FACULTY OF ENGINEERING

Scheme of Instructions and Examination

(AICTE Model Curriculum for the Academic Year 2020-21)

and

Syllabi

B.E. V and VI Semester

of

Four Year Degree Programme

in

Electrical and Electronics Engineering

(With effect from the academic year 2020 - 21)

(As approved in the faculty meeting held on XX-XX-2020)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2020

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Electrical and Electronics Engineering) V – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC235EE	Electrical Machines – II	3	1	-	4	30	70	3	4
2	PC236EE	Power Systems – I	3	-	-	3	30	70	3	3
3	PC237EE	Linear Control Systems	3	-	-	3	30	70	3	3
4	PC238EE	Microprocessors and Microcontrollers	3	-	-	3	30	70	3	3
5	PC239EE	Signals and Systems	3	-	-	3	30	70	3	3
6	PE1_ _EE	Professional Elective - I	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
7	PC263EE	Electrical Circuits Lab	-	-	2	2	25	50	3	1
8	PC264EE	Control Systems Lab	-	-	2	2	25	50	3	1
9	PC265EE	Power Electronics Lab	-	-	2	2	25	50	3	1
			18	**01**	**06**	**25**	**255**	**570**	-	**22**

Professional Elective – I		
1.	PE101EE	Electric Distribution System
2.	PE102EE	Renewable Energy Sources
3.	PE103EE	Hybrid Electric Vehicles

HS: Humanities and Social Sciences BS: Basic Science ES: Engineering Science
MC: Mandatory Course PC: Professional Core PE: Professional Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
EE: Electrical Engineering,

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

Course Code	Course Title						Core/Elective
PC235EE	**Electrical Machines – II**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- To be able to understand in detail about transformers and induction machines. Construction, principle, performance characteristics and testing.
- To understand the construction, principle and performance characteristics of fractional horse power motors.

Course Outcomes

After completing this course, the student will be able to:

1. Explain the rating, testing and applications of single phase, three phase transformers
2. Acquire the knowledge of Rotating magnetic field theory, Double field revolving theory
3. Develop equivalent circuit diagram of transformer, three phase induction motor and single phase induction motor.
4. Develop Slip-torque characteristics of single phase and three phase induction motors
5. Demonstrate knowledge of Starting methods, Speed control methods and applications of single and three phase induction motors.

UNIT-I

Three - Phase Induction Motors: Constructional features - Rotating magnetic field theory, Principle of operation of Squirrel cage and Slip ring motors, Phasor diagram, Equivalent Circuit, Expression for torque, starting torque, Max torque. Slip-torque characteristics, Equivalent circuit parameters from no-load and blocked rotor test, Circle diagram, Determination of performance characteristics of induction motor, Applications.

UNIT-II

Starting and Speed Control Methods: Starting methods of 3-phase induction motor –Auto transformer, Star-delta Starter. Double cage machine, Speed control methods – Resistance control, Voltage Control, Pole changing, Cascading, Induction Generator - Principle of operation, Applications.

UNIT-III

Synchronous machines: Types and Constructional Details - Types of Winding, Winding factors - E.M.F. equation - Fractional pitch and fractional slot windings - Suppression of harmonics and tooth ripple - Armature reaction and reactance - Synchronous impedance. Synchronous Generator**:** Voltage Regulation - Phasor diagram of alternator with non-salient poles - O.C. and S.C. Characteristics- Synchronous impedance, Ampere turn, ZPF methods for finding regulation - Principle of two reaction theory and its application for the salient pole-synchronous machine analysis - Synchronizing and parallel operation.

UNIT - IV

Synchronous Motor: Theory of operation - Vector diagram - Variation of current and p.f. with excitation - Hunting and its prevention - Current and power circle diagram - Predetermination of performance - Methods of starting and synchronizing - Synchronizing power, Synchronous condenser. Applications.

UNIT-V

Single Phase Motors: Double field revolving theory. Equivalent circuit of single phase induction Motor- Principle of operation, speed torque characteristics of a split phase and capacitor motors. Compensated and uncompensated series motor, Repulsion motor and universal motor - Applications.

Special Machines: Brushless DC Motor – Construction and Principle of Operation, Switched Reluctance Motor – Construction and Principle of Operation, Applications.

Suggested Readings:

1. P.S.Bimbhra, *Electrical Machinery*, 7th Edition, Khanna Publishers.
2. D.P. Kothari and I.J. Nagrath, *Electrical Machines*, Tata McGraw Hill, 4th Edition, 2010.
3. M.G.Say, *The Performance and Design of AC. Machines*, Pitman Publication, 2002.
4. Irving L. Kosow, *Electric Machinery and Transformers*, PPH, Pearson Education 2nd Edition, 2009.

Course Code	Course Title						Core/Elective
PC236EE	**Power Systems – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The course is introduced

- To be able to learn and understand the conventional and renewable generating power stations and economics of generation.
- To be able to understand design concepts of transmission lines and cables.

Course Outcomes

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

1. The students will acquire knowledge in conventional renewable generating power stations and economics of generation
2. The students will acquire knowledge regarding the design concepts of t transmission lines and cables.

UNIT I

Economics of Power Generation: Load Curve, Load Demand and Diversified factors, Base Load and Peak load operation, Types of costs and depreciation fund calculations, Methods of power factor improvement, Economics of power factor improvement, Tariffs, Distribution: 2 wire and 3 wire distributors, Ring mains, AC distribution calculations.

UNIT II

Steam Power Stations: Choice of site, Layout & various parts of station, Boilers, Turbines, Super Heaters, Economizers, Air pre-heaters etc. and their Pulverized fuel, Coal handling. Hydro-Electric Power plants: Estimation Hydrograph, Flow duration curve, Mass curve, Storage and poundage, Types electric plants and layouts, Prime movers for hydro- electric plants.

UNIT III

Nuclear Power Plants: Fissile materials, working principle of nuclear plants and reactor control, Shielding, Types of reactors. Non-Conventional Energy Sources – Basic principles of Wind, solar and gas turbines.

