FACULTY OF ENGINEERING

Scheme of Instructions and Examination

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

and

Syllabi

B.E. VII and VIII Semester

of

Four Year Degree Programme

in

Electrical and Electronics Engineering

(With effect from the academic year 2021 - 22)

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

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

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SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Electrical and Electronics Engineering) VII – 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	PC428EE	Control of Electric Drives	3	-	-	3	30	70	3	3
2	PC429EE	Switchgear and Protection	3	-	-	3	30	70	3	3
3	PC430EE	Power Electronic Applications to Power Systems	3	-	-	3	30	70	3	3
4	PE5__EE	Professional Elective - II	3	-	-	3	30	70	3	3
5	PE5__EE	Professional Elective - III	3	-	-	3	30	70	3	3
6	PE5__EE	Professional Elective - IV	3	-	-	3	30	70	3	3
Practical / Laboratory Courses										
7	PC462EE	Power Systems Lab	-	-	2	2	25	50	3	1
8	PC466EE	Electrical Simulation Lab	-	-	2	2	25	50	3	1
9	PW702EE	Project Work Phase – I	-	-	6	6	25	50	-	3
10	PW701EE	Summer Internship*	-	-	-	-	50	-	-	1
Total			**18**	**-**	**10**	**28**	**305**	**570**	**-**	**24**

Professional Elective – II, III & IV		
1	PE501EE	Electrical Machine Design
2	PE502EE	Special Electric Machines
3	PE505EE	High Voltage Engineering
4	PE506EE	Digital Control Systems
5	PE509EE	Power Quality Engineering
6	PE510EE	Energy Management Systems and SCADA

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 Engg.

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
PC428EE	**Control of Electric Drives**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

- Understand the concepts of development of control circuits, remote control and electric interlocking in an industry
- Understand the construction and operation of various control components for the control circuits
- Understand the development of control circuits for various operations of both DC and AC machines.
- To understand the procedure for trouble shooting of circuits
- To understand the driver circuits for step motor

Course Outcomes

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

1. Develop the control circuits for remote control and interlocking of electric drives
2. Develop the control circuits for starting and braking of DC machines and Induction machines
3. Trouble shoot the control circuits
4. Develop the driver circuits for step motor
5. Analyze the use of batteries and its usage and maintenance.

UNIT I

Introduction of Electrical Control of Machines: Manual control – Magnetic control Semi-automatic and Automatic control of Modern machinery – Development of Control circuits–Two wire and Three wire control – Remote control – Interlocking of drives – Control circuit components –Symbols for control components–Fuses, Switches and Fuse Switch units.

UNIT II

Protection of motors : Moulded– Case Circuit Breaker (MCCB) and Miniature Circuit Breaker (MCB) – Contactors – Types of contactors – Contactor ratings, Relays – D.C Series current relay – Frequency responsive relay – Latching relay – Over load relays – Bimetallic Thermal over load relay – time delay relay (Timers) – Motor drivers Electronic timer – Phase failure relay – Push button switches – Types, Limit switch – Float switch.

UNIT III

Control of Three-Phase Induction Motors: Motor current at start and during acceleration – Automatic starters – Increment Resistor type starter – Automatic Autotransformer starter – Open circuit and closed-circuit transition – Part winding motor starters Two step and Three step starting – Automatic Star-Delta starters Open circuit and closed-circuit transition – Starters for multi-speed motors. Starters for Wound rotor motors – Control circuit using contactor and flux delay relays.

UNIT IV

Control of Synchronous Motors: Manual Push button synchronizing Starter, Timed Semi-Automatic Synchronizing, Automatic Starter using Polarised Field Frequency Relay. Control of D.C motors: Principles of acceleration – Types of starters for automatic acceleration – Control circuits for DCL, Current limit acceleration starters – Reviewing of D.C motors – Control circuit for direct reversing and forward stop reverse operation – Jogging operation of D.C motor – Control circuits for braking action.

UNIT V

Control of stepper motors: Control circuit for Stepper motor – Block diagram of a typical step motor control – Types of drive circuits – simple power drive circuit – L/R drive Bi-level drive – Chopper drive – Linear constant current drive – Bipolar drives for Stepper motor – H type and L/R type bipolar drives – Bipolar Chopper drives. Trouble shooting in control circuits – Trouble spots –General procedure for trouble shooting.

Suggested Reading:

1. Bhattacharya S.K and Brijinder Singh, *Control of Electrical Machines*, New Age International Publishers, New Delhi.
2. Athani V.V, *Stepper Motors — Fundamentals, Applications and Design*, New Age International Publishers, New Delhi.

Course Code	Course Title						Core / Elective
PC429EE	**Switchgear and Protection**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	
	L	T	D	P			Credits
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To be able to understand the need of protection in power system and protection with conventional and static relays.
- To understand the protection of transformers, generators and need of circuit breakers.

Course Outcomes

At the end of the course students will be able to

1. Acquire the knowledge of construction, working principles of different electromagnetic and static relays used to protect generators, transformers, transmission lines and distribution feeders.
2. Analyze the Characteristics of over current, over voltage, distance and differential relays and also their applications in power system networks.
3. Explain the working principle. Construction, rating and applications of different types of circuit breakers used in power system networks.
4. Understand the construction details, advantages, disadvantages of Gas Insulation substations.

UNIT- I

Introduction to Protective Relays: Need for protection - primary protection - backup protection Zones of protection - Definitions of relay pick up and reset values - Classification of relays - Operating principles and construction of Electromagnetic and Induction type relays. Over current relay - Over voltage - Directional relay - Universal relay torque equation. Over current protection for radial feeder and ring mains - Protection of parallel lines - Relay settings for over current relays Earth fault and phase fault protection.

UNIT - II

Static Phase and Amplitude Comparators: Characteristics of dual input comparators. Static Relays - Instantaneous over current relay - Definite time over current relay - Inverse time over current relay - Directional over current relay (Block diagram approach only)

Distance protection - Characteristics of 2- input distance relays on the RX diagram - Input characteristics for various types of distance relays - 3-step distance relays, Microprocessor based over current relay (block diagram).

UNIT- III

Transformer and Generator Protection: Differential relays -Percentage differential relays protection of generator and transformer using percentage differential relays, Split phase protection, Overheating, Loss of excitation - Protection of transformers against magnetizing inrush - Buchholz relay - Protection of earthing transformers.

UNIT-IV

Circuit Breakers : Need for circuit breakers, Parts of circuit breaker trip coil circuit- Arc properties - Principles of arc quenching - Theories, Recovery and restriking voltages - Rating of circuit breakers - Rated symmetrical and asymmetrical breaking current - Rated making current - Rated capacity, Voltage and frequency of circuit breakers, Auto re-closure-duty cycle, Current chopping - Resistance switching - Derivations of RR'RV - Maximum RRRV, Recovery voltage, Problems - Types of circuit breakers - Oil, Minimum oil, Air, Air blast, SF , Vacuum and miniature circuit breakers, Testing of circuit breakers.

