half controlled bridge converter.
5. To study speed control of separately excited dc motor using single phase dual converter (Static Ward-Leonard Control).
6. To study speed control of separately excited dc motor using MOSFET/IGBT chopper.
7. To study closed loop control of separately excited dc motor.
8. To study speed control of single phase induction motor using single phase
9. ac voltage controller.
10. To study speed control of three phase induction motor using three phase ac voltage controller.
11. To study speed control of three phase induction motor using three phase current source inverter
12. To study speed control of three phase induction motor using three phase voltage source inverter
13. To study speed control of three phase slip ring induction motor using static rotor resistance control using rectifier and chopper
14. To study speed control of three phase slip ring induction motor using static scherbius slip power recovery control scheme

**Simulation Based Experiments (using MATLAB or any other software)**

15. To study starting transient response of separately excited dc motor
16. To study speed control of separately excited dc motor using single phase fully / half controlled bridge converter in discontinuous and continuous current modes.
17. To study speed control of separately excited dc motor using chopper control in motoring and braking modes.
18. To study starting transient response of three phase induction motor
19. To study speed control of three phase induction motor using (a) constant/V/F control (b) Constant Voltage and frequency control.

## BEE-42 SWITCH GEAR & PROTECTION

**Course category** : Department Core (DC)
**Pre- requisites** : Power System-I & II
**Contact hours/week** : Lecture: 3, Tutorial: 1,Practical: 2
**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Student gains knowledge on different Protective Equipments of Power Systems
2. Know about various protective systems- how it works and where it works?
3. Student gains knowledge on different Protective Equipments of Power Systems
4. Different applications of the relays, circuit breakers, grounding for different

elements of power system are also discussed in the subject.

5. Ability to discuss Recovery and Restricting.
6. Ability to express Oil circuit Breaker, Air Blast circuit Breakers, SF6 Circuit Breaker.
7. Ability to identify DMT, IDMT type relays**.**

**Topic Covered**

**UNIT I**

**Protective Relaying Fundamentals & Relays 9**

Introduction to protection system and its elements, Functional Characteristics of protective relaying, Protective zones, Primary and Backup protection, desirable qualities of protective relaying, basic terminology sealing/auxiliary relay. Electromagnetic, attracted and induction type relays, thermal relay, gas actuated relay.

**UNITII**

**Relay Applications/Characteristics & Static Relays: 9**

Over current relays, directional relays, distance relays, differential relay**.** Amplitude and phase comparators.Comparison between electromagnetic & static relays, classification and description of static relays.

**UNITIII 9**

**Protection of Transmission Line & Power Apparatus**

Over current protection, distance protection, pilot wire protection, carrier current protection, protection of bus bar, auto re-closing. Protection scheme for power transformers, generators and motors.

**UNITIV 9**

**Circuit Breaking Theories & Circuit Breakers:**

Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, resistance switching, capacitive current interruption, operating modes, selection of circuit breakers. Constructional features and operation of Air, Bulk Oil, Minimum Oil, Air Blast, $SF_6$, and Vacuum Circuit breakers, Ratings&Testing of Circuit Breakers.

**Text Books:**

1. S. S. Rao, “Switchgear and Protection”, Khanna Publishers.
2. B. Ravindranath and M. Chander, Power system Protection and Switchgear, Wiley Eastern Ltd.
3. B.Bhalja, R.P. Maheshwari& N. G. Chothani, Protection & Switch Gear, Oxford University Press.

**Reference Books:**

3. B. Ram and D. N. Vishwakarma, “Power System Protection and Switchgear”, Tata Mc. Graw Hill
4. Y. G. Paithankar and S R Bhide, “Fundamentals of Power System Protection”, Prentice Hall of India.
5. T.S.M Rao,“Power System Protection: Static Relays with Microprocessor Applications” Tata Macgraw Hill”.
6. A.R. Van C. Warringtaon , “ Protective Relays- Their Theory and Practice, Vol. I & II” Jhon Willey & Sons.

## SWITCH GEAR & PROTECTION LAB

**List of Experiments**

1. To study the IDMT over current relay and determine the time current characteristics.
2. To study percentage differential relay.
3. To study Impedance, MHO and Reactance type distance relays.
4. To study the working and principle of operation of Buchholz relay.
5. To understand the protection scheme of transformer through visit to local high voltage substation and to sketch labeled schematic diagram of various type of protection of transformer.
6. To understand the protection scheme using static relaying of nearby high voltage substation through visit and to sketch labeled schematic diagram.
7. To understand the protection scheme of alternator and to sketch labeled schematic diagram of various type of protection of alternator.
8. To understand various type of neutral earthling and specifications of earthling at different substations/locations and new trends in earthling schemes (information search).
9. To identify the components of different type of circuit breakers with their specifications (through/video/manuals)
10. To study operation of oil testing set and find out the break down strength of given oil sample.