UNIT IV

Over-Head Lines: Supports sag and tension calculations, Effect of wind and ice, Erection conditions, Insulators: Types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, Testing of insulators. Insulated Cables: Conductors for cables, Insulating materials, Mechanical protection, Low voltage cables, Grading of cables, Three phase high voltage cables and Super voltage cables, Capacitance of three-core cables.

UNIT V

Inductance and Capacitance of Transmission Lines: Inductance and capacitance of overhead line conductors, Single phase and three phase with symmetrical composite conductors, GMR and GMD Spacing, Transposition, Bundled conductors, Effect of earth capacitance.

Suggested Readings:

1. Wadhwa C.L., *Electrical Power Systems*, New Age International (P) Ltd., 4th Edition, 2007.
2. Wadhwa C.L., *Generation, Distribution and Utilization of Electrical Energy*, New Age International (P)

Ltd., 4th Edition, 2006.

3. Singh S.N., *Electrical Power Generation*, Transmission and Distribution, Prentice Hall of India, Pvt. Ltd., New Delhi, 2003.
4. V.K.Mehta, *Principles of Power Systems*, S. Chand and Co., 2007.

Course Code	Course Title						Core/Elective
PC237EE	**Linear Control Systems**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The course will introduce the students to

- To develop basic skills of utilizing mathematical tools needed to analyze and design classical linear control systems.
- To understand and develop the state space representation of control systems.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the concept of the terms control systems, feedback, Mathematical modeling of Electrical and Mechanical systems.
2. Explain the time domain and frequency response analysis of control systems.
3. Acquire the knowledge of various analytical techniques used to determine the stability of control systems.
4. Able to understand the importance of design of compensators.
5. Able to demonstrate controllability and observability of modern control systems.

UNIT-I

Introduction to Control Systems: Classification of control systems. Feed-Back Characteristics, Effects of feedback - Mathematical modeling of Electrical and Mechanical systems -Transfer function- Transfer function of Potentiometer, synchro, AC servo motor, DC servo motor - Block diagram reduction technique - Signal flow graph, Mason's gain formula

UNIT-II

Time Domain Analysis: Standard test signals - Time response of first order systems - Transient response of second order system for unit step input, Time domain specifications - Steady state response - Steady state errors and error constants - Effects of P, PD, Pl and PID controllers.

UNIT-III

Stability Analysis in S-Domain: The concept of stability - Routh's stability Criterion, Absolute stability and relative stability, Limitations of Routh's stability.

Root Locus Technique: The root locus concept, Construction of root loci, Effects of adding poles and zeros on the root loci.

UNIT-IV

Frequency Response Analysis: Introduction to frequency response - Frequency domain specifications - Bode plot - Stability analysis from Bode plots - Determination of transfer function from the Bode Diagram - Polar Plots, Nyquist Plots, Stability Analysis, Gain margin and phase margin.

Control System Design: Introduction - Lag, Lead and Lag-Lead Compensator design in frequency Domain.

UNIT-V

State Space Analysis: Concepts of state, State variables and state model, Derivation of state models of linear time invariant systems - Controllable, Observable and Diagonal state models - State transition matrix - Solution of state equation - Concepts of Controllability and Observability.

Suggested Readings:

1. Nagrath I.J. and Gopal.M, *Control System Engineering*, Wiley Eastern, 2003.
2. B.C.Kuo, *Automatic Control Systems*, Wiley India, 7th Edition, 2002.
3. K. Ogata, *Modern Control System*, Prentice Hall of India, 4th Edition, 2002.
4. N.C.Jagan, *Control Systems*, B.S Publications, 2nd Edition, 2008.

Course Code	Course Title						Core/Elective
PC238EE	**Microprocessors and Microcontrollers**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand about 8085 microprocessor architecture, Instruction set and addressing modes.
- To know the use of interfacing devices and process of interfacing.
- To understand about 8051 microcontroller architecture, and programming.

Course Outcomes

After completing this course, the student will be able to:

1. Understand 8085 microprocessor architecture and its operation.
2. Write assembly language program for a given task.
3. Interface memory and I/O devices to 8085 using peripheral devices.
4. Understand uses of microcontrollers and their applications.
5. Write microcontroller programs and interface devices.

UNIT- I

Microprocessor Architecture: Microprocessors, Microcomputers, and Assembly Language, Architecture Details and its operation, Bus organization of 8085, Registers, Memory unit of 8085, Instruction decoding & execution, 8085-Based single board Microcomputer, Pin out Diagram of 8085, Bus timings, 8085 Interrupts (Hardware and Software), 8085 Vectored Interrupts. Introduction to Advanced Controllers, ARM, MSP controllers.

UNIT-II

8085 Programming: The 8085 Programming Model, Operand Types, Instruction Format, Addressing Modes, Instruction set, Writing and debugging simple assembly Language Programs, Delays.

UNIT-III

Interfacing: Memory and I/O interfacing, Programmable Peripheral Interface 8255 (PPI), Interfacing seven segment display, Interfacing matrix keyboard, A/D and D/A interfacing, Programmable Interval Timer (8253), Programmable Interrupt Controller (8259).

UNIT- IV

Microcontroller Architecture: Types of Microcontrollers, 8051 Microcontroller – Architecture, Memory organization, special function registers, pins and signals, timing and control, Ports and circuits, Counters and timers, Serial data input / output, Interrupts & timers.

UNIT-V

8051 Programming: The 8051-programming model, Operand Types, Instruction cycle, addressing modes, 8051 instruction set, Classification of instructions. Simple programs and I/O interfacing.

Suggested Readings:

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming and Applications with the 8085,* Penram International Publishing, 5th Edition, 2011.
2. Krishna Kant, *Microprocessors and Microcontrollers - Architecture, Programming and System Design 8085, 8086, 8051, 8096,* Prentice-Hall India - 2007.
3. Kenneth. J. Ayala, *The 8051 Microcontroller Architecture Programming and Applications,* Thomson publishers, 2nd Edition, 2007.
4. A.K. Ray and Bhurchandi, *Advanced Microprocessors and Peripherals,* Tata McGraw Hill, 2003.