UNIT-V

Gas Insulated Substations and Over Voltage Protection: Constructional details (components), Merits and

Demerits of Gas Insulated Substations over conventional Air insulated Substations. Protection of transmission

lines against direct lightning strokes – ground wires - Protection angle
Protection zone - Tower footing resistance and its effects - Equipment protection assuming rod gaps, arcing horns - Different types of lightning arresters - their construction Surge absorbers - Peterson coil - Insulation coordination.

Suggested Reading:

1. Wadhwa C.L, *Electrical Power System*, Wiley Eastern Ltd., 3rd Edition-2002.
2. Badriram, Viswakarma, *Power System Protection and Switchgear*, Tata McGraw Hill, 2003.
3. Sunil S. Rao, *Switchgear and Protection*, Khanna Publications, 2000.
4. M.S. Naidu, *Gas Insulated Substations*, I.K. int. Publishing House Pvt. Ltd. -2008.

Course Code	Course Title						Core / Elective
PC430EE	**Power Electronic Applications to Power Systems**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC411EE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the issues involved in existing Power Transmission system
- To be familiar with the Techniques to overcome the problems associated with AC Power Transmission system
- To Understanding the control of active and reactive power control using Power electronic converters

Course Outcomes

1. The student will be able to know the application of FACTS devices in Power Transmission system.
2. The student will be able to Study and apply the power transmission schemes – HVDC Transmission
3. The student will be able to implement the control circuits based on the Controlling parameters of HVDC system

UNIT - I

Facts concepts: Reactive power control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.

UNIT - II

Static shunt and series compensators: Shunt compensation - objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators - SVC, STATCOM, SVC and STATCOM comparison. Series compensation - objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes.

UNIT -III

Combined compensators: Unified power flow controller (UPFC) - Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.

UNIT-IV

Hvdc transmission: HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DClinks, Layout of HVDC Converter station and various equipments. HVDC Converters, analysis of bridge converters with and without overlap, inverter operation, equivalent circuit representation of rectifier and inverter configurations

UNIT-V

Control of HVDC system: Principles of control, desired features of control, converter control characteristics, power reversal, Ignition angle control, current and extinction angle control. Harmonics-introduction, generation, ac filters and dc filters. Introduction to multiterminal DC systems and applications, comparison of series and parallel MTDC systems.

Suggested Reading:

1. Song, Y.H. and Allan T. Johns, *Flexible AC Transmission Systems (FACTS)*, Institution of Electrical Engineers Press, London.
2. Hingorani ,L.Gyugyi, *Concepts and Technology of Flexible AC Transmission System*, IEEE Press New York, 2000.
3. Padiyar, K.R.,*HVDC Transmission Systems*, Wiley Eastern Ltd., 2010.

4. Mohan Mathur R. and Rajiv K.Varma , *Thyristor based FACTS Controllers for Electrical Transmission*

systems, IEEE press, Wiley Inter science , 2002.
5. Padiyar K.R., *FACTS controllers for Transmission and Distribution systems,* New Age International Publishers, 1st Edition, 2007.
6. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar AngelesCamacho *FACTS – Modeling and simulation in Power Networks* John Wiley & Sons, 2002.

Course Code	Course Title						Core / Elective
PE501EE	**Electrical Machine Design (Professional Elective – II/III/ IV)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC403EE, PC409EE	**3**	**1**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To Study the Qualitative & Quantitative analysis of magnetic circuit design, Electrical Circuit Design and Thermal Circuit. Design of Electrical Machine.
- To understand the Design and analysis of different types of windings used for DC/AC machines.
- To understand the Design principles of different rotating machines can be studied.

Course Outcomes

At the end of the course students will be able to

1. Make a choice of material to evolve a particular design problem at hand and make reference to the standards used by the industry
2. Understand the behavior of magnetic materials, thermal performance and rating of machines.
3. Design DC machine along with the materials, ventilation and cooling aspect used in it
4. Design AC machine along with the materials, ventilation and cooling aspect used in it.
5. To make the trials using a computer program and hundreds of design are worked in repetitive manner to evolve a cost optimized design by using computer aided design

UNIT-I

Electrical engineering materials insulating materials: Properties of ideal insulating materials, classification and types of insulating materials, Conducting materials, general properties of Cu, Al and steel, High resistance alloys, carbon and other conducting materials, super conductors-Magnetic materials: classification of magnetic materials, soft and hard magnetic materials, Sheet steel, cold rolled steels, solid core and laminated core materials.

UNIT-II

Magnetic circuit: Basic principles, magnetic circuit calculations, Flux density in air gap and tooth-Carters coefficient, Ampere turns for gap and teeth, real and apparent flux density, Magnetic leakage, armature leakage, leakage flux from salient poles, Field distribution curves, field turns, ampere reaction ampere turns

Thermal circuit: Types of enclosures ventilation and cooling system, Losses, temperature rise time curve, rating of electrical machines, calculation for quantity of cooling medium

Rating of motors: heating effects, load conditions and classes of duty, Determination of power rating.

UNIT-III

DC Machine design: Output equation, main dimensions, Choice of specific magnetic and electric loading, selection of no of poles, Choice of armature core length, armature diameter, Length of air gap, armature design and design of field system.

UNIT-IV

AC machine design: Transformer design, main dimensions, Output equation, core design, cooling system design, 3 Phase Induction motors: output equation, main dimensions, design of stator and rotor, Design of squirrel cage rotor, design of end rings.

Synchronous machine: Output equation, main dimensions, SCR, length of air gap, Selection of armature slots, design of field system and turbo alternators.

UNIT-V

Computer aided design: Introduction, advantages of digital computers, computer aided design- different approaches, Analysis, synthesis and hybrid method, optimization-General procedure for optimization, variable constraints, Computer aided design of 3 phase IM, Lists of symbols used, general design procedure.

Suggested Reading:

1. A.K. Sawhney, A course in Electrical Machines Design, Dhanpat Rai and Sons, 1996.
2. R.K. Agarwal, Principles of Electrical Machines Design, S.K. Kataria& sons, 4th Edition, 2000, NaiSarak, New Delhi.

Course Code	Course Title						Core / Elective
PE502EE	**Special Electrical Machines (Professional Elective – II/ III/ IV)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC403EE, PC409EE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To explain theory of operation and control of switched reluctance motor.
- To explain the performance and control of stepper motors, and their applications.
- To describe the operation and characteristics of permanent magnet dc motor.
- To distinguish between brush dc motor and brush less dc motor.
- To explain the theory of travelling magnetic field and applications of linear motors.

Course Outcomes

1. Explain theory of operation and control of switched reluctance motor.
2. Explain the performance and control of stepper motors, and their applications.
3. Describe the operation and characteristics of permanent magnet dc motor.
4. Distinguish between brush dc motor and brush less dc motor.
5. Explain the theory of travelling magnetic field and applications of linear motors.

UNIT -I

Stepper Motors: Constructional features, Principle of operation, Variable Reluctance (VR) stepping motor- Single Stack, Multi-Stack, Permanent Magnet Step motor, Hybrid Step Motor, Torque Equation Open Loop Drive, Open loop and closed loop control of Step Motor, Applications.