## BEE-43 POWER SYSTEM OPERATION AND CONTROL

**Course category** : Department Core(DC)
**Pre- requisites** **:** Power System-I & II
**Contact hours/week** **:** Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability an understanding of Energy control center, analysis of real time control of power system parameters, learn about SCADA system
2. Ability to solve load dispatch problems with computer aided techniques for economy load dispatch.
3. Ability to analysis of real & reactive power control, load frequency control & Interconnected power systems
4. Ability to analysis of automatic excitation control systems and explore static and dynamic responses of system.
5. Ability to explain the importance of FACTS devices & their controllers.

**Topic Covered**
**UNIT-I**
**Introduction:** **9**

Overview of power system operation, Energy control center and real time computer control, SCADA system, power system operation and control in India, system security, voltage stability, role of information technology in energy control system, contingency analysis, system states and transient diagrams

**UNITII**

**Economic Operation: 9**

Energy demand, demand factor, load factor, diversity factor, types of loads, Economic operation of power system and unit commitment, Input-output characteristics of power plants, Economy loading with and without transmission losses, Penalty factor, computerized approach for economy load dispatch.

**UNIT III**

**Load Frequency Control: 9**

Role of system frequency in real power control, Concept of load frequency control, control area concept, single area and multi area load frequency control scheme, steady state and dynamic response, Automatic load frequency control for interconnected power systems, Automatic load dispatching

**UNIT IV**

**Voltage and Reactive Power control: 9**

Schematic diagram and block diagram representation, automatic excitation control systems, static and dynamic response, low power factor causes, improvement in power factor, concept of real and reactive power, Shunt compensation, series compensation, Flexible AC Transmission Systems**:** Concept and objectives of FACTS controllers, Working & Characteristics of different FACTS Controllers.

**Text Books:**

1. D.P. Kothari & I.J. Nagrath, "Modern Power System Analysis" Tata McGraw Hill, 3rd Edition.
2. P.S.R. Murty, "Operation and control in Power Systems" B.S. Publications.
3. N. G. Hingorani& L. Gyugyi, "Understanding FACTs" Concepts and Technology of Flexible AC Transmission Systems"
4. J. Wood & B.F. Wollenburg, "Power Generation, Operation and Control "John Wiley Sons.

**Reference Books:**

5. O.I. Elgerd, "Electric Energy System Theory" Tata McGraw Hill.
6. P. Kundur, "Power System Stability and Control McGraw Hill.
7. M.H. Rashid, "Power Electronics: Circuits, devices and Applications" Prentice Hall of India,3rd Edition.
8.T. K. Nagsarkar&M.S.Sukhiza,' Power System Analysis' Oxford University Press.

**BEE-44 UTILIZATION AND TRACTION**

**Course category** **:** Department Core(DC)
**Pre- requisites** **:** Electromechanical Energy Conversion-I& II
**Contact hours/week** **:** Lecture : 3, Tutorial :1 , Practical :0

**Number of Credits** : 4
**Course Assessment** **:** Continuous assessment through tutorials,assignments, **methods**Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Advantages and methods of electrical heating, concept of resistance heating, electrical arc heating, induction heating and dielectric heating
2. Knowledge of electric arc welding, resistance welding and electronic welding control, laws of electrolysis, concept of electro deposition and application of electrolysis
3. Laws of illumination, requirement of good lighting, design of indoor and outdoor lighting , concept of refrigeration and air condoning systems ,domestic refrigerator and water cooler, concept of window air conditioner
4. Knowledge of types of electric traction, system of electrification, traction mechanism ,speed time curve specific energy consumption mechanism of train movement, coefficient of adhesion and its influence
5. Salient features of traction drives, series parallel control of traction drives and energy saving, power electronic control dc and ac traction drives, diesel electric traction

**Topic Covered**

**UNITI**

**Electric Heating:** **9**

Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating**,** Electric Arc Welding, Electric Resistance welding, Electronic welding control ,Principles of electro deposition, Laws of electrolysis, applications of electrolysis

**UNIT II**

**Illumination:** **9**

Various definitions, Laws of illumination, requirements of good lighting, Design of indoor lighting and outdoor lighting systems, Refrigeration systems, domestic refrigerator, water cooler, Types of air conditioning, Window air conditioner

**UNITIII**

**Electric Traction:** **9**

Types of electric traction, systems of track electrification , types of services, speed time curve and its simplification, average and schedule speeds, Tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence

**UNITIV**

**Modern Electric Traction** **9**

Salient features of traction drives, Series – parallel control of dc traction drives (bridge transition) and energy saving, Power Electronic control of dc and ac traction drives, Diesel electric traction.

**Text Books**:

1. H.Partab,"Art and Science of Electrical Energy" DhanpatRai& Sons.
2. G.K.Dubey,"Fundamentals of Electric Drives" Narosa Publishing House

**Reference Books:**

3. H. Partab, "Modern Electric Traction" DhanpatRai& Sons.
4. C.L. Wadhwa, " Generation, Distribution and Utilization of Electrical Energy" New Age International Publications.