Course Code	Course Title						Core/Elective
PC239EE	**Signals and Systems**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The course is introduced

- To understand the classification of continuous-time and discrete-time signals and systems
- To develop ability to solve systems represented by differential equations and difference equations using analytical methods and Laplace and Z-transforms.
- To acquire the knowledge of representing the signals in frequency domain using Fourier series and Fourier transform.

Course Outcomes

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

1. Classify and analyze the continuous time signals and discrete time signals and systems.
2. Generate discrete time signals through sampling process and reconstruct them.
3. Determine the responses of continuous and discrete-time systems which are represented by differential equations and difference equations.
4. Analyze continuous time systems with the help of Laplace transform and discrete time system with Z-transform.
5. Analyze the continuous and discrete-time systems in frequency domain with the help of Fourier series and Fourier Transform.

UNIT-I

Introduction to continuous time signals: Examples of signals and systems as seen in everyday life in relation to engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time- limited signals; Introduction to discrete-time signals - Sampling and Reconstruction: The Sampling Theorem and its implications. Spectra of sampled signals. Aliasing and its effects. Reconstruction: ideal interpolator, zero-order hold and first-order hold. Classification of discrete time signals.

UNIT-II

Behavior of continuous and discrete-time LTI systems: System properties: linearity: additivity and homogeneity, shift-invariance, causality and stability. Linear time invariant system, properties convolution integral and convolution sum. System representation through differential equations and difference equations.

UNIT-III

Laplace transforms: Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. **Z-transforms:** The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis and solution to difference equations.

UNIT-IV

Frequency domain representation of continuous time signals: Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, properties, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality.

UNIT-V

Frequency domain representation of discrete time signals: The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Suggested Readings:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, *Signals and systems*, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*, Pearson, 2006.
3. H. P. Hsu, *Signals and systems*, Schaum's series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, *Signals and Systems*, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, *Discrete-Time Signal Processing*, Prentice Hall, 2009.
6. M. J. Robert, *Fundamentals of Signals and Systems*, McGraw Hill Education, 2007.
7. B. P. Lathi, *Linear Systems and Signals*, Oxford University Press, 2009.

Course Code	Course Title						Core/Elective
PE101EE	**Electric Distribution System (Professional Elective – I)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- To understand the concepts and Importance of different loads characteristics, Design of Sub-Transmission Lines, Sub-Stations and Feeders.
- To make the students understand about importance of Power Quality and Applications of capacitors in distribution systems.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the concept of different factors used in design of distribution system components.
2. Explain the different types of secondary distribution systems and their performances.
3. Acquire the knowledge of various components, functions and applications of distribution automation and SCADA.
4. Design the optimal locations and ratings of shunt capacitors used in radial feeder for different loading conditions.

UNIT-I

Introduction, Load characteristics. Diversified demand. Non- coincidence demand. Coincidence factor, contribution factor Problems. Rate structure, customer billing, types of distribution transformers.

UNIT-II

Design of Sub-transmission lines and distribution sub-stations. Substation bus schemes, rating of distribution substation, service area with multiple feeders, percent voltage drop Calculations.

UNIT-III

Design considerations of primary systems, radial type and loop type primary feeder, primary feeder loading, uniformly distributed load application to a long line. Design considerations of secondary systems. Secondary banking. Secondary networks. Network transformers, unbalanced loads and voltages.

UNIT-IV

Voltage drop and power loss calculations of 3-phase systems. Voltage fluctuations, measures to reduce flickering. Methods of load flow of Distribution Systems - forward sweep and backward sweep methods.

UNIT-V

Application of capacitors to distribution systems. Effect of series and shunt capacitors, power factor correction, economic justification for capacitors. Best capacitor location-Algorithm. Distribution Automation: Definitions, Components of distribution SCADA. Advanced Metering Infra and Automatic Metering Reading.

Suggested Readings:

1. Turan Gonen, *Electric Power Distribution Engineering,* Mc Graw Hill Book Co., International Student Edition. 1986.
2. A.S. Pabla, *Electric Power Distribution,* Tata McGraw Hill Publishing Company Ltd., 1997.

Course Code	Course Title						Core/Elective
PE102EE	**Renewable Energy Sources (Professional Elective – I)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the concepts and Importance of renewable energy sources such as solar, wind, biomass, tidal power.
- To make the students understand the advantages and disadvantages of different renewable energy sources

Course Outcomes

At the end of the course students will be able to

1. Explain the advantages, disadvantages and applications of different conventional and non-conventional sources.
2. Acquire the knowledge of various components, principle of operation and present scenario of different conventional and non-conventional sources.

UNIT-I

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells — Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT-III

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations - Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT-IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.

UNIT-V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifiers.

Suggested Readings:

1. Rai G.D, *Non-Conventional Sources of Energy*, Khandala Publishers, New Delhi, 1999.
2. David M Buchla and Thomas E Kissell , *Renewable Energy Systems*, 1st Edition by, Pearson India.
3. M.M.El-Wakil, *Power Plant Technology*, McGraw Hill, 1984.
4. John Twidell, Tony Weir, *Renewable Energy Resources*, 3rd Edition, Taylor and Francis.

Course Code	Course Title						Core/Elective
PE103EE	**Hybrid Electric Vehicles (Professional Elective – I)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Know the history of electric hybrid electric vehicles (EV & HEV) and emphasize the need and importance of EV-HEV for sustainable future.
- Introduce the fundamental concepts and principles of electric and hybrid electric vehicles drive train topologies
- Develop a thorough understanding of the key elements of EV/HEV: Electric Machines for Propulsion Applications and Energy Sources..

Course Outcomes

At the end of the course students will be able to

1. To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future.
2. To identify and describe the principles of various EV/HEVs drive train topologies along with their power flow control and fuel efficiency estimation.
3. To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control.
4. To compare and evaluate various energy sources and energy storage components for EV and HEV applications.