UNIT -II

Switched Reluctance Motors: Constructional features, Principle of Operation, Torque equation, Torque-speed characteristics, Power Converter for SR Motor-Asymmetrical converter, DC Split converter, Control of SRM, Rotor Position sensors, Current Controllers, Applications.

UNIT-III

Permanent Magnet Synchronous Motor: Permanent magnets and their characteristics, Machine Configurations-SPM, SIPM, IPM and Interior PM with circumferential, Sensorless control, Applications.

UNIT -IV

Brushless DC Motor: Construction, Principle of Drive operation with inverter, Torque speed Characteristics, Closed loop control, Sensorless control, Applications.

UNIT-V

Linear Induction Motors and Linear Synchronous Motors: Linear induction motor, Construction details, LIM Equivalent Circuit, Steps in design of LIM, Linear Synchronous Motor: Principle and Types of LSM, LSM Control, Applications.

Suggested Readings:

1. R. Krishnan*, Electric Motor Drives*, Pearson Education, 2007
2. B.K. Bose, *Modern Power Electronics and AC Drives*, PHI, 2005
3. Venkataratnam, *Special electrical Machines*, University Press, 2008
4. E.G. Janardanan, *Special Electrical Machines*, PHI, 2014
5. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drive*, Clarendon Press, Oxford,

Course Code	Course Title						Core / Elective
PE505EE	**High Voltage Engineering (Professional Electives-II/ III/ IV)**						**Elective**
Prerequisites	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the concepts of Conduction and Breakdown of Gaseous Insulating Materials.
- To make the students understand the Generation, Measurement and Testing of High Voltage DC, AC & impulse Currents.

Course Outcomes

The students will be able to:

1. Explain the fundamentals of conduction and breakdown in various solid, liquid and gaseous insulating materials.
2. Able to design the circuits used in high voltage AC, DC generation, measurement and testing.
3. Able to understand the significance of standard impulse wave shapes and radio interference measurement.

UNIT-I

Conduction and Breakdown of Gaseous Insulating Materials: Ionization processes and current growth -- Townsend‘s criterion for breakdown - Breakdown in electronegative gases - Time lags for breakdown - Paschen‘s law - Corona discharges - Breakdown in non-uniform fields - Practical considerations for selecting gases for insulation purposes.

UNIT-II

Conduction and Breakdown in Liquid and Solid Dielectrics: Various mechanisms of breakdown in liquid dielectrics - Liquid dielectrics used in practice- Various processes - Breakdown in solid dielectrics- Solid dielectrics used in practice.

UNIT-III

Generation of High Voltages and Currents: Generation of high D.C voltages using voltage multiplier circuits - Van de Graff generator. Generation of high alternating voltages using cascade transformers- Production of high frequency A.C high voltages - Standard impulse wave shapes - Marx circuit - Generation of switching surges - Impulse current generation - Tripping and control of impulse generators.

UNIT-IV

Measurement of High Voltages and Currents: High D.C voltage measurement techniques - Methods of measurement for power frequency A.C voltages - Sphere gap measurement technique - Potential divider or impulse voltage measurements -Measurement of high D.C, A.C and Impulse currents - Use of CRC for impulse voltage and current measurements.

UNIT-V

High Voltage Testing: Tests on insulators - testing on bushings - Testing of isolators and circuit breakers - Cable testing of transformers Surge diverter testing - Radio interference measurement - Use of I.S.S. for testing.

Suggested Reading:

1. M.S. Naidu and V. Kamaraju, *High Voltage Engineering,* Tata McGraw Hill, 1982.
2. E. Kuffel and M. Abdullah, *High Voltage Engineering,* Pergamon Press, 1970.

Course Code	Course Title						Core / Elective
PE506EE	**Digital Control Systems (Professional Electives-II/ III/ IV)**						**Elective**
Prerequisites	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC415EE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To impart knowledge in the significance and features of design of discrete- time control system.
- To review on the different transform techniques for digital control system design.
- To impart knowledge on the techniques to analyse the system performance in the discrete-time domain.
- To impart knowledge in discrete state space controller design.

Course Outcomes

After completing this course, the student will be able to

1. Understand the various issues related to digital control systems such as effects of sampling and quantization, discrete time signals and models.
2. Represent a discrete-time control system using state space technique.
3. Design discrete control systems via pole placement.
4. Design observers for discrete control systems.
5. Analyse the stability of a discrete-time control system.

UNIT-I

Introduction to digital control Configuration of basic digital control system: discrete transfer function, discrete model sampled data systems using z- transform, transfer function model, signal analysis and dynamic response, zero-order hold equivalent, introduction to first-order-hold equivalent, transformation between splane, z-plane and w-plane, z-Domain description of sampled continuous-time systems. Controller design Controller Design using transform techniques: Root locus and frequency domain analysis compensator design.

UNIT-II

State space theory Control system analysis using state variable method: vector and matrices, state variable representation, conversion of state variable to transfer function and vice versa, conversion of transfer function to canonical state variable models, system realization, solution of state equations. Solution of discrete-time state equation. Computational methods.

UNIT-III

State space design using state-space methods: controllability and observability, control law design, pole placement, pole placement design using computer aided control system design (CACSD).

UNIT-IV

Observer design: Full order and reduced order discrete observer design - Kalman filter and extended Kalman filter design.

UNIT-V

Stability improvement by state feedback: Stability analysis and Jury‘s stability criterion, Lyapunov stability analysis to linear systems and discrete systems, Stability Improvement by state feedback.

Suggested Readings:

1. K. Ogata, *Discrete Time Control Systems*, Prentice Hall India, 2nd edition, 2005.
2. M. Gopal, *Digital Control and State Variable Methods*, Tata McGraw Hill, 3rd edition., 2008.

3. R. Isermann, *Digital Control Systems* Vol 1&2, Springer-Verlag, 1991.
4. B. C. Kuo, *Digital Control System*, Oxford University Press, 2nd edition., 2007

Course Code	Course Title						Core / Elective
PE509EE	**Power Quality Engineering (Professional Elective-II/ III/ IV)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The student able to learn and understand the importance of power quality, different power quality issues and their effects in power system network

Course Outcomes

1. Describe the different PQ disturbances and state remedies to improve PQ.
2. Determine voltage sag for different network configurations.
3. Demonstrate the effect of ASD systems on power quality and the effect of voltage sags on operation of various electrical machines.
4. Evaluate harmonic levels for distribution systems.
5. Describe power quality monitoring and measuring techniques.

UNIT-I

Introduction: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring. Power Quality Data: Data collection, Data analysis, Database structure, Creating PQ databases, Processing PQ data.

UNIT-II

Voltage Sag Characterization: Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, Meshed systems, voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

UNIT-III

PQ Considerations in Industrial Power Systems: Adjustable speed drive (ASD) systems and applications, mitigation of harmonics. Characterization of voltage sags experienced by three-phase ASD systems: Types of sags and phase - angle jumps. Effects of momentary voltage dips on the operation of induction and synchronous motors. Voltage sag coordination for reliable plant operation.