## BEE-46 POWER QUALITY

**Course category** : Department Core(DC)
**Pre- requisites** : Power System-I & II Power Electronics
**Contact hours/week** **:** Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** **:** 4
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Acquire the knowledge of different terms and definitions of power quality.
2. Gains knowledge on causes and effects of voltage sags and its mitigations.
3. Gains knowledge on power system transients and harmonics with their effects and mitigation techniques.
4. Know about various power quality measuring, analyzing and testing devices.
5. Get introductory knowledge of custom power devices for further knowledge enhancement

**Topic Covered**

**UNIT I**

**Introduction to Power Quality: 9**

Terms and definitions of transients, Long Duration Voltage Variations: under Voltage, Under Voltage and Sustained Interruptions**;** Short Duration Voltage Variations: interruption, Sag, Swell; Voltage Imbalance; Notching D C offset,waveform distortion; voltage fluctuation; power frequency variations**.**

**UNITII**

**Voltage Sag: 9**

Sources of voltage sag: motor starting, arc furnace, fault clearing etc; estimating voltage sag performance and principle of its protection; solutions at end user level- Isolation Transformer, Voltage Regulator, Static UPS, Rotary UPS, Active Series Compensator.

**UNIT III**

**Electrical Transients: 9**

Sources of Transient Over voltages- Atmospheric and switching transients- motor starting transients, pf correction capacitor switching transients, ups switching transients, neutral voltage swing etc; devices for over voltage protection.

**Harmonics:** Causes of harmonics; current and voltage harmonics: measurement of harmonics; effects of harmonics on – Transformers, AC Motors, Capacitor Banks, Cables,

and Protection Devices, Energy Metering, Communication Lines etc. harmonic mitigation techniques.

**UNIT IV**

**Measurement and Solving of Power Quality Problems: 9**

Power quality measurement devices- Harmonic Analyzer , Transient Disturbance Analyzer, wiring and grounding tester, Flicker Meter, Oscilloscope, multimeter etc.

**Introduction to Custom Power Devices**-Network Reconfiguration devices; Load compensation and voltage regulation using DSTATCOM; protecting sensitive loads using DVR; Unified power Quality Conditioner.

**Text Books:**

1. Roger C Dugan, McGrahan, Santoso&Beaty, "Electrical Power System Quality" McGraw Hill
2. ArinthomGhosh& Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices" Kluwer Academic Publishers
3. C. Sankaran, " Power Quality" CRC Press.

## BEE- 51 HIGH VOLTAGE ENGINEERING

**Course category** : Department Core(DC)
**Pre- requisites** : Power System-I&II
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts of break down in gases, solids & liquids with numerical calculation.
2. The concept of generation & measurement of high voltages & currents.
3. The concept of various high voltage testing.

**Topic Covered**

**UNIT I**

**Break Down In Gases: 9**

Ionization processes, Townsend's criterion, breakdown in electronegative gases, time lags for breakdown, streamer theory, Paschen's law, break down in non-uniform field, breakdown in vacuum.

**Break Down In Solid & Liquid Dielectrics:**

Classification of liquid dielectric, characteristic of liquid dielectric, breakdown in pure liquid and commercial liquid.Intrinsic breakdown, electromechanical breakdown, breakdown of solid, dielectric in practice, breakdown in composite dielectrics.

**UNIT II**

**Generation of High Voltages and Currents: 9**

Generation of high direct current voltages, generation of high alternating voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

**UNITIII**

**Measurement of High Voltages and Currents: 9**

Measurement of high direct current voltages, measurement of high alternating and impulse voltages, measurement of high direct, alternating and impulse currents, Cathode Ray Oscillographs for impulse voltage and current measurements.

**UNIT IV**

**Non-Destructive Testing: 9**

Measurement of direct current resistively, measurement of dielectric constant and loss factor, partial discharge measurements

**High Voltage Testing:**

Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of transformers, testing of surge arresters, radio interference measurements.

**Text Book:**

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering, Tata Mc-Graw Hill.

**Reference Books:**

2. E. Kuffel and W. S. Zacngal, High Voltage Engineering", Pergamon Press.
3. M. P. Chaurasia , "High Voltage Engineering", Khanna Publishers
4. R. S. Jha, "High Voltage Engineering", DhanpatRai& sons
5. C. L. Wadhwa, "High Voltage Engineering", Wiley Eastern Ltd.
6. M. Khalifa,' High Voltage Engineering Theory and Practice,' Marcel Dekker.
7. Subir Ray,' An Introduction to High Voltage Engineering' Prentice Hall of India

## BEE- 52 INTELLIGENT INSTRUMENTATION

**Course category** : Department Core(DC)
**Pre- requisites** : Electrical Measurement & Measuring Instruments
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts of intelligent instrumentation system.
2. The concept of signal processing, manipulation & transmission.
3. The concept of Smart Sensors, Interfacing Instruments & Computers.
4. Recent trends in sensor technology.