UNIT-I

Introduction : Basics of vehicles mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, Power/Energy supplies requirements for EV/HEV applications, vehicle power source characterization, and transmission characteristics. Vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design.

UNIT II

Drive-Train Topologies: Review of electric traction, various electric drive-train topologies, basics of hybrid traction system, various hybrid drive-train topologies, power flow control in drive-train topologies, fuel efficiency analysis.

UNIT III

Electrical Machines and Power Converters for Hybrid and Electric Vehicles: Electric system components for EV/HEV, suitability of DC and AC machines for EV/HEV applications, AC and DC Motor drives. Permanent magnet and switch reluctance machines, configuration and control of drives. Power Converters- Converters for EV and HEV applications.

UNIT V

Energy Sources for EV/HEV: Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, characteristics and comparison of energy sources for EV/HEV, hybridization of different energy sources.

UNIT V

Electric Vehicles Charging Station: Type of Charging station, Selection and Sizing of charging station, Components of charging Station and Single line diagram of charging station. Contactless inductive charging-Stationary Inductive charging, resonant and compensation circuit topologies.

Suggested Readings:

1. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiely, USA, 2012.
2. Chris Mi, M. Abdul Masrur &David Wenzhong Gao, *Hybrid Electric Vehicles: Principles and Applications with Practical Perspective*, , Wiely, 2011
3. Iqbal Hussain, *Electric & Hybrid Vehicles – Design Fundamentals*, 2nd Edition, CRC Press, 2011.
4. Simora Onori, *Hybrid Electric Vehicles Energy Management Strategies*, Springer.

Course Code	Course Title						Core/Elective
PC263EE	**Electrical Circuits Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**2**	**25**	**50**	**1**

Course Objectives

- To Train the Students for acquiring practical knowledge in time response and frequency response of series / parallel RC, RL and RLC Circuits.
- To prepare the students for finds out parameters of a given two port network.
- To make the students for understanding the verification of theorems.

Course Outcomes

At the end of the course students will be able to

1. Evaluate the time response and frequency response character sties of R,L, C Series and parallel circuits.
2. Able to validate the network theorems.
3. Able to find various parameters of a two-port network.
4. Able to simulate electrical circuits using spice.
5. Able to synthesize networks from a given transfer function.

List of Experiments:

1. Charging and Discharging Characteristics of RC and RL series circuits.
2. Locus diagrams of RC and RL Circuits.
3. Frequencies Response of a Series RLC Circuits.
4. Frequencies Response of a Parallel RLC Circuits.
5. Parameters of two port network.
6. Series, parallel and cascade connection of two port networks.
7. Verification of Thevenin's and Norton's theorems.
8. Verification of Superposition theorem and Maximum power transfer theorem
9. Two Wattmeter method.
10. Simulation and transient analysis of series RLC circuits using PSPICE.
11. Mesh and Nodal analysis of electrical circuit using PSPICE.
12. Network Synthesis.
13. Characteristics of Linear, Non-Linear and Bilinear Elements.

Note: At least ten experiments should be conducted in the Semester.

Suggested Readings:

1. Van Valkenburg M.E., Network Analysis, Prentice Hall of India, 3rd Edition, 2000.
2. William Hayt H, Kimmerly Jack E, Steven Durbin M, Engineering Circuit Analysis, McGraw Hill, 6th Edition, 2002.
3. Jagan N.C, Lakshrninarayana C., Network Analysis, B.S. Publications, 3rd Edition, 2014.

Course Code	Course Title						Core/Elective
PC264EE	**Control Systems Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To develop transfer function of various control system plants practically by conducting the experiments.
- To understand the various controllers, basic features of PLC
- Programming and control system concepts using MATLAB.

Course Outcomes

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

1. Able to understand Performance of P, PI and PID Controllers.
2. Able to develop PLC programs for certain applications.
3. Acquire the knowledge of Data acquisition system and Industrial process control.

List of Experiments:

1. Characteristics of D.C. and AC. Servomotor and their transfer function.
2. Characteristics of synchros.
3. Frequency response of second order system.
4. Operating characteristics of Stepper motor.
5. Step response of second order system.
6. D.C. Position control system.
7. A.C. Position control system.
8. Performance of P, PI and PID Controller on system response.
9. Design of lag and lead compensation.
10. ON - OFF temperature control systems.
11. Simulation of control system concepts using MATLAB.
12. PLC (Programmable Logic Controller) applications. (a) Bottle filling (b) Speed control of Stepper motor (c) Liquid level control.
13. Data acquisition system and applications.
14. Industrial process control trainer.

Note: At least ten experiments should be conducted in the Semester.

Suggested Readings:

1. Nagrath I.J. & Gopal.M., *Control System Engineering*, Wiley Eastern, 2003.
2. B.C.Kuo, *Automatic Control Systems*, Wiley India, 7th Edition, 2002.
3. K.Ogata, *Modern Control System*, Prentice Hall of India, 4th Edition, 2002.
4. N.C.Jagan, *Control Systems*, B.S Publications, 2nd Edition, 2008.

Course Code	Course Title						Core/Elective
PC265EE	**Power Electronics Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To be able to understand various power switching devices, trigger circuits, characteristics and applications by conducting the experiments.
- To learn and understand the rectifiers, choppers and inverters principle operation, characteristics and applications.

Course Outcomes

At the end of the course students will be able to

1. Able to understand speed control of motors by using controlled rectifier
2. Able to understand the applications of cyclo-converters
3. Able to simulate different power electronic devices using software.

List of Experiments:

1. R, RC, UJT Trigger Circuits for SCR's.
2. Design and fabrication of trigger circuits for single phase half and fully controlled bridge rectifiers.
3. Study of SCR chopper.
4. Design and fabrication of trigger circuit for MOSFET chopper.
5. Study of forced commutation techniques of SCRs.
6. Speed control of separately excited DC motor by controlled rectifier.
7. Speed control of universal motors using choppers.
8. Study of single phase half and fully controlled rectifier.
9. Study of single phase and three phase AC voltage controller.
10. Study of single phase dual converter.
11. Study of single phase cyclo converter.
12. IGBT based PWM inverters.
13. Simulation of single phase half and fully controlled rectifier.
14. Simulation of single phase and three phase AC voltage controller.
15. Simulation of single phase inverter & three phase inverter.