UNIT-IV

Effects of Harmonics on Power Quality: Harmonic analysis of industrial customers, technical barriers in ASDs. Methods of evaluation of harmonic levels in industrial distribution systems. Harmonic effects on transformers. Impact of distribution system capacitor banks on PQ. Guidelines for limiting voltage harmonics.

UNIT-V

Power Quality Monitoring: Introduction, site surveys, Transducers, IEC measurement techniques for Harmonics, Flicker, IEC Flicker meter.

Suggested Readings:

1. Math H.J. Bollen, *Understanding Power Quality Problems*, IEEE Press, 1999.
2. Roger C. Dugan, MarkF. McGranaghan, Surya Santoso, H. WayneBeaty, *Electrical Power Systems Quality*, Second Edition, Tata McGraw-Hill Edition.
3. C. Sankaran, *Power Quality*, CRC Press, 200.

Course Code	Course Title						Core / Elective
PE510EE	**Energy Management Systems and SCADA (Professional Elective-II/ III/ IV)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	**Credits**
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Outline energy management systems and unit commitment and its solution techniques.
- Discuss power generation scheduling with limited energy.
- Describe the architecture, functions and applications of supervisory control and data acquisition (SCADA) and apply SCADA in power system automation and communications.

Course Outcomes

After completing this course, the student will be able to

1. Understand energy management centers.
2. Know the principles of power generation scheduling.
3. Be acquainted with the configurations of SCADA
4. Have a knowledge of SCADA communication

UNIT-I

Energy Management Centers: Introduction, Energy management centers and their functions, architectures, recent developments, characteristics of power generating units and economic dispatch, unit commitment (spinning reserve, thermal, hydro and fuel constraints), solution techniques of unit commitment.

UNIT-II

Generation Scheduling: Generation scheduling with limited energy, energy production cost models, budgeting and planning, practical considerations, interchange evaluation for regional operations, types of interchanges, exchange costing techniques.

UNIT-III

Supervisory Control And Data Acquisition: Introduction to supervisory control and data acquisition, SCADA functional requirements and components. SCADA Application: General features, functions and applications, benefits of SCADA, architectures of SCADA, applications of SCADA.

UNIT-IV

SCADA and Power Systems: Configurations of SCADA, RTU (remote terminal units) connections, power systems SCADA and SCADA in power system automation.

UNIT-V

SCADA and Communication: SCADA communication requirements, SCADA communication protocols: past present and future, structure of a SCADA communications protocol.

Suggested Readings:

1. Handschin E, *Energy Management Systems*, Springer Verlag, 1^{st} Edition, 1990.
2. Handschin E, *Real Time Control of Electric Power Systems*, Elsevier, 1^{st} Edition, 1972.
3. John D Mc Donald, *Electric Power Substation Engineering*, CRC press, 1^{st} Edition, 2001.
4. Wood, A J and Wollenberg, B F, *Power Generation Operation and Control*, John Wiley and Sons, 2^{nd} Edition 2003.
5. Green, J N Wilson, R, *Control and Automation of Electric Power Distribution Systems*, Taylor and Francis, 1^{st} Edition, 2007.
6. Turner, W C, *Energy Management Handbook*, Fairmont Press, 5^{th} Edition, 2004.

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Course Code	Course Title						Core / Elective
PC462EE	**Power System Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC408EE, PC418EE	-	-	-	2	25	50	1

Course Objectives

- To determine regulation & efficiency of short, medium and long transmission lines and to calculate A, B, C, D constants.
- To understand the importance of protective relays in power system such as different protection of transformer DMT Characteristics of over current relay, Buchholz relay and static relays.
- To understand the procedure to determine sequence parameters of transformer and alternator.

Course Outcomes

1. Determine ABCD constants of transmission lines and evaluate regulation, efficiency.
2. Acquire knowledge in relay setting for safe operating of power system.
3. Determine sequence parameters of transformer and alternator and draw its importance.
4. Determine the time constant of an alternator.
5. Determine the dielectric strength of oil and calculate the efficiency of string insulators.

List of Experiments:

1. Determination of regulation & efficiency of Short, Medium and Long transmission lines.
2. IDMT characteristics of Over-current relay & Study of Bucholz relay.
3. Determination of A, B, C, D constants of Short, Medium and Long lines. Drawing of Circle diagrams.
4. Differential protection of transformer.
5. Sequence impedance of 3-Phase Alternators.
6. Determination of positive, negative and zero-sequence reactance of 3- Phase transformers using sequence current excitation fault calculation.
7. Synchronous machine reactance and time constant from 3-Phase S. Ctest.
8. Characteristics of Static relays.
9. Static excitation of Synchronous Generator.
10. Determination of dielectric strength of oils and study of Megger.
11. Parallel operation of Alternators.
12. Measurement of capacitance of 3-core cables.
13. Fault location of Underground cables.
14. Simulation of string of insulators for determination of Voltage distribution and String efficiency.

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

Course Code	Course Title						Core / Elective
PC466EE	**Electrical Simulation Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- The student learns analysis of electrical system through computer simulation, using software packages.
- To simulate a given electrical circuits in any environment, to analyse its dynamic characteristics and to figure out its stability considerations.

Course Outcomes

After completing this course, the student will be able to

1. Simulate the concepts of Electrical Circuits, Control Systems and Power Systems and interpret data.
2. Demonstrate the knowledge of programming environment, compiling, debugging, linking and executing variety of programs in MATLAB.
3. Demonstrate ability to develop Simulink models for various electrical systems.
4. Validate simulated results from programs/Simulink models with theoretical calculations.

Simulation experiments should be conducted in the following areas using MATLAB / Simulink (with DSP Tool Box, Control System Tool Box & Power System Tool Box) PSpice /PSCAD / SABER / EDSA/ Power Trans

1. Verification of Network theorems
   a. Thevinin's theorem
   b. Superposition theorem
   c. Maximum power transfer theorem.
2. Transient responses of Series RLC, RL and RC circuits with Sine and Step inputs.
3. Series and Parallel resonance.
4. Bode plot, Root-Locus plot and Nyquist plot.
5. Transfer function analysis
   (i) Time response for Step input
   (ii) Frequency response for Sinusoidal input.
6. Design of Lag, Lead and Lag - Lead compensators.
7. Load flow studies.
8. Fault analysis.
9. Transient stability studies.
10. Economic Power Scheduling
11. Design of filters (Low pass filter).
12. Chopper fed dc motor drives.
13. VSI /CSI Fed induction motors drives. Doubly fed Induction motor.
14. Phase Control of DC motor Drives.
15. Control of BLDC motor.

Note: At least ten experiments should be conducted.