**Topic Covered**

**UNIT I**

**Introduction: 9**

Intelligence, features characterizing intelligence, intelligent instrumentation system; features of intelligent instrumentation; components of intelligent instrumentation system; Block diagram of an intelligent instrumentation system.

**UNIT II**

**Signal Processing, Manipulation and Transmission: 9**

Signal amplification & attenuation (OP-AMP based); Instrumentation Amplifier (circuit diagram, high CMRR & other features); Signal Linearization (different types such as Diode-resistor combination, OP-AMP based, etc); Bias Removal, Signal filtering (outputs from ideal filters, outputs from constant-k filters, matching of filter sections active analog filters); OP-AMP based Voltage-to-current converter, Current-to-voltage conversion, Signal integration, Voltage follower (pre-amplifier), voltage comparator Phase locked loop, Signal addition, Signal multiplication, Signal Transmission (Signal amplification, Shielding, Current loop transmission, Voltage-to-frequency conversion, Fiber optic transmission).

**UNIT III**

**Smart Sensors, Interfacing Instruments & Computers**: **9**

Nonlinearity: took up table method, polygon interpolation, polynomial interpolation, cubic spline interpolation, Approximation & regression; Noise & interference; Response time; Drift; Cross-sensitivity; Basic issues of interfacing; Address decoding; Data transfer Control; A/D converter; D/A converter, Sample & hold circuit; Other interface considerations.

**UNIT IV**

**Recent Trends in Sensor Technologies: 9**

Introduction; Film sensors (Thick film sensors, thin film sensors); Semiconductor IC technology-standard methods; microelectro-mechanical systems (Micro-machining, some application examples); Nano-sensons.

**Text Book:**

1. Barney, G.C. Intelligent Instruments. Hemel Hempstead: Prentice Hall, 1985.
2. Alan S. Morris, Principles of Measurement& instrumentation. N. Delhi; PHI Pvt. Ltd., 1999.

**Reference Book:**

1. D. Patranabis, Sensors & Transducers N. Delhi: 2003.
2. Roman Kuo, Introduction to Digital Signal Processing. N. York: McGraw-Hill Pub, Co.

## BEE-53 DIGITAL CONTROL SYSTEM

**Course category**: Department Core(DC)
**Pre- requisites**: Control System Engineering

**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** **:** 4
**Course Assessment** : Continuous assessment through tutorials, assignments, **methods**Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts ofSignal Processing in Digital Control.
2. The concept of Time Domain and Frequency Domain Analysis.
3. The concept of State Space Analysis and Design.
4. Stability of Discrete System.

**Topic Covered**

**UNITI**

**Signal Processing in Digital Control: 9**

Basic digital control system, advantages of digital control and implementation problems, basic discrete time signals, z-transform and inverse z-transform, modelling of sample-hold circuit, pulse transfer function, solution of difference equation by z-transform method.

**UNITII**

**Time Domain and Frequency Domain Analysis: 9**

Steady state accuracy, transient response and frequency response specifications, digital compensator design using frequency response plots and root locus plots.

**UNIT III**

**State Space Analysis and Design: 9**

State space representation of digital control system, conversion of state variable models to transfer functions and vice-versa, solution of state difference equations, controllability and observability, design of digital control system with state feedback.

**UNITIV**

**Stability of Discrete System: 9**

Stability on the z-plane and Jury stability criterion, bilinear transformation, Routh stability criterion on $r^{th}$ plane.

**References:**


1. K. Ogata, "Discrete-Time Control System", Pearson Education.
2. B.C. Kuo, "Digital Control System", Saunders College Publishing.
3. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill.


## BEE- 54 CONVENTIONAL& CAD OF ELECTRICAL MACHINES

**Course category** : Department Core(DC)
**Pre- requisites** **:** Electromechanical Energy Conversion-I&II**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :2**Number of Credits** : 5
**Course Assessment** **:** Continuous assessment through tutorials, assignments, **methods** Quizzes and Three Minor tests and One major test&Practical

Examination

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts of transformer design.
2. The concept of3-phase synchronous machines, IM & computer aided design.

**Topic Covered**

**UNITI**

**Basic Considerations:** **9**

Basic concept of design, limitations in design, standardization, modern trends in design and manufacturing techniques, Classification of insulating materials.Heating and Cooling of electrical machines. Transformer Design: Output equation design of core, yoke and windings, overall dimensions, Computation of no load current, voltage regulation, efficiency and cooling system designs

**UNIT II**

**Design of 3-phase synchronous machines:** **9**

Output equation, specific electric and magnetic loadings, factors affecting size of machines, separation of main dimensions, Stator design, losses in stator, damper winding design, rotor design of salient pole synchronous machines, determination of OCC by design data, stator leakage reactance, rotor design of cylindrical machines

**UNIT III**

**Design of 3-phase induction machines:** **9**

Output equation, specific electric and magnetic loadings, factors affecting size of machines, separation of main dimensions, Stator design, losses in stator, Rotor design, concept of flattened flux density, no load current, Estimation of performance, construction of circle diagram from design data, stator temperature rise.