Note: At least ten experiments should be conducted in the Semester.

Suggested Readings:

1. Bimbra.P.S., *Power Electronics*, Khanna Publications, 2006.
2. Rashid M.H., *Power Electronics Circuits, Devices and Applications*, PHI, 2004.
3. Singh. M.D., Khanchandani K.B., *Power Electronics*, TMH, 14th reprint, 1999.
4. Mohan, Undeland and Robbins, *Power Electronic Converters. Applications and Design*, John Wiley & Sons, 3rd Edition, 2007.

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Electrical and Electronics Engineering) VI–SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC240EE	Power Systems – II	3	-	-	3	30	70	3	3
2	PC241EE	Electrical Measurements and Instrumentation	3	1	-	4	30	70	3	4
3	PC242EE	Digital Signal Processing and Applications	3	1	-	3	30	70	3	4
4	PC243EE	Utilization of Electrical Energy	3	-	-	3	30	70	3	3
5	OE2_ _EE	Open Elective - I	3	-	-	3	30	70	3	3
6	OE2_ _EE	Open Elective – II	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
7	PC266EE	Electrical Machines Lab – II	-	-	2	2	25	50	3	1
8	PC267EE	Measurements and Instrumentation Lab	-	-	2	2	25	50	3	1
9	PC268EE	Microprocessors and Microcontrollers Lab	-	-	2	2	25	50	3	1
10	PC901EE	Summer Internship*	Six Weeks du5ing Summer Vacation							
			18	**1**	**06**	**25**	**255**	**570**	--	**23**

Open Elective – I & II		
1.	OE201EE	Electrical Energy Conservation and Auditing
2.	OE202EE	Reliability Engineering
3.	OE203EE	Non-Conventional Energy Sources
4.	OE204EE	Illumination and Electric Traction Systems

HS: Humanities and Social Sciences BS: Basic Science ES: Engineering Science
MC: Mandatory Course PC: Professional Core OE: Open Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
EE: Electrical Engineering

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.
3. The students have to undergo a Summer Internship of six-week duration after VI–Semester and credits will be awarded in VII–Semester after evaluation.

Course Code	Course Title						Core/Elective
PC240EE	**Power Systems – II**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To expose the students to:

- The student able to learn and understand the performance analysis of transmission lines and cables.
- To be able to comprehend analysis of symmetrical and unsymmetrical faults in the power system.

Course Outcomes

On successful completion of the course, the students would be able to:

1. Acquire modeling of different short, medium and long transmission lines
2. Understand the impact of different types of faults on overhead transmission lines and calculation of fault currents and their significance.
3. Explain the reasons for voltage variation, importance of maintaining constant voltage in power system and different voltage control methods.
4. Acquire the knowledge of natural impedance of transmission line and significance in the operation of power system network.

UNIT-I

Transmission Line Theory: Performance of short, medium, long lines - Line calculations - Tuned lines, Power circle diagram and their applications. Corona - Causes - Disruptive and Visual critical voltages - Power loss - Minimization of corona effects.

UNIT-II

Symmetrical Faults: Use of per unit quantities in power systems, advantages of per unit system. Symmetrical Three-phase Faults, Transients in RL series circuits - Short circuit currents - Reactance‘s of synchronous machines - Symmetrical fault calculations, Short circuit capacity of bus.

UNIT-III

Unsymmetrical Faults: Symmetrical components of unsymmetrical phasors - Power in terms of symmetrical components - Sequence impedance and sequence networks, Sequence networks of unloaded generators - Sequence impedances of circuit elements - Single line to ground, line to line and double line to ground faults on unloaded generator - Unsymmetrical faults of power systems, Open circuit faults.

UNIT-IV

Voltage Control: Phase modifiers, Induction Regulators -Tap changing Transformers, Series and Shunt Capacitors, Reactive Power requirement calculations, Static VAR compensators - Thyristor Controlled reactor, Thyristor switched capacitor.

UNIT-V

Travelling Wave Theory : Causes of over voltages - Travelling wave theory - Wave equation - Open circuited line - The short circuited line - Junction of lines of different natural impedances - Reflection and Refraction Coefficients - Junction of cable and overhead lines - Junction of three lines of different natural impedances- Bewley Lattice diagram.

Suggested Readings:

1. CL Wadhwa - Electrical Power Systems, New Age International, 4th Edition, 2006.
2. Grainger and Stevenson - Power System Analysis, Tata McGraw Hill, 4th Edition, 2003.
3. Nagarath and Kothari - Modern Power System Analysis, Tata McGraw Hill, 4th Edition, 2012.

Course Code	Course Title						Core/Elective
PC241EE	**Electrical Measurements and Instrumentation**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

The objectives of this course is to impart knowledge of

- To learn and understand the fundamental concepts, principle of operation and applications of various electrical measuring instruments.
- To understand various types of Bridges in measurement of resistance, inductance, capacitance and frequency.
- To understand the operation and applications of Ballistic Galvanometer, Flux meter and DC/AC Potentiometer.
- To understand the application of CRO for measurement of Amplitude, Phase and frequency of sinusoidal signals.

Course Outcomes

After completing this course, the student will be able to:

1. Choose the suitable instrument like Ammeter, Voltmeter for AC/DC applications.
2. Select suitable Bridge for measurement of electrical parameters and quantities.
3. Use CRO for measurement of Amplitude, Phase and frequency of sinusoidal signals.

UNIT – I

Instruments: Indicating, Recording and Integrating instruments, Ammeter, Voltmeter, Expression for torque of moving coil, moving iron, Dynamometer, induction and electrostatic instruments. Extension of range of instruments, Wattmeter Torque expression for dynamometer instruments, Reactive power measurement.