Course Code	Course Title						Core / Elective
PC702EE	**Project Work Phase – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**6**	**25**	**50**	**3**

Course Objectives

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.
The department will appoint a project coordinator who will coordinate the following:
Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
Grouping of students (max 3 in a group)
Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.
Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes‘presentation followed by 10 minutes‘discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Electrical and Electronics Engineering) VIII – 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	PE5_EE	Professional Elective – V	3	-	-	3	30	70	3	3
2	PE5_EE	Professional Elective –VI	3	-	-	3	30	70	3	3
3	OE6_EE	Open Elective-III	3	-	-	3	30	70	3	3
Practical / Laboratory Courses										
4	PC463EE	Digital Signal Processing Lab	-	-	2	2	25	50	3	1
5	PW703EE	Project Work Phase – II	-	-	16	16	50	100	-	8
Total			**09**	**-**	**18**	**27**	**165**	**360**	**-**	**18**

Professional Elective – V & VI		
1	PE511EE	AI Techniques in Electrical Engineering
2	PE512EE	Advances in Power Electronics
3	PE513EE	Grid Integration of Renewable Energy Systems
4	PE514EE	Smart Grid Technology
5	**PE515EE**	**POWER SYSTEM OPERATION AND CONTROL**

Open Elective – III		
1	OE605EE	Smart Building Systems (Not for EEE & EIE Students)
2	OE606EE	Programmable Logic Controllers (Not for EEE & EIE Students)
3	OE631AE	Automotive Maintenance (Not for Mech./Prod./Auto. Engg. students)
4	OE631ME	Mechatronics (Not for Mech./Prod./Auto. Engg. students)
5	OE603CE	Road Safety Engineering (Not for Civil Engg. Students)
6	OE604IT	Software Engineering (Not for IT Students)

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 Engg.

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 thestudent to complete the experiment.

Course Code	Course Title						Core / Elective
PE515EE	**Power System Operation and Control**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC236EE, PC240EE	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

- To understand the concepts and Importance of Load flow studies, Economic Operation of thermal power units, frequency control of inter connected Power System Networks.
- To make the students understand about reactive Power Control and Stability of Power System Networks.

Course Outcomes

After completing this course, the student will be able to

1. Solve load flow by appropriate modelling of the given power system and formulation of Ybus.
2. Evaluate generation mix for economic operation with and without transmission losses.
3. Explain load frequency control and estimate the frequency deviation through modelling.
4. Analyse and describe different types of power system stability and establish SSSL.
5. Identify various methods of voltage control and study the reactive power compensation.
6. Design the railway steel bridges and bridge bearings.

UNIT-I

Load Flow Studies: Formulation of Y bus for a system, modelling of tap changing and phase shifting transformer, Formulation of load flow problem, Solution of load flow by Gauss-Seidel, Newton-Raphson, Decoupled and Fast Decoupled methods, comparison of different load flow methods.

UNIT-II

Economic Operation of Power System: Input-Output curves, Heat rates and incremental cost curves, Equal Incremental cost criterion neglecting transmission losses with and without generator limits, Bmn coefficients, Economic operation including transmission losses.

UNIT-III

Load Frequency Control: Governor Characteristics, Regulation of two generators, coherency, concept of control area, Incremental power balance of a control area, Single area control, Flat frequency control, Flat tie-line frequency control, Tie-line bias control, Advantages of pool operation, Development of model for two-area control.

UNIT-IV

Power System Stability: Definitions of Steady state stability and Transient stability, Steady state stability of a synchronous machine connected to infinite bus, calculation of steady state stability limit, synchronous machine models with and without saliency, Equal area criterion, Application of equal area criterion, Swing equation, Step by step solution of Swing equation, factors effecting transient stability, Auto Reclosures, mathematical formulation of voltage stability problem.

UNIT-V

Reactive Power Control: Reactive power generation by synchronous generators, Automatic voltage regulators, FACTS Controllers-TCSC, STATCOM, UPFC.

Suggested Readings:

1. D. P. Kothari and I.J. Nagrath, *Modern Power System Analysis,* Tata McGraw Hill.
2. John. J. Grangier, William D. Stevenson Jr., *Power System Analysis*, Tata McGraw Hill.
3. C.L. Wadhwa, *Electric Power Systems*, New Age International (p) Ltd

4. Haadi Sadat , *Power System Analysis,* Tata McGraw Hill.
5. Elgerd, *Electrical Energy Systems Theory,* Tata McGraw Hill
6. P. Chandrashaker, P. Satish Kumar, *Computer Methods in Power Systems – Analysis with MATLAB*, BSP Publishers, 2020.

Course Code	Course Title						Core / Elective
PE511EE	**AI Techniques in Electrical Engineering (Professional Elective – V / VI)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	
	L	T	D	P			Credits
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To be able to understand basics of ANN & Fuzzy based systems.
- To make the students to understand the ANN based systems for function approximation used in load forecasting.

Course Outcomes

At the end of the course students will be able to

1. Understand how the soft computing techniques can be used for solving the problems of Electrical Engineering.
2. Design of ANN based systems for function approximation used in load forecasting.
3. Design of Fuzzy based systems for load frequency control in power systems
4. Solve problem of Optimization in power systems.

UNIT-I:

Introduction: Introduction: definition of AI -difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA

UNIT-II:

Artificial Neural Networks: Introduction, Models of Neuron Network-Architectures –Knowledge representation, Artificial Intelligence and Neural networks–Learning process-Error correction learning, Hebbian learning – Competitive learning-Boltzman learning, supervised learning-Unsupervised learning–Reinforcement learning-Learning tasks. Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT-III:

Fuzzy Logic: Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy cartesion Product, Operations on Fuzzy relations –Fuzzy logic –Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods .

UNIT-IV:

Genetic Algorithms: Introduction-Encoding –Fitness Function-Reproduction operators, Genetic Modeling – Genetic operators-Cross over-Single site cross over, Two point cross over –Multi point cross over-Uniform cross over, Matrix cross over-Cross over Rate-Inversion & Deletion, Mutation operator –Mutation –Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm.

UNIT-V:

Applications of ANN: Fuzzy logic and GA in power systems operation and control for solving problems of load forecasting, voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment. Condition monitoring.

Reference Books:

1. S. Rajasekaran, G. A. Vijayalakshmi, *Neural Networks, Fuzzy logic and Genetic Algorithms,* Pai PHI publication,
2. Kalyanmoy De, *Optimization for Engineering Design*, PHI publication
3. Kalyanmoy Deb, *Multi-objective Optimization using Evolutionary Algorithms*, Willey Publications.
4. Om P. Malik, *Artificial Intelligence in Power System Optimization,* IEEE SA & NC Sections.

Course Code	Course Title						Core / Elective
PE512EE	**Advances in Power Electronics (Professional Elective – V / VI)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	**Credits**
	L	T	D	P			
PC411EE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To make the student familiar with the concepts of
- Understanding of requirements of high-power devices.
- Understanding the operation of various power converters.
- Design concepts of controllers for power electronic converters.

Course Outcomes

After completing this course, the student will be able to

1. Explain about High power devices
2. Obtain emulated resistance by using PWM rectifiers.
3. Perform state space modelling of DC-DC converters.
4. Explain the operation of Multi-level inverters.
5. Understand design of various controllers for power electronic systems

UNIT-I

Introduction to switches: Advanced Silicon devices - Silicon HV thyristors, MCT, BRT &EST. SiC devices - diodes, thyristors, JFETs & IGBTs. Gallium nitrate devices - Diodes, MOSFETs.

UNIT-II

Pulse Width Modulated Rectifiers: Properties of ideal rectifier, realization of near ideal rectifier, control of the current waveform, single phase and three-phase converter systems incorporating ideal rectifiers and design examples. Non-linear phenomena in switched mode power converters: Bifurcation and Chaos.

UNIT-III

Control of DC-DC converters: State space modelling of Buck, Boost, Buck-Boost, Cuk Fly back, Forward, Push-Pull, Half & Full-bridge converters. Closed loop voltage regulations using state feedback controllers. Soft-switching DC - DC Converters: zero-voltage-switching converters, zero-current switching converters, Multi-resonant converters and Load resonant converters.

UNIT-IV

Advance converter topologies: Multi level converters - Cascaded H-Bridge, Diode clamped, NPC, Flying capacitor. Modular Multi-level converters(MMC), Multi-Input DC-DC Converters, Multi pulse PWM current source converters, Interleaved converters, Z-Source converters.

UNIT-V

Control Design Techniques for Power Electronic Systems: Modelling of systems, Digital Controller Design, Optimal and Robust Controller Design.

Suggested Readings:

1. Andrzej M Trzynadlowski, _Introduction to Modern Power Electronics, John Wiley and sons. Inc, New York, 1998
2. L. Umanand, _Power Electronics Essentials &Applications‘, Wiley publishing Company, 1st Edition,2014
3. B. Jayant Balinga, 'Advanced High Voltage Power Device Concepts', Springer New York 2011.
4. BIN Wu, 'High Power Converters and AC Drives', IEEE press Wiley Interscience, 2006.
5. Satish Kumar Peddapelli, *Pulse Width Modulation- Analysis and Performance in Multilevel Inverters,* De-Gruyter Oldenbourg Publisher, Germany, 2016.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core / Elective</td></tr>
<tr><td>PE513EE</td><td colspan="6">Grid Integration of Renewable Energy Systems
(Professional Elective – V / VI)</td><td rowspan="2">Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td><td>Credits</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
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Course Objectives

Upon successful completion of the course the students will be familiar with:

- To introduce the characteristics of various types of renewable energy sources and converters.
- To explain the power system operation, power quality, renewable energy grid integration and types of grid.
- To study the basic analysis and operation techniques on power electronic systems.
- To understand power control and management systems for grid.
- To understand the issues in grid integration of renewable energy sources.

Course Outcomes

At the end of the course, the student should be able to:

1. Identify the characteristics of renewable energy sources and converters.
2. Understand the operation of power system
3. Analyze the importance of power electronic systems in renewable power applications.
4. Realize the management systems for grid integration.
5. Analyze the challenges faced by the grid by integrating renewable energy sources.

UNIT-I

Review of characteristics of power sources: Basic review of power generation from wind - Solar PV - Thermal - Small hydro - Biomass power strategies in each of these energy conversion systems - Review of maximum power point tracking techniques in solar PV and wind (perturb & observe, hill climbs, incremental conductance).

UNIT-II

Power system operation: Introduction on electric grid, supply guarantees, power quality and stability, introduction to renewable energy grid integration, concept of mini/micro grids and smart grids; wind, solar, biomass power generation profiles, generation electric features, Load scheduling.

UNIT-III

Introduction to basic analysis and operation techniques on power electronic systems: functional analysis of power converters, power conversion schemes between electric machines and the grid, power systems control using power converters; electronic conversion systems application to renewable energy generation systems, basic schemes and functional advantages; wind power and photovoltaic power applications.

UNIT-IV

Power control and management systems for grid integration: island detection systems, synchronizing with the grid; Issues in integration of converter-based sources; Network voltage management; power quality management and frequency management; Influence of PV/WECS on system transient response.

UNIT-V

Issues in grid integration of renewable energy sources: Overview of challenges in integrating renewable sources to the grid - Impact of harmonics on power quality – need to maintain voltage within a band and fluctuations in voltage because of renewable integration - power inverter and converter technologies - mechanism to synchronize power from renewable sources to the grid - overview of challenges faced in designing power injection from offshore generation sources - challenges in modeling intermittent nature of renewable power in a power system.

Suggested Readings:

1. Kersting W. H. *Distribution System Modeling and Analysis*, Second Edition, CRC Press, 2004.
2. Vittal V. and Ayyanar R. *Grid Integration and Dynamic Impact of Wind Energy*, Springer, 2012.
3. Bollen M. H. and Hassan F. *Integration of Distributed Generation in the Power System*, Wiley-IEEE Press, 2011.
4. Keyhani A. *Design of Smart Power Grid Renewable Energy Systems*, Wiley–IEEE Press, 2011.
5. Muhannad H. R. *Power Electronics: Circuits, Devices and Applications*, Pearson Prentice Hall. 2004.
6. Gellings C. W. *The Smart Grid: Enabling Energy Efficiency and Demand Response*, First Edition, CRC Press, 2009.
7. Teodorescu R. Liserre M. Rodriguez P. *Grid Converters for Photovoltaic and Wind Power Systems*, First Edition, Wiley-IEEE Press, 2011.

Course Code	Course Title						Core / Elective
PE514EE	**Smart Grid Technologies (Professional Elective – V / VI)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand various aspects of smart grid
- To study various smart transmission and distribution technologies
- To appreciate distribution generation and smart consumption
- To know the regulations and market models for smart grid

Course Outcomes

1. Understand technologies for smart grid.
2. Appreciate the smart transmission as well distribution systems.
3. Realize the distribution generation and smart consumption.
4. Know the regulations and market models for smart grid.

UNIT-I

Introduction to Smart Grid: Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions-comparison of Power Grid and Smart Grid-New Technologies for Smart Grid – Advantages – Present development and International policies in Smart Grid, Indian Smart Grid. Key Challenges for Smart Grid. Components and Architecture of Smart Grid-Description.

UNIT-II

DC Distribution and Smart Grid: AC Vs DC Sources-Benefits of and drives of DC power delivery systems – Powering equipment and appliances with DC-Data centers and information technology loads equipment and appliances with DC-Data centers and information technology loads – Future neighbourhood- Potential future work and research.

UNIT-III

Smart Grid Communications and Measurement Technology: Communication and Measurement – Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area measurement System (WAMS).

UNIT-IV

Renewable Energy and Storage: Introduction to Renewable Energy Technologies-Micro grids-Storage Technologies-Electric Vehicles and plug-in hybrids-Environmental impact and Climate Change-Economic Issues. Grid integration issues of renewable energy sources.

UNIT-V

Smart Power Grid System Control: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid.

Suggested Readings:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013.
2. A.G. Phadke and J.S. Thorp, ―Synchronized Phasor Measurements and their Application‖, Springer Edition, 2010.
3. Iqbal Hussein, ―Electric and Hybrid Vehicle: Design fundamentals‖, CRC Press, 2003.
4. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.
5. Fereidoon P. Sioshansi, ―Smart Grid: Integrating Renewable, Distributed & Efficient Energy‖, Academic Press, 2012.
6. Jean Claude Sabonnadiere, Nouredine Hadjsaid, ―Smart Grids‖. Wiley-ISTE, IEEE Press, May 2012.

Course Code	Course Title						Core / Elective
OE605EE	**Smart Building Systems (Open Elective-III)**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the basic blocks of Building Management System.
- To design various sub systems (or modular system) of building automation
- To integrate all the sub systems

Course Outcomes

At the end of the course students will be able to

1. Describe the basic blocks and systems for building automation
2. Use different subsystems for building automation and integrate them.
3. Understand basic blocks and systems for building automation
4. Design different systems for building automation and integrate those systems

UNIT-I

Introduction: Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

UNIT-II

Fire Alarm (FA) System: concept of fire, Fire modes, History, Components, and Principles of Operation. Different fire sensors, smoke detectors and their types, Fire control panels, design considerations for the FA system. Field Components, Panel Components, Applications. Types of FAS Architectures, Examples. Classification of FAS loops, Examples. FAS Design procedure in brief, NFPA 72A, BS 5839, IS, Concept of IP enabled fire & alarm system, design aspects and components of PA system.

UNIT-III

Access Control System: Access Components, Access control system Design.
CCTV: Camera Operation & types, Camera Selection Criteria, Camera Applications, DVR Based system, DVM, Network design, Storage design. Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system. CCTV Applications.

UNIT-IV

Security Systems Fundamentals: Introduction to Security Systems, Concepts.
Perimeter Intrusion: Concept, Components, Technology, Advanced Applications. Security system design for verticals. concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components, Computer system access control –DAC, MAC, RBAC.
EPBX System & BMS subsystem integration: Design consideration of EPBX system and its components, integration of all the above systems to design BMS.

UNIT-V

Energy Management: Energy Savings concept & methods, Lighting control, Building Efficiency improvement, Green Building (LEED) Concept & Examples.
Building Management System: IBMS (HVAC, Fire & Security) project cycle, Project steps BMS, Advantages & Applications of BMS, IBMS Architecture, Normal & Emergency operation, Advantages of BMS.

Suggested Reading:

1. Jim Sinopoli, *Smart Buildings,* Butterworth-Heinemann imprint of Elsevier,2nd ed., 2010.
2. Reinhold A. Carlson, Robert A. Di Giandomenico, *Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs),* R.S. Means Company Publishing, 1991.

3. Albert Ting-Pat So, WaiLok Chan, Kluwer , *Intelligent Building Systems*, Academic publisher,3rd ed., 2012.
4. Robert Gagnon, *Design of Special Hazards and Fire Alarm Systems*, Thomson Delmar Learning; 2nd edition, 2007.
5. Levenhagen, John I.Spethmann, Donald H, *HVAC Controls and Systems*, McGraw-Hill Pub.
6. Hordeski, Michael F, *HVAC Control in the New Millennium*, Fairmont press, 2001.
7. Bela G. Liptak, *Process Control-Instrument Engineers Handbook*, Chilton book co.

Course Code	Course Title						Core / Elective
OE606EE	**Programmable Logic Controllers (Open Elective-III)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	
	L	T	D	P			Credits
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To be able to understand basics of Programmable logic controllers, basic programming of PLC.
- To make the students to understand the Functions and applications of PLC

Course Outcomes

At the end of the course students will be able to

1. Develop PLC programs for industrial applications.
2. Acquire the knowledge of PLC counter functions and PLC Arithmetic functions and data handling functions.

UNIT-I

PLC Basics: Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUs and Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures - Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLC input and output modules are connected - Input on/off switching devices - Input analog devices - Output analog on/off devices and output analog devices.

UNIT-II

Basic PLC Programming: Programming on/off inputs to produce on/off outputs - PLC input instructions - Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gate logic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from process control descriptions - Sequence listings - Large process ladder diagram constructions.

UNIT-III

Basic PLC Functions: General Characteristics of Registers - Module addressing - Holding registers - Input registers - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLC counter functions.

UNIT-IV

Intermediate Functions: PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock - PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmetic functions - PLC number comparison functions. PLC basic comparison functions and applications - Numbering systems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numbering systems.

UNIT-V

Data Handling Functions: The PLC skip and master control relay functions - Jump functions - Jump with non return - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions working with bits - PLC digital bit functions and applications - PLC sequence functions - PLC matrix functions.

Suggested Reading:

1. John W. Weff, Ronald A. Reis, Programmable Logic Controllers, Prentice Hall of India Private Limited, Fifth edition, 2003.
2. Frank D. Petruzella, *Programmable Logic Controllers*, 5th Edition, Mc-Graw Hill, 2019.

AUTOMOTIVE MAINTENANCE

OE 631 AE

Instruction: 3 periods per week	*Duration of SEE: 3 hours*
*CIE: 30 *marks*	*SEE: 70 marks*
Credits: 3	

Objectives:

1. To study basic types of vehicle maintenance along with its importance
2. To understand the trouble diagnosis procedure for electrical and electronic systems in automobiles
3. To acquaint with various Trouble shooting, fault tracing practices available in automobile industry
4. To understand the maintenance procedure for air-conditioning in automobiles.

Outcomes:

Student will be able to

1. Demonstrate the maintenance procedure for automotive Engine.
2. Illustrate the trouble diagnosis procedure for electrical systems like Battery, Starting Systems
3. Identify the trouble diagnosis procedure for steering and suspension system
4. Illustrate trouble diagnosis procedure for lubrication and fuel delivery system etc.
5. Explain trouble diagnosis procedure for heating system of automobile.

UNIT – I

Maintenance, Workshop Practices, Safety and Tools: Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis.
vehicles, fire safety - First aid. Basic tools –Scheduled maintenance services – service intervals - Towing and recovering.

UNIT – II

Engine and Engine Subsystem Maintenance: introduction engine IC Engine General Engine service- cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management. **S**ervice - fault diagnosis- servicing emission controls.

UNIT – III

Transmission and Driveline Maintenance: Clutch- general checks, adjustment and service- road testing, Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

UNIT – IV

Steering, Brake, Suspension and Wheel Maintenance: *Inspection*, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Parking brake. Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage.