**UNIT IV**

**Computer Aided Design:** **9**

Philosophy of computer aided design, advantages and limitations. Computer aided design approaches analysis, synthesis and hybrid methods. Concept of optimization and its general procedure. Flow charts and ‘c’ based computer programs for the design of transformer, dc machine, three phase induction and synchronous machines.

Core and armature design of dc machines, design of field system of dc machine

**Text Books:**

1. K. Sawhney, “A Course in Electrical Machine Design” DhanpatRai& Sons.
2. K.G. Upadhyay,“ Design of Electrical Machines” New Age International Publishers, New Delhi.

**Reference Books:**

3. M.G. Say, "The Performance and Design of AC Machines" Pitman & Sons.
4. A.E. Clayton and N.N. Hancock, "The Performance and Design of D.C.Machines" Pitman & Sons.
5. S.K. Sen, "Principle of Electrical Machine Design with Computer Programming" Oxford and IBM Publications.

## CAD LAB

1. CAD of 3-phase Synchronous Machines: Design of Core, Yoke, dimensions etc.
2. CAD of 3-phase Induction Motors: Design of main dimensions, Yoke dimensions etc.
3. CAD of Transformer: Design of Core, Yoke, dimensions etc.

## BEE- 55 EHV AC & DC TRANSMISSION

**Course category** : Department Core(DC)
**Pre- requisites** : Power System-I&II
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** : Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The basic concepts ofEHV & DC transmission.
2. The concept ofExtra High Voltage Generation, Measurement and Testing .
3. The concept of HVDC transmission

**Topic covered**

**UNIT I**

**Introduction: 9**

Need of EHV transmission, standard transmission voltage, comparison of EHV ac & dc transmission systems and their applications & limitations, mechanical design considerations of transmission lines, modern trends in EHV AC and DC transmission systems

**UNIT II**

**EHV AC Transmission: 9**

Corona effects, Corona loss formulas, audible noise – generation and characteristics, corona Pulses, generation and properties, radio interference, over voltages in EHV system caused by switching operations, Concept of travelling waves and standing waves

**UNIT III**

**Extra High Voltage Generation, Measurement and Testing: 9**

Characteristics and generation of impulse voltage, Impulse current, generation of high AC and DC voltages, measurement of high voltages, general lay out of EHV Labs, Standard testing methods, EHV line insulation testing characteristics, protection of EHV lines.

**UNIT IV**

**HVDC Transmission: 9**

Types of dc links, converter station, choice of converter configuration and pulse number, effect of source inductance on operation of converters. Principle of dc link control, converter controls characteristics, firing angle control, excitation angle control, Converter faults, generation of harmonics, ac and dc filters, Multi Terminal DC systems (MTDC): Types, control, protection and applications.

**Text Books :**

1.R. D. Begamudre, "Extra High Voltage AC Transmission Engineering" Wiley Eastern.
2.K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions" New Age International.
3.J. Arrillaga," High Voltage Direct current Transmission" IFFE Power Engineering Series 6, Peter PeregrinusLtd,London.
4.M. S. Naidu & V. Kamaraju, "High Voltage Engineering" Tata McGraw Hill.

**Reference Books:**

5.M. H. Rashid , " Power Electronics : Circuits, Devices and Applications" Prentice Hall of India.
6.S. Rao, "EHV AC and HVDC Transmission Engineering and Practice" Khanna Publisher.
7."EPRI, Transmission Line Reference Book, 345 KV and above" Electric Power Research Institute. Palo Alto, California, 1982.

## BEE- 56 ADVANCED MICROPROCESSOR AND MICRO CONTROLERS

**Course category** : Department Core(DC)
**Pre- requisites** : Introduction to Microprocessors
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :2
**Number of Credits** : 5
**Course Assessment methods** : Continuous assessment through tutorial ,assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Its Architecture & assembly languages.
2. Interfacing & Coprocessor 8087.
3. The concept of Micro-controller.
4. High end processor.

**Topic covered**

**UNIT I**

**Introduction toArchitecture of Microprocessors: 9**

General definitions of mini computers, microprocessors, micro controllers and digital signal processors.Overview of 8085 microprocessor.Overview of 8086 microprocessor.Signals and pins of 8086 microprocessor.

**Assembly language of 8086:**Description of Instructions.Assembly directives. Assembly software programs with algorithms.

**UNIT II**

**Interfacing with 8086: 9**

Interfacing with RAMs, ROMs along with the explanation of timing diagrams.Interfacing with peripheral ICs like 8255, 8254, 8279, 8259, 8259 etc.Interfacing with key boards, LEDs, LCDs, ADCs, and DACs etc.