UNIT II

Meters: Energy meters, single phase and 3-phase, Driving torque and braking torque equations, Errors and testing compensation, Maximum demand indicator, Power factor meters, Frequency meters, Electrical resonance and Weston type of synchro scope.

UNIT III

Bridge Methods and transducers: Measurement of inductance, capacitance and resistance using Bridges, Maxwell's, Hay's. bridge, Anderson, Wein, Desauty's, Schering's bridges, Kelvin's double bridge, Megger, Loss of charge method, Wagners earthing device, Transducers - Analog and digital transducers, Strain gauges and Hall effect transducers.

UNIT IV

Magnetic Measurements and instrument transformers: Ballistic galvanometer, Calibration by Hibbert' s magnetic standard flux meter, Lloyd-Fischer square for measuring iron loss, Determination of B-H curve and Hysteresis loop using CRO, Instrument transformers – Current and potential transformers, ratio and phase angle errors of CT's and PT's.

UNIT V

Potentiometers: Crompton's DC and AC polar and coordinate types, Applications, Measurements of impedance, Calibration and ammeter voltmeter and wattmeters. Use of oscilloscope in frequency, phase and amplitude measurements.

Suggested Readings:

1. Shawney A.K., *Electrical and Electronics Measurements and Instruments*, Dhanpatrai & Sons, Delhi, 2000.
2. Umesh Sinha, *Electrical, Electronics Measurement and Instrumentations*, Satya Prakashan, New Delhi.
3. Golding E.W., *Electrical Measurements and Measuring Instruments*, Sir Issac & Pitman & Sons Ltd., London.
4. U.A.Bakshi, A.V.Bakshi, *Electrical and Electronic Instrumentation,* Technical publications

Course Code	Course Title						Core / Elective
PC242EE	**DIGITAL SIGNAL PROCESSING AND APPLICATIONS**						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
NIL	3	1	-	-	**30**	**70**	**4**

Course Objectives

- To be able to understand and apply classification: characterization, representation and analysis of signals and systems in time and frequency domain.
- To understand the principle and design of digital filters and to introduce digital signal processor and their architecture.

Course Outcomes

At the end of the course students will be able to

- Acquire the knowledge of - Classification of discrete time signals & discrete time systems, Properties of Z-transforms, Discrete time Fourier transform.
- Analyze the Characteristics of IIR digital filters, FIR digital filters.

  Explain the Advantages of Digital signal processors over conventional Microprocessors.

UNIT- I

Introduction to Digital Signal Processing: Sampling, Quantizing and coding, Classification of discrete time signals & discrete time systems, linear shift invariant systems, Stability and causality, Solution to Linear constant coefficient difference equations.

Z-transforms: Properties Inverse z – transform, System function, Relation between s-plane and z- plane - Stability in Z-domain, Solution of difference equations using one sided z-transform.

UNIT - II

Frequency domain analysis : Discrete time Fourier transform (DTFT), Properties, Frequency domain representation of discrete time signals and systems - DFS, Properties- Frequency domain sampling OFT, Properties - circular convolution - Linear convolution using OFT - Fast Fourier transforms (FFT), Radix-2 decimation in time(DIT) and decimation in frequency(DIF) FFT Algorithms, IDFT using FFT.

UNIT-III

IIR digital filters: Analog filter approximations, Butterworth and Chebyshev filters, Design of IIR Digital filters from analog filters using bilinear transformation, Impulse invariant and step invariant methods. Realization of IIR filters - Direct form - I, Direct form - II, Cascade and parallel form realizations

UNIT- IV

FIR digital filters: Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital filters using window techniques, linear phase realization, Applications of digital signal processing to speech processing.

UNIT-V

Introduction to Digital Signal Processors: Introduction to programmable DSPs -Advantages of Digital signal processors over conventional Microprocessors - Architecture of TMS 320C5X.

Introduction, Bus Structure, Central Arithmetic Logic Unit, Auxiliary Register, Index Register, Auxiliary Register Compare Register, Block Move Address Register, Parallel Logic Unit, Memory mapped registers, Program controller, Status registers, on- chip memory and On-chip peripherals

Suggested Readings:

1. Proakis & Manolakis, *Digital Signal Processing, Principles, Algorithms and Applications*, PHI Publications, 3rd Edition, 1994.
2. Opeinheim and Schaffter, *Digital Signal Processing*, PHI Publications, 2002.
3. Salivahanan Valluaraj and Gnanapriya, *Digital Signal Processing*, Tata McGraw Hill, 2001.
4. Anand Kumar.A, *Digital Signal Processing*, PHI learning Private Ltd, 2013.
5. B.Venkataramani and M. Bhaskar, *Digital Signal Processors, Architecture Programs and Applications*, Tata McGraw Hill, 2007.

Course Code	Course Title						Core/Elective
PC243EE	**Utilization of Electrical Energy**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the various methods of electrical heating.
2. Acquire the knowledge of connection diagrams for motor control.
3. Understand the concepts of illumination and various discharge lamps.
4. Acquire the knowledge of electric traction, traction motors and train lighting.

UNIT I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens - Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

UNIT II

Schematic Utilization and Connection Diagrams for Motor Control: Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

UNIT III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations - Determination of M.S.C.P, Rousseau‘s construction,

Discharge lamps, Sodium vapour lamps, Mercury vapour lamps - Fluorescent lamp, LED lamp, starting and power factor corrections, stroboscopic effects - Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT IV

Electric Traction: System of Electric Traction - Transmission of drive - Systems of track electrification - Traction mechanics - Speed time curves - Tractive effort - Power of Traction motor Specific energy consumption - Mechanics of train movement -Coefficient of adhesion.

Traction Motors: Desirable characteristics, d.c series motors, a.c series motors 3-phase induction motors, d.c motor series and parallel control, Energy saving.