UNIT – V

***Auto Electrical and Air Conditioning Maintenance*:** Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

Suggested Readings:

1. Ed May, "*Automotive Mechanics Volume* $O^{1}n^{7}e$‖, McGraw Hill Publications, 2003.

2. Ed May, "*Automotive Mechanics Volume Two*‖, McGraw Hill Publications, 2003
3. *Vehicle Service Manuals of reputed manufacturers*
4. *Bosch Automotive Handbook*, Sixth Edition, 2004

MECHATRONICS

OE 631 ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

Student has to understand the

1. How to identify, formulate, and solve engineering problems
2. The design a system, component, or process to meet desired needs within realistic constraints
3. The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
4. The use of drive mechanisms and fluid power systems
5. The use of industrial electronic devices
6. The demonstrate the design of modern CNC machines, and Mechatronics elements

Outcomes:

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

1. Model and analyse electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and Mechatronics elements

Unit-I

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

Unit-II

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

Unit-III

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits

Unit-IV

Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response

Unit-V

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

Suggested Reading:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education

2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3. Michaels Histand & David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill International Edition
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning
5. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi
6. Godfrey Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann

ROAD SAFETY ENGINEERING

OE 821 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. Introduction to various factors considered for road safety and management
2. Explain the road safety appurtenances and design elements
3. Discuss the various traffic management techniques

Outcomes:

Student will be able to

1. Understand the fundamentals of traffic safety analysis
2. Analyze Accident data
3. Remember the concepts of road safety in urban transport
4. Apply crash reduction techniques
5. Design of urban Infrastructure considering safety aspects.

UNIT – I

Introduction: Road Safety scenario in India and World, Road Accident Characteristics.

Traffic Safety Analysis: Fundamentals of Traffic Engineering - Basic Characteristics of Motor-Vehicle Traffic, Highway Capacity, Applications of Traffic Control Devices, Design of Parking Facilities, Traffic Engineering Studies; Statistical Methods in Traffic Safety Analysis – Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons.

UNIT – II

Accident Analysis: Accident Investigations and Risk Management, Collection and Analysis of Accident Data, Condition and Collision Diagram, Causes and Remedies, Traffic Management Measures and Their Influence on Accident Prevention, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements, Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectiveness of Safety Design Features, Accident Reconstruction. Application of computer analysis of accident data.

UNIT – III

Road Safety in planning and Geometric Design: Vehicle And Human Characteristics, Road Design and Road Equipment's, Redesigning Junctions, Cross Section Improvements, Reconstruction and Rehabilitation of Roads, Road Maintenance, Traffic Control, Vehicle Design and Protective Devices, Post Accident Care.

UNIT – IV

***Traffic Signals & Road signs*:** Traffic Signals, Factors affecting signal design, street lighting, Provisions for NMT Vehicles in India, Safety Provisions for Pedestrians & Cyclists, Road Signs and Pavement Markings.

Safety at Construction Site: Safety provisions for workers at construction site, Construction Zone markings, signs.

UNIT – V

Traffic Management safety audit: Traffic Management Systems for Safety, Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Approach to Safety, Road Safety Improvement Strategies, ITS and Safety.

Suggested Readings:

1. Kadiyali L.R,. *Traffic Engineering and Transport planning*, 9th Edition, Khanna Tech Publishers, 2013.
2. C.E.G. Justo, A. Veeraragavan and S. K. Khanna, *Highway Engineering*, 10th Edition, Nem Chand Publishers, 2017.
3. Donald Drew, *Traffic Flow Theory Chapter 14 in Differential Equation Models*, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, *Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017*

5. Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, *Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009.*
6. Highway Research Programme (NCHRP) Synthesis 336.*A synthesis of Highway Research Board, Washington D.C, 2016*.

SOFTWARE ENGINEERING

OE 822 IT

Instruction: 3 periods per week | *Duration of SEE: 3 hours*
*CIE: 30 *marks* | *SEE: 70 marks*
Credits: 3

Objectives:

1. To introduce the basic concepts of software development processes from defining a product to shipping and maintaining
2. To impart knowledge on various phases, methodologies and practices of software development
3. To understand the importance of testing in software development, study various testing strategies along with its relationship with software quality and metrics

Outcomes:

Student will be able to

1. Acquired working knowledge of alternative approaches and techniques for each phase of software development
2. Judge an appropriate process model(s) assessing software project attributes and analyze necessary requirements for project development eventually composing SRS.
3. Creation of visual models to describe (non-) algorithmic solutions for projects using various design principles.
4. Acquire skills necessary as an independent or as part of a team for architecting a complete software project by identifying solutions for recurring problems exerting knowledge on patterns.

UNIT – I

Introduction to Software Engineering:

A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns, Process Assessment.

Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.

An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models

UNIT – II

Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment.

System Engineering: Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling.

Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT – III

Building the Analysis Model: Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model.

Design Engineering: Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design.

UNIT – IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design.

Modeling Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components.

Performing User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT – V

Testing: Strategies: A Strategic Approach to Conventional Software Testing, Test Strategies for O-O Software.

Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods.

Debugging: Debugging Techniques, The Art of Debugging.

Product Metrics: A Framework for Product Metrics, Metrics for each phase of software development.

Software Quality: Definition, ***Quality Assurance:*** Basic Elements, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO9000 Quality Standards, SQA Plan.

Suggested Readings:

1. Roger S. Pressman, *Software Engineering: A Practitioner's Approach*, 7th Edition, McGraw Hill, 2009
2. Ali Behforooz and Frederick J. Hudson, *Software Engineering Fundamentals*, Oxford University Press, 1996
3. Pankaj Jalote, *An Integrated Approach to Software Engineering*, 3rd Edition, Narosa Publishing House, 2008

Course Code	Course Title						Core/Elective
PC463EE	**Digital Signal Processing Lab (Common to EEE and EIE)**						**Core**
Prerequisite	L	T	D	P	CIE	SEE	Credits
PC424EE	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives:

- To prepare the students
- To develop MATLAB code to generate different discrete signals and perform basic operations.
- To develop MATLAB code to convert continuous to discrete by DFT and FFT computations. to obtain Convolution of sequences and sampling theorem.
- To develop MATLAB code to design FIR and IIR filters.
- To use DSP kit and CCS, write code to obtain convolution of sequences, design of FIR and IIR filters, compute DFT and FFT algorithms, Impulse response and generate basic waves

Course Outcomes:

On successful completion of this course student will be able to

1. Compute and write MATLAB code to generate basic waves and perform basic operations on them.
2. Compute and write MATLAB code to apply sampling theorem, to obtain convolution and compute DFT and FFT.
3. Compute and write MATLAB code to design FIR and IIR filters.
4. Compute and write MATLAB code to obtain convolution of sequences, Design of FIR and IIR filters, compute DFT and FFT algorithms, Impulse response and generate basic waves using DSP kit

List of Experiments

1. Generation of different discrete signal sequences and Waveforms.
2. Basic Operations On Discrete Time Signals
3. DFT Computation and FFT Algorithms.
4. Verification of Convolution Theorem.
5. Verification of sampling theorem.
6. Design of Butterworth and Chebyshev LP and HP filters.
7. Design of LPF using Rectangular, Hamming and Kaiser Windows.
8. To perform linear and circular convolution for the given sequences.
9. Design and implementation of FIR and IIR filter.
10. Computation of DFT using DIT and DIF algorithm.
11. Generation of basic waves.
12. Impulse response.

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

Course Code	Course Title						Core / Elective
PW703EE	**Project Work Phase - II**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**16**	**50**	**100**	**8**

Course Objectives

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of Project work– Phase II is to implement and evaluate the proposal made as part of Project Work - Phase I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students - deletion of internship candidates from groups made as part of projectWork-Phase I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

Note: Three periods of contact load will be assigned to each project guide.

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