**Coprocessor 8087:**Architecture of 8087, interfacing with 8086. Data types, instructions and programming

**UNIT III**

**Introduction to Micro controllers: 9**

Overview of the architecture of 8051 microcontroller.Overview of the architecture of 8096, 16 bit microcontroller.

**Assembly language of 8051:**Description of Instructions.Assembly directives. Assembly software programs with Algorithms.

**Interfacing with 8051:**Interfacing with keyboards, LEDs, 7 segment LEDs, LCDs, Interfacing with ADCs.Interfacing with DACs, etc.

**UNIT IV**

**High end processors: 9**

Introduction to 80386, 80486 and Pentium Processors.

**REFERENCES**


1. Ramesh S. Gaonkar "Microprocessor Architecture, Programming, and Applications with the 8085", Prentice Hall PTR, 2002.
2. A.K. Ray & K. M. Bhurchandi, "Advanced microprocessors and Peripherals", Tata McGraw Hill.
3. James L. Antonakos, "An Introduction to the Intel family of Microprocessors" Pearson Education 1999.
4. Barry.B.Breg," The Intel Microprocessors Architecture , Programming and Interfacing , PHI,2002.
5. James L. Antonakos , " The Pentium Microprocessor '' Pearson Education , 1997.


## ADVANCED MICROPROCESSORS AND MICRO CONTROLLERS LAB

**List of Experiments:**

1. Description of 8086 Pin Diagram
2. Study of 8086 Instruction Set

**• 8086 Programs**

3. 16-bit addition using 8086 microprocessor
4. Move contents of array
5. Sum of 'n' consecutive numbers
6. Conversion of BCD number to decimal
7. Separating Odd and Even numbers
8. Description of 8051 Pin Diagram

9 . Study of8051 Instruction Set

**• 8051 Programs**

10. Addition of 8-bit numbers using 8051

11. Subtraction of 8-bit numbers using 8051

**BEE-57 MODERN CONTROL SYSTEM**

**Course category** **:** Department Core(DC**)**

**Pre- requisites** **:** Digital Control System

**Contact hours/week** **:** Lecture : 3, Tutorial :1 , Practical :0

**Number of Credits** : 4

**Course Assessment methods** **:** Continuous assessment through tutorials,assignments**,** Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concept of control system design, state space analysis & state space control design.
2. The concept of Non-Linear System.

**Topic covered**

**UNIT I**

**Introduction to Control Design:** **9**

Introduction, review of conventional control design techniques, continuous-time and discrete-time system modelling, time response analysis, and frequency response analysis; control design problem and preliminary considerations; lead, lag and lead-lag networks, compensator design using root locus plots and frequency response plots.

**UNIT II**

**State Space Analysis:** **(9 Lectures**

State variable representation, state variable model, conversion of state variable models to transfer function and vice-versa, solution of state equations, state transition matrix, controllability and observability.

**UNIT III**

**State Space Control Design:** **9**

Design of state observer and controller.Pole-placement technique, Ackerman formula, observer-controller design.

Stability Analysis: Continuous-time and discrete-time systems stability analysis, Lyapunov's stability theorems.

**UNIT IV**

**Nonlinear System:** **9**

Types of nonlinearities, nonlinear systems analysis, linearization method, system analysis by phase-plane method, describing function and their applications.

**References:**

1. I. J. Nagrath and M. Gopal, "Control System Engineering", 4th Edition, New age International.
2. K. Ogata, "Modern Control Engineering", Pearson Education, 4th Indian reprint.
3. D.RoyChoudhary, "Modern Control Engineering", Prentice Hall of India.
4. Ajit K. Mandal, "Introduction to Control Engineering" New Age International, 2006.

## BEE- 58 SCADA & ENERGY MANAGEMENT SYSTEM

**Course category** : Department Core(DC)
**Pre- requisites** : Power System-I&II
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts of SCADA & its use in power system.
2. The concept of energy management system.
3. SCADA System Components and Applications.

**Topic covered**

**UNIT I**

**An Introduction to SCADA: 9**

Purpose and necessity, general structure, data acquisition, transmission & monitoring, general power system hierarchical Structure. Overview of the methods of data acquisition systems, transducers, RTUs, Master terminal unit, various communication channels- cables, telephone lines, power line, microwaves, optical fiber channels and satellites.

**UNIT II**

**SCADA in Power System: 9**

Tasks in power system operation, Operational tasks at various hierarchical levels, National load control center, regional load control center, generating station control management, SCADA types, Automatic generation control, SCADA in power distribution, SCADA in power grid, distribution substation and feeder automation

**UNIT III**

**Supervisory Power Management: 9**

Energy Management system, power system operational states, security analysis, state estimation, load forecasting, classification of load forecast, effecting factors, methods of load forecasting, energy audit, utility distributed system design, regulation and distribution automation, fault control management.