UNIT V

Train Lighting: Systems of train lighting - Special requirements of train lighting - Methods of obtaining unidirectional polarity - Methods of obtaining constant output - Single battery system - Double battery parallel block system - Principal equipment of double battery system - Coach wiring - Dynamo.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Readings:

1. Partab H, *Art and Science of Utilization of Electric Power,* Dhanpat Rai & Sons, 1997.
2. K.B. Raina and S.K. Bhattacharya, *Electrical Design, Estimating and Costing,* Wiley Eastern Ltd., 1991.
3. Partab H, *Modern Electric Traction,* Dhanpat Rai & Sons, 2000.

Course Code	Course Title						Core/Elective
OE201EE	**Electrical Energy Conservation and Auditing (Open Elective)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the concepts of basic energy and various forms of energy.
- To understand the energy management and need of energy audit.
- To understand the energy efficiency technologies.

Course Outcomes

At the end of the course students will be able to

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of different energy efficient devices.

UNIT-I

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

UNIT-II

Basics of Energy and its various forms: Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-III

Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT-IV

Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

UNIT-V

Energy Management and Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for

preparing process flow, material and energy balance diagrams.

Suggested Readings:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. S. C. Tripathy, *Utilization of Electrical Energy and Conservation*, McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org).

Course Code	Course Title						Core/Elective
OE202EE	**Reliability Engineering (Open Elective)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the concepts of different types of probability distributions. importance of reliability evaluation of networks.
- To make the students understand about Reliability, availability model of Power Systems and markov modeling of Power Plants. with identical and nonidentical units.

Course Outcomes

At the end of the course students will be able to

1. Understand the meaning of discrete and continuous random variables and their significance, causes of failures of a system.
2. Acquire the knowledge of different distribution functions and their applications.
3. Able to develop reliability block diagrams and evaluation of reliability of different systems..

UNIT-I

Discrete and continuous random variables. Probability density function and Cumulative distribution function. Mean and variance. Binomial, Poisson, Exponential and WeibulI distributions.

UNIT-II

Failure and causes of failure. Failure rate and failure density. Reliability function and MTTF. Bath tub curve for different systems. Parametric methods for above distributions. Non - Parametric methods from field data.

UNIT-III

Reliability block diagram. Series and parallel systems. Network reduction technique, Examples. Evaluation of failure rate, MTTF and reliability, Active and Standby Redundancy, r out of n configuration. Non-series - parallel systems. Path based and cut set methods.

UNIT - IV

Availability, MTTR and MTBF, Markov models and State transition matrices. Reliability models for single component. two components, Load sharing and standby systems. Reliability and availability models of two unit parallel systern with repair and standby systems with repair.

UNIT – V

Repairable Systems. maintainability. Preventive maintenance, Evaluation of reliability and J1TTF. Overhauling and replacement. Optimum maintenance policy. Markov model of a power plant with identical units and non-identical units. Capacity outage probability table. Frequency of failures and Cumulative frequency.

Suggested Readings:

1. Charles E. Ebeling. Reliability and Maintainability Engineering, McGraw Hill International Edition, 1997.
2. Balaguruswamy, Reliability Engineering, Tata McGraw Hill Publishing Company Ltd, 1984.
3. R.N. Allan. Reliability Evaluation of Engineering Systems, Pitman Publishing, 1996.
4. Endrenyi. Reliability Modeling in Electric Power Systems. John Wiley & Sons, 1978.

Course Code	Course Title						Core/Elective
OE203EE	**Non-Conventional Energy Sources (Open Elective)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand basics and types of Non-conventional energy sources.
- To understand the working and operation of Solar and wind energy systems.
- To understand the working and operation of Ocean, Geo-thermal and biomass energy systems.

Course Outcomes

At the end of the course students will be able to

1. Understand the applications of non-conventional energy sources and fuel cells.
2. Acquire the knowledge of Solar energy storage systems, wind generation and control.
3. Acquire the knowledge of Geothermal, Biomass and ocean energy conversion systems.

UNIT-I

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells- Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT-III

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations - Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT-IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.

UNIT-V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass - Biomass gasifies

Suggested Readings:

1. Rai G.D, Non-Conventional Sources of Energy, Khandala Publishers, New Delhi, 1999.
2. M.M.El-Wakil, Power Plant Technology. McGraw Hill, 1984.

Course Code	Course Title						Core/Elective
OE204EE	**Illumination and Electric Traction Systems (Open Elective)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system.

Course Outcomes

At the end of the course students will be able to

1. Students will be able to design and use op-amps for various linear and non-linear applications.
2. Ability to design and use voltage regulators and active filters.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens — Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

UNIT–II

Schematic Utilization and Connection Diagrams for Motor Control: Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

UNIT – III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations — Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps — Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects — Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT – IV

Electric Traction: System of Electric Traction — Transmission of drive — Systems of track electrification — Traction mechanics — Speed time curves — Tractive effort — Power of Traction motor — Specific energy consumption — Mechanics of train movement— Coefficient of adhesion. Traction Motors: Desirable characteristics, d.c series motors, a.c series motors 3-phase induction motors, d.c motor series & parallel control, Energy saving.

UNIT – V

Train Lighting: Systems of train lighting — Special requirements of train lighting — Methods of obtaining unidirectional polarity — Methods of obtaining constant output — Single battery system — Double battery parallel block system — Principal equipment of double battery system — Coach wiring — Dynamo.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Readings:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating
3. and Costing, Wiley Eastern Ltd., 1991.
4. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
5. B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol —I.

Course Code	Course Title						Core/Elective
PC266EE	**Electrical Machines Lab - II**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To learn operation and performance characteristics of induction machines by conducting various experiments and tests practically.
- To understand the operation and performance characteristics of synchronous machines by conducting various experiments and tests.

Course Outcomes

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

1. Understand Performance characteristics of single-phase induction motor.
2. Understand the importance of Voltage regulation of an alternator.
3. Explain different methods used to measure the voltage regulation of an alternator.

List of Experiments:

1. No-load test, blocked rotor test and load test on 3-phase induction motor.
2. Speed control of 3-phase induction motor by
   a. Cascade connection
   b. Rotor resistance control
   c. Pole changing
   d. Slip power recovery scheme.
3. Power factor improvement of three phase Induction motor using capacitors.
4. Dynamic braking of 3-phase induction motor.
5. Load characteristics of induction generator.
6. Performance characteristics of single-phase induction motor.
7. Voltage regulation of an alternator by (a) Synchronous impedance method (b) Ampere - turn method (c) Z.P.F. method.
8. Regulation of alternator by slip test.
9. Determination of V curves and inverted V curves of synchronous motor.
10. Power angle characteristics of a synchronous machine.
11. Speed control of BLDC motor.
12. Speed control of SRM motor.

Note: At least ten experiments should be conducted in the Semester.

Suggested Readings:

1. Kothari D.P. & Nagrath I.J., *Electrical Machines*, Tata McGraw Hill, 2004.
2. Bhimbra P.S., *Generalized Theory of Electrical Machines*, Khanna Publications, 2000.
3. Say MG., *The Performance and Design of AC. Machines*, Pitman Publication, 2002.
4. Satish Kumar Peddapelli and Sridhar Gaddam., *Electrical Machines-A Practical Approach*, De Gruyter Publisher, Germany, 2020.
5. Irving L. Kosow, *Electric Machinery and Transformers*, PPH, Pearson Education, 2nd Edition. 2009.

Course Code	Course Title						Core/Elective
PC267EE	**Electrical Measurements and Instrumentation Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To train the students for acquiring practical knowledge for measuring resistance, inductance and capacitance using various bridges.
- To train the student for the usage of A.C. and D.C. potentiometers.
- To make the student understand the operation of CRO and its usefulness in finding the amplitude, phase and frequency of waveforms.

Course Outcomes

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

1. Measure the inductance, capacitance and resistance using various bridges.
2. Measure resistance and calibrate ammeter, voltmeters and wattmeter using A.C. and D.C. potentiometers.
3. Have hands on experience on the operation of CRO.

List of Experiments:

1. Measurement of low resistance by Kelvin's Double Bridge.
2. Calibration of single phase energy meter.
3. Measurement of inductance by Maxwell's and Anderson's bridges.
4. Measurement of capacitance by Desauty's and Schering's bridges.
5. Measurement of Iron losses by Lloyd, Fishers magnetic square.
6. Measurement of Resistance and calibration of Ammeter using D.C. potentiometer.
7. Calibration of voltmeter and wattmeter using D.C. potentiometer.
8. Measurement of unknown voltage and impedance using A.C. potentiometer.
9. Calculation of iron losses using B-H curve with oscilloscope.
10. Localizing Ground and short circuit faults using Murray loop test and Varley loop test.
11. Measurement of relative permittivity (Ɛr) of a dielectric medium using Schering bridge.
12. Measurement of frequency of unknown sinusoidal signal with CRO.
13. Measurement of phase and amplitude using CRO.
14. Calibration of given power factor meter using calibrated voltmeter, ammeter and wattmeter.

Note: At least ten experiments should be conducted in the Semester.

Suggested Readings:

1. Shawney A.K., *Electrical and Electronics Measurements and Instruments*, Dhanpatrai & Sons, Delhi, 2000.
2. Umesh Sinha, *Electrical, Electronics Measurement and Instrumentations*, Satya Prakashan, New Delhi.
3. Golding E.W., *Electrical Measurements and Measuring Instruments*, Sir Issac and Pitman & Sons Ltd., London.

Course Code	Course Title						Core/Elective
PC268EE	**Microprocessor and Microcontrollers Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- Developing of assembly level programs and providing the basics of the processors
- To provide solid foundation on interfacing the external devices to the processor according to the user requirements to create novel products and solutions for the real time problems
- To assist the students with an academic environment needed for a successful professional career.

Course Outcomes

At the end of the course students will be able to

1. Familiarize with the assembly language programming.
2. Write programs for given task using different addressing modes.
3. Interface various IO devices using 8255 PPI
4. Write programs using various interrupts.
5. Interface the microcontroller for some real life applications.

List of Experiments:

8085 based:

1. Signed/unsigned multiplication and division.
2. Finding average, largest, square root, etc.
3. Sorting set of numbers.
4. Code conversion like BCD numbers into binary.
5. 8255 PPI for interfacing LEDs.
6. 8255 PPI for interfacing to generate triangular wave using DAC.
7. Using interrupts.
8. Interfacing seven segment display.
9. Interfacing matrix keyboard.

8051 based:

1. Data transfer – block move, exchange, sorting, finding largest element in array.
2. Arithmetic instructions: multi byte operations.
3. Boolean & logical instructions (Bit manipulations).
4. Programs to generate delay, programs using serial port and on chip timer/counter.
5. Use of JUMP and CALL instructions.
6. Square wave generation using timers.
7. Interfacing of keyboard and 7-segment display module.
8. DAC interfacing for generation of sinusoidal wave.

Note: At least five experiments for 8085 and at least five experiments for 8051.

Course Code	Course Title					Core/Elective
PC901EE	**Summer Internship**					**Core**
Prerequisite	Contact Hours			CIE	SEE	Credits
	L/T	D	P			
-	**-**	**-**	**Six Weeks**	**50**	**-**	**2**

Course Objectives

- To give an experience to the students in solving real life practical problems with all its constraints.
- To give an opportunity to integrate different aspects of learning with reference to real life problems.
- To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry.

Course Outcomes

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

1. Design/develop a small and simple product in hardware or software.
2. Complete the task or realize a pre-specified target, with limited scope, rather than taking up a complex task and leave it.
3. Learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre-specified criteria.
4. Implement the selected solution and document the same.
5. Able to write a technical report and present it to appropriate audience.

Summer Internship is introduced as part of the curriculum for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Electronics Industry / R & D Organization / National Laboratory for a period of six weeks. This will be during the summer vacation following the completion of the VI Semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the summer internship, students will submit a brief technical report on the internship executed and present the work through a seminar talk to be organized by the department. Award of sessional are to be based on the performance of the student at the work place to be judged by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Summer Internship.

***Students have to undergo summer internship of six Weeks duration at the end of VI semester and two credits will be awarded in the VII Semester after evaluation.**