**UNIT IV**

**SCADA System Components and Applications: 9**

Intelligent electronic device, SCADA server, Human-Machine interface, Components of control system, Programmable logic controllers, SCADA applications in various utilities,

SCADA applications for transmission and distribution sector, SCADA base Instrumentation, Case studies on SCADA.

**Text Books:**

1. TorstenCergrell, " Power System Control Technology", Prentice Hall International.
*2.* George L Kusic "Computer Aided Power System Analysis",, Prentice Hall of India,
3. A. J. Wood and B. Woolenberg, "Power Generation Operation and Control", John Wiley & Sons.
4. T.K Bisht, " SCADA and Energy Management System" S K Kataria and sons

## BEE- 59 ENERGY EFFICIENCY & CONSERVATION

**Course category** : DepratmentCore(DC)
**Pre- requisites** : Power System-I&II
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts of Energy conservation& Energy Audit.
2. The concept ofDemand Side Management,Voltage and Reactive power in Distribution System.
3. The concept of Efficiency in Motors and Lighting system.

**Topic covered**

**UNIT I**

**Energy conservation: 9**

Principles of Energy Conservation, Energy conservation Planning, Energy conservation in small scale industries, Large scale industries and in electrical generation, transmission and distribution.Energy conservation Legislation.

**Energy Audit:-**

Aim of energy Audit, Strategy of Energy Audit, Energy management Team Considerations in implementing energy conservation Programme, Instruments for energy audit, Energy audit of Electrical System, HVAC, Buildings, Economic analysis.

**UNIT II**

**Demand Side Management: 9**

Concept and Scope of Demand Side Management, Evolution of Demand Side Management, DSM Strategy, Planning, Implementation and its application. Customer Acceptance & its implementation issues. National and International Experiences with DSM. 8

**UNIT III**

**Voltage and Reactive power in Distribution System: 9**

Voltage and reactive power calculations and control: Voltage classes and nomenclature, voltage drop calculations, Voltage control, VAR requirements and power factor, Capacitors unit and bank rating, Protection of capacitors and switching, Controls for switched capacitors and fields testing.

**UNIT IV**

**Efficiency in Motors and Lighting system: 9**

Load scheduling/shifting, Motor drives- motor efficiency testing, energy efficient motors, and motor speed control. Lighting- lighting levels, efficient options, fixtures, day lighting, timers, Energy efficient windows.UPS selection, Installation operation and maintenance. Indian Electricity Act 1956, Distribution Code and Electricity Bill 2003

**Text / Reference Books**


1. Tripathy S. C., "Electric Energy Utilization and conservation", Tata McGraw Hill.
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
3. "The Efficient Use of Energy", Edited by I.G.C.Dryden, Butterworths, London, 1982.
4. Energy Management Handbook, Edited by W.C.Turner, Wiley, New York, 1982.
5. L.C.Witte, "P.S.Schmidt, D.R. Brown, Industrial Energy Management and Utilization", HemispherePubl,Washington, 1988
6. Power Capacitor Handbook, Butterworth & Co (Publishers) Ltd, 1984.
7. Electrical Systems Analysis and Design for Industrial Plants, McGraw-Hill Book Company.
8. IEEE Bronze Book, 'Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities, IEEE Press.


**BEE-60 BIO INSTRUMENTATION**

**Course category** : Department Core(DC)
**Pre- requisites** : Instrumentation & Process Control
**Contact hours/week** : Lecture : 3, Tutorial :1 , Practical :0
**Number of Credits** : 4
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The Fundamentals of Bio-Medical Instrumentation.
2. The concept of the Cardiovascular System and Measurements.
3. The concept of the Nervous & Respiratory System and its Measurements.
4. Patient Care Monitoring & Imaging Techniques.

**Topic covered**

**UNIT I**

**Fundamentals of Bio-Medical Instrumentation: 9**

Introduction to bio-instrumentation, anatomy & physiology, basic medical instrumentation scheme, different physiological systems of body, Problems encountered in measuring living systems,Transducers for biomedical applications. Generation, propagation and distribution of different bioelectric potentials (ECG, EEG, EMG etc.).Bio-potentials electrodes, electrode theory, types of electrodes, biochemical transducers.Action& resting potentials.

**UNIT II**

**The Cardiovascular System and Measurements: 9**

The heart, electrical &mechanical activity, cardiovascular systems, Electrocardiography, ECG lead configurations ECG recording and their types, Einthoven triangle, interferences. measurement methods of blood flow, heart sound, Phonocardiogram, circulation block diagram of blood pressure and measurement.

**UNIT III**

**The Nervous & Respiratory System and its Measurements 9**

The anatomy of nervous system, Neuronal communication, EPSP & IPSP, Organization of the brain, Measurements from the nervous system, Respiratory system, Different types of Spiro-meters, Body & skin temperature measurements.

**UNIT IV**

**Patient Care Monitoring & Imaging Techniques: 9**

Elements of intensive care, Organization of the Hospital (HIS) for patient-care monitoring, Pace-makers-types, modes and generators, Defibrillators-types.Instrumentation for diagnostic; X Rays, Ultrasonic, CT & MRI, biomedical computer applications. Shock hazards from electrical equipments, methods of accident prevention.

**Text Book:**

1. T. Cromwell, F.J. Weibell&F.A.Pfieffer, "Biomedical Instrumentation & Measurements" Prentice Hall International

**Reference Books:**

2. R.S. Khanpur, "Handbook of Biomedical Instrumentation" Tata McGraw Hill
3. H.E. Thomas, "Handbook of Biomedical Instrumentation and Measurement" RestonePublishing
Company
5. J.G. Webester, "Medical Instrumentation", Houghton Mifflin.

**BOE- 10 NON-CONVENTIONAL ENERGY RESOURCES**

**Course category** **:** Department Core(DC)
**Pre- requisites** **:** NIL
**Contact hours/week** **:** Lecture : 2, Tutorial :1 , Practical :0
**Number of Credits** : 3
**Course Assessment methods** **:** Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Various non-conventional energy resources.
2. The concept of Solar Thermal Energy.
3. The concept of Geothermal Energy & Wind Energy Generation.

**Topic covered**

**UNIT I**

**Introduction** **7**

Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits.

**Solar Cells:** Theory of solar cells.solar cell materials, solar cell array, solar cell power plant, limitations.

**Bio-mass:** Availability of bio-mass and its conversion theory.

**UNIT-II** **7**

**Solar Thermal Energy:**

Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

**Thermo-electrical and thermionic Conversions:** Principle of working, performance and limitations.

**UNIT-III** **7**

**Geothermal Energy:**

Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.

**Magneto-hydrodynamics (MHD):** Principle of working of MHD Power plant, performance and limitations.

**Fuel Cells:** Principle of working of various types of fuel cells and their working, performance and limitations.

**UNIT-IV** **7**

**Wind Energy:**

Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.

**Ocean Thermal Energy Conversion (OTEC):**Availability, theory and working principle, performance and limitations.

**Wave and Tidal Wave:** Principle of working, performance and limitations.Waste Recycling Plants.

**Text/References Books:**


1. Raja etal, “Introduction to Non-Conventional Energy Resources” Scitech Publications.
2. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.

3. M.V.R. KoteswaraRao, " Energy Resources: Conventional & Non-Conventional " BSP Publications,2006.
4. D.S. Chauhan,"Non-conventional Energy Resources" New Age International.
5. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
6. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.

## BOE-11 FUNDAMENTALS OF ELECTRIC DRIVES

**Course category** : Department Core(DC)
**Pre- requisites** : NIL
**Contact hours/week** : Lecture : 2, Tutorial :1 , Practical :0
**Number of Credits** : 3
**Course Assessment methods** : Continuous assessment through tutorials,assignments, Quizzes and Three Minor tests and One MajorTheory

**Course Outcome** : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts of basic electric drives & its dynamics.
2. The concept of Motor power rating, Braking and Calculation of Energy loss.
3. The concept of Power Electronic Control of DC Drives.
4. Power Electronic Control of AC Drives, Special Drives & Application of Motors.

**Topic covered**

**UNIT I**

**Basic Electric Drives and its Dynamics** **7**

Electric Drives and its parts, advantages ofelectric drives, Classification of electric drives, Speed-torque conventions and multi-quadrant operations, group drives and individual drives, Constant torque and constant power operation. Types of load torque components, nature and classification. Dynamics of motor-load combination; Steady state stability of Electric Drive; Load equalization

**UNIT II**

**Motor power rating, Braking and Calculation of Energy loss** **7**

Thermal model of motor for heating and cooling, classes of motor duty, determination motor power rating for continuous duty, short time duty and intermittent duty.Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors ,Calculation of acceleration time and energy loss during starting of dc shunt and three phaseinduction motors.

**UNIT III**

**Power Electronic Control of DC Drives:** **7**

Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only), dual converter fed separately excited dc motor drive, rectifier control of dc series motor. Chopper control of separately excited dc motor and dc series motor.

**UNIT IV**

**Power Electronic Control of AC Drives,Special Drives & Application of Motors 7**

Three Phase induction Motor Drive: Static Voltage control scheme, static frequency control scheme (VSI, CSI) static rotor resistance and slip power recovery control schemes. Brushless dc motor. Selection of motor for particular applications

**Text Books:**

1. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House.
2. S.K.Pillai, "A First Course on Electric Drives", New Age International.

**Reference Books:**

3. M.Chilkin, "Electric Drives",Mir Publishers, Moscow.
4. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia, Pvt. Ltd. Singapore.
5. N.K. De and PrashantK.Sen, "Electric Drives", Prentice Hall of India Ltd.
6. V.Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill.