LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUK, Kakinada
Accredited by NAAC with "A" Grade and NBA (CSE, EEE & ME)
Jonnada (Village), Denkada (Mandal), Vizianagaram Dist. – 535 005
Phone No. 08922-241111, 241112
E-Mail: lendi_2008@yahoo.com **Website: www.lendi.org**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.Tech (Power System and Control Automation) Course Structure –R19

(w.e.f the academic year 2019-20)

I Year -I Semester

S.No	Course Code	Subject	L	P	Credits
1	EE-PSCA1101	Microprocessors & Microcontrollers	3	--	3
2	EE-PSCA1102	HVDC Transmission	3	--	3
3	EE-PSCA1103	Power System Operation and Control	3	--	3
4	EE-PSCA1104	Reactive Power Compensation & Management	3	--	3
5	EE-PSCA1105	**Elective – I**	3	--	3
	EE-PSCA1105.1	1. Electrical Distribution Systems			
	EE-PSCA1105.2	2. Analysis of Power Electronics Converters			
	EE-PSCA1105.3	3. Renewable Energy Systems			
	EE-PSCA1105.4	4. Artificial Intelligence Techniques			
6	EE-PSCA1106	**Elective – II**	3	--	3
	EE-PSCA1106.1	1. Power System Security			
	EE-PSCA1106.2	2. Advanced Digital Signal Processing			
	EE-PSCA1106.3	3. Programmable Logic Controllers &Applications			
	EE-PSCA1106.4	4. Modern Control Theory			
7	EEE-PSCA1107	Simulation Laboratory	--	4	2
8	AC-ERPW1101	Audit Course 1: English For Research Paper Writing	3	--	--
		Total Credits			20

I Year-II Semester

S.No	Course Code	Subject	Category	L	P	Credits
1	EE-PSCA1201	Power System Dynamics and Stability	PC	3	--	3
2	EE-PSCA1202	Flexible AC Transmission Systems	PC	3	--	3
3	EE-PSCA1203	Real Time Control of Power Systems	PC	3	--	3
4	EE-PSCA1204	Advanced Power System Protection	PC	3	--	3
5	EE-PSCA1205	**Elective – III**	PE	3	--	3
	EE-PSCA1205.1	1. Smart Grid Technologies				
	EE-PSCA1205.2	2. Power Quality				
	EE-PSCA1205.3	3. Power System Reliability				
	EE-PSCA1205.4	4. Energy Audit, Conservation & Management				
6	EE-PSCA1206	**Elective – IV**	PE	3	--	3
	EE-PSCA1206.1	1. Power System Deregulation				
	EE-PSCA1206.2	2. High Voltage Testing Techniques				
	EE-PSCA1206.3	3. Power System Transients				
	EE-PSCA1206.4	4. Electrical and Hybrid Vehicles				
7	EE-PSCA1207	Power Systems Laboratory	PC	--	4	2
8	AC-RMIP1201	Audit Course 2: Research Methodology and IPR	MC	3	--	--
	Total Credits					20

II Year -I Semester

S.NO	Course Code	Subject	L	P	Credits
1	EE-PSCA2101	Seminar – I	--	--	2
2	EE-PSCA2102	Project Stage – I	--	--	10
	Total Credits				**12**

II Year -II Semester

S.NO	Course Code	Subject	L	P	Credits
1	EEEPSCA2203	Project Stage – II	--	--	16
Total Credits					**16**

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1101	Microprocessors & Microcontrollers	3	0	3

Course Objectives:

- To learn the basic architecture of 8086.
- To learn the assembly language programming using 8086.
- To teach various peripheral devices to interface processor with different components.
- To learn the operation of 8255 with different interfacing devices
- To Interface different communicate interfaces like 8254,8259A,8279 to 8086 microprocessor
- To learn the 8051 micro controller and its various modes of operation and its instruction set

Course Outcomes:

After completion of this course the students will be able to:

1. Understand the basic architecture of 8086(L2).
2. Develop assembly language programming using 8086(L3).
3. Analyze various peripheral devices to interface processor with different components (L4).
4. Apply the Interfacing techniques of different communication interfaces like 8254,8259A,8279 to 8088 (L3).
5. Understand the 8051 micro controller and its various modes of operation and its instruction set (L2).

UNIT – I

Register Organization of 8086, Architecture, Signal description of 8086, memory segmentation, addressing modes of 8086. 8086/8088 instruction set and assembler directives, machine language instruction formats, Assembly language Programs, Applications.

Learning outcomes: After completion of this unit students will be able to

- Understand the basic architecture of 8086 (L2)
- Understand the instruction set of assembly language (L2)

UNIT – II

General Bus Operation, minimum mode operation of 8086 and timing diagrams, Fundamental I/O considerations, Programmed I/O, Interrupt I/O, Block transfers and DMA.

Learning outcomes: After completion of this unit students will be able to

- Understand the basic Assembly programmable language (L2)
- Analyze the architecture of 8086 with interrupts (L4)

UNIT – III

Introduction to stack, stack structure of 8086/8088, Interrupts and Interrupt service routine, interrupt cycle of 8086/8088. Interfacing ROM/RAM, Interfacing of I/O ports to Micro Computer System, PPI (Programmable Peripheral Interface), 8255 modes of operation, Interfacing A to D converters, Interfacing D to A converters, Interfacing Principles and stepper motor interfacing, applications

Learning outcomes: After completion of this unit students will be able to

- Understand various peripheral devices to interface processor with different components (L2)
- Understand the i/o ports of Microcomputer system (L2)
- Understand the operation of 8255 with different interfacing devices (L2)
- Analyze the stepper motor interfacing (L4)

UNIT – IV

Programmable Interval timer 8254, Programmable Interrupt Controller 8259A, Key Board or Display Controller 8279, Programmable Communication Interface 8251 USART, Applications

Learning outcomes:

- Understand interfacing of the key board display controller 8279 (L2)
- Understand the Interfacing techniques of different communication interfaces like 8254, 8259A, 8251(L2).

UNIT – V

Introduction to 8051/31 Micro Controller, PIN diagram, architecture, Different modes of Operation of timer/counters, addressing modes of 8051 and instruction set. Over view of 16 bit Microcontrollers

Learning outcomes: After completion of this unit students will be able to

- Understand the 8051 micro controller and its various modes of operation and its instruction set (L2).
- Understand the entire overview of 16 bit micro controllers (L2)

Text Books

1. Microprocessors and Interfacing: Programming and Hardware by Douglas V. Hall, 2nd edition, TMH, New Delhi, 1999.
2. The 8051Microcontrollers: Architecture, Programming & Applications by Kenneth J Ayala, Second Edition, Penram International Publishing (India).

Reference Books

1. Advanced Microprocessors and Peripherals, Architecture Programming and Interfacing by A.K. Ray & K.M. Bhurchandi, Forth reprint 2004, TMH.
2. Micro Computer Systems: The 8086/8088 family by YU-CHENG LIU, GLENN A.GIBSON, 2nd edition, PHI India, 2000.
3. The 8051 Microcontroller and Embedded Systems – Mohammad Ali Mazdi, Janice GillispieMazidi, Pearson Education (Singapore) Pvt. Ltd., 2003.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1102	HVDC Transmission	3	0	3

Course Objectives:

The objectives of the course are to make the students learn about:

- Various schemes of HVDC transmission.
- The basic HVDC transmission equipment.
- The control of HVDC systems.
- The interaction between HVAC and HVDC system.
- The various protection schemes of HVDC engineering.

Course Outcomes:

After completion of this course the students will be able to

- Study the various schemes of HVDC transmission. (L2)
- Understand the basic HVDC transmission equipment.(L2)
- Understand the control of HVDC systems.(L2)
- Understand the interaction between HVAC and HVDC system.(L2)
- Study the various protection schemes of HVDC engineering.(L2)

UNIT-I

Limitation of EHV AC Transmission, Advantages of HVDC Technical economical reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links- Apparatus and its purpose.

Learning outcomes: After completion of this unit students will be able to

- Compare Technical and Economic considerations of HVDC (L2).
- Understand the static converter principles and configurations (L2).

UNIT-II

Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

Learning outcomes: After completion of this unit students will be able to

- Analyze Power Converters based on number of pulses (L4)
- Analyze Rectifier and inverter operations and HVDC link (L4)
- Explain Special features of converters (L2)

UNIT-III

Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ.Filters Harmonic elimination.

Learning outcomes: After completion of this unit students will be able to

- Understand converter systems in HVDC (L2)
- Understand power control in HVDC (L2)

UNIT-IV

Interaction between HVAC and DC systems – Voltage interaction, Harmonic in stability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

Learning outcomes: After completion of this unit students will be able to

- Understand MTDC operation connection and operations (L2)
- Study the development of DC circuit breakers(L2)

UNIT-V

Transient over voltages in HVDC systems: Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection-valve group and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Learning outcomes: After completion of this unit students will be able to

- Identify faults in HVDC system (L3)
- Determine protection in HVDC system.(L5)

Text Books

1. S Kamakshaihand V Kamaraju: HVDC Transmission-MG hill.
2. K.R. Padiyar: High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.

Reference Books

1. E.W. Kimbark : Direct current Transmission, Wiley Inter Science– New York.
2. J.Arillaga: H.V.D.C. Transmission Peter Peregrinus ltd., London UK 1983
3. Vijay K Sood: HVDC and FACTS controllers: Applications of static converters in power systems by, Kluwer Academic Press.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1103	Power System Operation And Control	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- To understand the concept of unit commitment problem for economic load dispatch.
- To study the load frequency control of single area system .
- To understand the concept of two –area load frequency control.
- To impart knowledge of the effect of generation with limited energy supply.
- To explain the effectiveness of interchange evaluation in interconnected power system.

Course Outcomes:

After completion of the course, students will be able to:

1. Determine the unit commitment problem for economic load dispatch.(L5)
2. Explain the need of keeping frequency constant and design the block diagram for single area control.(L5)
3. Analyze two –area load frequency control in controlled and uncontrolled cases.(L4)
4. Analyze the generation with limited energy supply.(L4)
5. Determine the interchange evaluation in interconnected power systems.(L5).

UNIT-I

Unit commitment problem and optimal power flow solution : Unit commitment :Constraints in UCP,UC solutions. Methods-priority list method, introduction to Dynamic Programming Approach.

.**Learning Outcomes:** students will be able to

- Understand the concept of unit commitment problem (L2)
- Identify the constraints and methods involved in unit commitment.(L3)

UNIT-II

Single area load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response, load frequency control and Economic dispatch control.

Learning outcomes: students will be able to

- Understand the necessity of keeping frequency constant.(L2)
- Understand the Concept of single area control(L2)
- Develop the block diagram of an isolated power system.(L6)
- Analyze the dynamic response and steady state analysis(L4)

UNIT-III

Load Frequency Controllers: Two area Load Frequency Control: Load frequency control of 2-area system: uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment

Learning outcomes: students will be able to

- Deduct the error using Proportional plus Integral Control(L5)
- Understand the concept of load frequency control and economic dispatch control(L2)

UNIT-IV

Generation with limited Energy supply: Take-or-pay fuel supply contract, compositegeneration production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming

Learning outcomes: students will be able to

- Analyze the load Frequency control of two-area system in both controlled and uncontrolled case.(L4)
- Analyze how the frequency can be controlled in an optimal way(L4)

UNIT-V

Interchange Evaluation and Power Pools Economy Interchange, Economy interchangeEvaluation, Interchange Evaluation with unit commitment, Multiple Interchange contracts. Afterthe-fact production costing, Transmission Losses in transaction Evaluation, other types of Interchange, power pools.

Learning outcomes: students will be able to

- Understand the concept of take or pay fuel supply contract.(L2)
- Make use of slack variables(L3)
- Explain the fuel scheduling by linear programming(L2)

Text Books

1. Modern Power System Analysis - by I.J.Nagrath&D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.
2. Power system operation and control PSR Murthy B.Spublication.

Reference Books

1. Power Generation, Operation and Control-by A.J.WoodandB.F.Wollenberg, John wiley& sons Inc.1984.
2. Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3. Reactive Power Control in Electric Systems - by TJE Miller, John Wiley &sons.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1104	Reactive Power Compensation & Management	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- The basic objectives of reactive power compensation.
- The types of compensation and their behavior.
- The mathematical modeling of reactive power compensating devices.
- The reactive power compensation at distribution side and user side.
- The role of reactive power compensation at electric traction systems and arc furnaces.

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

1. Understand the basic objectives of reactive power compensation. (L2)
2. Learn the various load compensations.(L2)
3. Obtain the mathematical model of reactive power compensating devices.(L3)
4. Study the reactive power compensation at distribution side and user side.(L2)
5. Study the application of reactive power compensation in electrical traction and arc furnaces (L2)

UNIT-I

Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

Learning Outcomes: After completion of this unit student will be able to

- Study the objectives of reactive power compensation.(L2)
- Analyze the load compensator as voltage regulator.(L4)
- Understand the phase balancing and power factor correction of unsymmetrical loads.(L2)

UNIT-II

Reactive Power Compensation in Transmission System: Steady state- Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples Transient state Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples.

Learning Outcomes: After completion of this unit student will be able to

- Study the various types of reactive power compensation in transmission system under steady state condition.(L2)
- Study the reactive power compensation using synchronous condensers. (L2)

UNIT-III

Reactive power coordination: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady – state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences.

Learning Outcomes: After completion of this unit student will be able to

- Derive the mathematical modeling of reactive power compensating device. (L3)
- Understand the basic concepts of power quality and its disturbances. (L2)

UNIT-IV

Distribution side Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

User side reactive power management: KVAR requirements for domestic appliances –

Purpose of using capacitors – selection of capacitors – deciding factors – types of 20 available capacitor, characteristics and Limitations.

Learning Outcomes: After completion of this unit student will be able to

- Study the system losses and loss reduction methods. (L2)
- Understand the reactive power planning and its objectives. (L2)
- Understand the selection of capacitors and deciding factors for reactive power management. (L2)

UNIT-V

Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace.

Learning Outcomes: After completion of this unit student will be able to

- Understand the typical layout of the traction systems. (L2)
- Learn the reactive power compensation at electric traction system and arc furnaces. (L2)

Text Books

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982.
2. Reactive power Management by D.M.Tagare, Tata McGraw Hill, 2004.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1105.1	Electrical Distribution Systems	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- To learn the importance of economic distribution of electrical energy.
- To study the design of distribution feeders, and rating and location of a substation.
- To analyze the distribution networks for V-drops, PLoss calculations and reactive power.
- To understand the co-ordination of protection devices.
- To impart knowledge of capacitive compensation/voltage control.

Course Outcomes:

After completion of this course the students will be able to:

1. Analyze a type of distribution system.(L4)
2. Design the types of distribution feeders and their loading effects.(L6)
3. Evaluate calculations on voltage drop and power losses.(L5)
4. Identify the protective systems and their co-ordination.(L3)
5. Improve power factor by capacitive compensation.(L6)

UNIT-I

(Residential, Commercial, Agricultural and Industrial) and their characteristics

Learning outcomes: students will be able to

- Analyze the type of distribution system.(L4)
- Identify the types of loads and their characteristics.(L3)

UNIT-II

Distribution Feeders and Substations : Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of the secondary distribution system. Location of Substations : Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations..

Learning outcomes: students will be able to

- Design different types of feeders.(L6)
- Estimate a place for location of substation and benefits derived through optimal location of substation.(L5)

UNIT-III

System analysis : Voltage drop and power loss calculations : Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines..

Learning outcomes: students will be able to

- Evaluate voltage drop and power loss calculations.(L5)
- Analyze of three-phase and non three-phase primary lines.(L4)

UNIT-IV

Protective devices and coordination : Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices : General coordination procedure.

Learning outcomes: students will be able to

- Understand the objectives of distribution system protection.(L2)
- Evaluate fault calculation and types of fault occurrence.(L5)
- Identify the types of protective devices and their co-ordination.(L3)

UNIT-V

Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

Learning outcomes: students will be able to

- Analyze the effect of different types of capacitors.(L4)
- Improve power factor by locating a capacitor .(L6)

Text Books

1. "Electric Power Distribution System Engineering "byTuranGonen, Mc.Graw-Hill Book Company,1986.
2. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.

Reference Books

1. Electrical Distribution V.Kamaraju-McGraw Hill
2. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1105.2	Analysis of Power Electronic Converters	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- The control principle of ac to ac conversion with suitable power semiconductor devices.
- The knowledge of ac to dc conversion and single phases ac to dc converter topologies.
- The effect of operation of controlled rectifiers on p.f and improvement of p.f with PFC converters
- The knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- Multilevel inverter configuration to improve the quality of the inverter output voltage.

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

1. Have the knowledge on principle of ac voltage controller and their control techniques.(L2)
2. Convert ac voltage to dc voltage and different control strategies of the single phase and three phase converter..(L3)
3. Control the power factor of single phase and three phase ac to dc converters. .(L4)
4. Understand the conversion of dc to ac and their control strategies..(L2)
5. Analyze different multilevel inverters to improve the quality of the output voltage of the inverter.(L4)

UNIT-I

AC voltage Controllers: Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers –Application- numerical problems Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application- numerical problems.

Learning outcomes: After completion of this unit student will be able to

- Understand the working principle of single phase ac voltage controller with different loads and it's applications (L2)
- Analyse single phase and three phase ac voltage controller with star and delta connected loads (L4)

UNIT-II

AC-DC converters for single phase: Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems. Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems

Learning outcomes: After completion of this unit student will be able to

- Design of single phase half and fully controlled converters with RL load (L6)
- Evaluate input power factor and harmonic factor and power factor improvement methods (L5)

UNIT-III

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

Learning outcomes: After completion of this unit student will be able to

- Understand different power factor correction converters (L2)
- Analyse three phase PFC boost converters (L4)

UNIT-IV

PWM Inverters: Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 600 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

Learning outcomes: After completion of this unit student will be able to

- Understand the operation of different PWM inverters of single phase and three phase (L2)
- Understand the concepts of current source inverters and variable dc link inverters (L2)

UNIT-V

Multi level inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters-Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Learning outcomes: After completion of this unit student will be able to

- Understand the concept of multilevel inverter and different types of multilevel inverters (L2)
- Compare different types of multilevel inverters and their outputs (L5)

Text books

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint-2008.1
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons 2nd Edition.

Reference books

1. Power Electronics – Lander –Ed.2009
2. Modern power Electronics and AC Drives – B.K.Bose
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing Pvt Ltd.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1105.3	Renewable Energy Systems	3	0	3

Course Objectives: The objectives of the course are to make the students

- To know about Solar radiation data and measurement, thermal collectors
- To understand about operation of wind energy conversion system
- To understand about bio mass energy based power plants
- To understand about Tidal and wave energy based system
- To classify Geo thermal energy sources

Course Outcomes:

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

1. Analyze solar radiation data and solar thermal concentrators.(L4)
2. Explain operation of wind energy conversion system and its major components.(L2)
3. Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications.(L2)
4. Analyze the principle and operation of tidal & wave based power plants.(L4)
5. Classify and analyze Geothermal Energy sources for power generation.(L4)

UNIT-I

Solar Energy: - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds. Numerical Problems and applications.

Learning Outcomes: At the end of this unit, the student is able to

- Analyze solar radiation data, extraterrestrial radiation, and radiation on earth's surface (L4)
- Understand the concepts of heat transfer methods (L2)
- Understand the operation of non concentric type solar collectors (L2)

UNIT-II

Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow. Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of wind energy, Numerical problems and applications.

Learning Outcomes: At the end of this unit, the student is able to

- Explain wind energy conversion systems and wind power generators (L2)
- Understand Horizontal axis wind turbine, Vertical axis wind turbine design considerations (L2)

UNIT-III

Biomass Energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat –

Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine, Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Explain basic principle and working of biomass and biogas plant (L2)
- Understand the concept of pyrolysis, gasification, combustion and fermentation (L2)

UNIT-IV

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse, Wave Energy– Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.
Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Understand the basic principle of conversion of Ocean Energy to electrical energy (L2)
- Identify the factors effecting energy equation to extract the maximum amount of energy (L2)
- Understand the principal and operation of Wave power plants (L2)
- Analyze the concept of Wave Energy and Different wave energy conservation devices. (L2)

UNIT-V

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifer energy analysis - Estimation of thermal power - Extraction techniques - Prime movers,Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Classify different Geothermal Energy sources (L4)
- Understand the thermal power - Extraction techniques and Prime movers (L2)

Text Books

1. Renewable Energy Resources / John Twidell and Tony Weir / E&F.N.Spon
2. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme /TMH

Reference Books

1. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
2. Solar Energy Thermal Processes,/Duffie& Beckman
3. Solar Heating and Cooling / Kreith&Kreider, CRC press.
4. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind
5. Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
6. Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGraws Hill.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1105.4	Artificial Intelligence Techniques	3	0	3

Course Educational Objectives: The objectives of the course are to make the students

- To introduce the concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and fuzzy logic controllers.
- To know the applications of AI Techniques in electrical engineering.

Course Outcomes:

After completion of this course the students will be able to:

1. Understand neural networks and analyze different types of neural networks. (L2)
2. Analyze training algorithms for neural networks. (L3)
3. Develop genetic algorithm for optimization. (L6)
4. Understand the concepts of classical and fuzzy sets properties, Operations and relations.(L2)
5. Apply AI Techniques in electrical engineering.(L3)

UNIT-I

Introduction to Neural Networks: Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.Applications.

Learning Outcomes: At the end of this unit student is able to

- Understand the Biological Neuron and Artificial Neuron Models.(L2)
- Understand Historical Developments, Potential, and Applications of Artificial Neural Networks. (L2)

UNIT-II

Feed Forward Neural Networks: Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feed forward recall and error back propagation training-Radial basis function algorithms-Hope field networks. Applications.

Learning Outcomes: At the end of this unit student is able to

- Understand the Architectures of Artificial Neural Networks. (L2)
- Analyse the Learning Strategies and Learning Rules of ANN.(L4)

UNIT-III

Genetic algorithms &Modeling-introduction-encoding-fitness function-reproduction operators-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm. Applications.

Learning Outcomes: At the end of this unit student is able to

- Understand the basic concepts of Genetic algorithms.(L2)
- Develop genetic algorithms for optimization.(L6)

UNIT-IV

Classical and Fuzzy Sets: Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions.

Fuzzy Logic System Component: Fuzzification, Membership value assignment, evelopment of rule base and decision making system, defuzzification to crisp sets, defuzzification methods. Applications.

Learning Outcomes: At the end of this unit student is able to

- Understand the concept of fuzziness involved in various systems and fuzzy set theory.(L2)
- Understand the concepts of classical and fuzzy sets properties, Operations.(L2)
- Analyze the rules of the fuzzy logic system&Defuzzification to crisp sets. (L4)

UNIT-V

Application of AI Techniques: Load forecasting-load flow studies-economic load dispatch-load frequency control-reactive power control-speed control of dc and ac motors

Learning Outcomes: At the end of this unit student is able to

- Apply neural networks in electrical engineering. (L3)
- Apply Fuzzy logic genetic algorithms in electrical engineering. (L3)

Text Books

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai–PHI Publication.

Reference Books

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
2. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 200

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1106.1	Power System Security	3	0	3

Course Objectives: The objectives of the course are to make the students learn about:

- To analyze and simulate the short circuit analysis of AC power systems.
- To evaluate the short circuit analysis of balanced and unbalanced power systems.
- To understand the design and planning of short circuit limiters and their applications.
- To understand and analyze the concept of security by different approaches.
- To understand and apply the real time control on power systems and the software implementation

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

1. Analyze and simulate the short circuit analysis of AC power systems.(L4)
2. Evaluate the short circuit analysis of balanced and unbalanced power systems.(L5)
3. Understand the design and planning of short circuit limiters and their applications.(L2)
4. Analyze and understand the concept of security by different approaches.(L2 & L4)
5. Apply and understand the real time control on power systems and the software implementation (L2 & L3)

UNIT-I

Short circuit analysis techniques in AC power Systems- Simulation of short circuit and open circuit faults using network theorems- fixed impedance short circuit analysis techniques- time domain short circuit analysis in large scale power systems- analysis of time variation of AC and DC short circuit components.

Learning outcomes: After completion of this unit, students will be able to

- Analyze and simulate the short circuit and open circuit faults using network theorems.(L4)
- Analyze large scale power systems through time domain short circuit analysis.(L4)

UNIT-II

Fixed impedance Short circuit analysis of large scale power systems-general analysis of balanced, unbalanced and open circuit faults- 3-phase short circuit analysis in large scale power systems, Network equivalents and practical short circuit current assessments in large scale Ac power systems-general studies- uncertainties in short circuit current calculations-probabilistic Short circuit analysis.

Learning outcomes:After completion of this unit, students will be able to

- Evaluate balanced and unbalanced open circuit faults.(L5)
- Analyze short circuit currents in large scale AC Power systems.(L4)
- Assess uncertainties in short circuit currents.(L5)

UNIT-III

Risk assessment and safety considerations-control and limitation of high short circuit currents-limitation of short circuit currents in power system operation, design and planning, Types of short circuit fault current limiters- earthing resistor or reactor connected to transformer neutral-pyrotechnic fault current limiters- series resonant current limiters-saturable reactor limiters-other types of fault current limiters and their applications.

Learning outcomes: After completion of this unit, students will be able to

- Evaluate the limitations of short circuit currents in power system operation, design and planning.(L5)
- Understand the operation and application of current limiters.(L2)

UNIT-IV

Power System Security analysis- concept of security- security analysis and monitoring- factors affecting power system security- detection of network problems. contingency analysis for generator and line outages by ILPF method – fast decoupled inverse Lemma-based approach, network sensitivity factors –contingency selection –concentric relaxation and bounding.

Learning outcomes: After completion of this unit, students will be able to

- Understand the concept of security and the factors affecting.(L2)
- Identify network problems.(L3)
- Apply the different approacheson contingency selection.(L3)

UNIT-V

Computer control power systems – need for real time and computer control of power systems- operating states of power system – SCADA- implementation considerations – software requirements for implementing above functions.

Learning outcomes: After completion of this unit, students will be able to

- Understand the need of real time and computer control of power systems.(L2)
- Apply the implementation on software requirements.(L3)

Text Books

1. Allen J. Wood and Bruce Woolen berg: Power System Generation, Operation and Control ,John Willey andsons,1996.
2. John J.Grainger and William D Stevenson Jr.: Power System analysis, McGrawHill, ISE,1994.

Reference Books

1 Nasser D.Tleis : Power System Modelling and fault analysis, Elsevier,2008.

2 Hand book of Power Systems, GrigsBee.,CRCPress,Newyork.

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1106.2	Advanced Digital Signal Processing	3	0	3

Course Objectives: The objectives of the course are to make the students learn about:

- The importance and structures of different filters.
- The design of different filters.
- Understand the discrete Fourier transforms number representation and algorithm implementation.
- Analyze the process and effect of quantization.
- Study the errors using error feedback for filters.
- Understand the power spectrum methods.

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

1. Classify the importance of different digital filters and their structures (L2 & L5)
2. Design and apply the different digital filters (L3 & L6)
3. Understand and apply the discrete Fourier transformation representation and algorithm implementation, quantization effect (L2 & L3)
4. Design and explain the error feedback filters (L2 & L6)
5. Analyze different power spectrum estimation techniques (L4)

UNIT-I

Digital Filter Structure: Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

Learning outcomes: After completion of this unit, the students will be able to

- Understand the importance of different filters (L5)
- Classify the different filter structures (L2)

UNIT-II

Digital filter design: Preliminary considerations- Bilinear transformation method of IIR filter design-design of Low pass, high pass- Band pass, and Band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on Windowed Fourier series-design of FIR digital filters with least –mean-Square-error-constrained Least-square design of FIR digital filters

Learning outcomes: After completion of this unit, the students will be able to

- Design the different digital filters (L6)
- Apply the preliminary consideration for transformation method (L3)

UNIT-III

DSP algorithm implementation: Computation of the discrete Fourier transform-Number representation-Arithmetic operations- handling of overflow-Tunable digital filters-function approximation.The Quantization process and errors-Quantization of fixed-point and floating-point Numbers-Analysis of coefficient Quantization effects- Analysis of Arithmetic Round-off errors,

Learning outcomes: After completion of this unit, the students will be able to

- Apply the discrete fourier transformation representation (L3)
- Understand the algorithm implementation and the quantization effect(L2)

UNIT-IV

Filters: Dynamic range scaling-signal-to-noise ratio in Low-order IIR filters-Low-Sensitivity Digital filters- Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters- Round off errors in FFT Algorithms.

Learning outcomes: After completion of this unit, the students will be able to

- Explain the errors of low order IIR filters (L2)
- Design the error feedback for filters (L6)

UNIT-V

Power Spectrum Estimation: Estimation of spectra from Finite Duration Observations signals–Non-parametric methods for power spectrum Estimation–parametric method for power spectrum Estimation, Estimation of spectral form-Finite duration observation of signals-Non-parametric methods for power spectrum estimation-Walsh methods-Blackman &torchy method.

Learning outcomes: After completion of this unit, the students will be able to

- Analyze the power spectrum estimation (L4)
- Explain the power spectrum methods (L2)

Text Books

1. Digital signal processing-sanjit K. Mitra-TMH second edition
2. Discrete Time Signal Processing–Alan V.Oppenheim, Ronald W.Shafer-PHI-1996 1st edition-9th reprint

Reference Books

1. Digital Signal Processing principles, algorithms and Applications – John G.Proakis-PHI–3rd edition-2002
2. Digital Signal Processing– S.Salivahanan,A.Vallavaraj, C. Gnanapriya– TMH -2nd reprint-2001
3. Theory and Applications of Digital Signal Proceesing- LourensR. Rebinar&Bernold
4. Digital Filter Analysis and Design-Auntonian-TMH

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1106.3	Programmable Logic Controllers & Applications	3	0	3

Course Objectives: The objectives of the course are to make the students learn about:

- To study the Knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

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

1. Understand the PLCs and their I/O modules.(L2)
2. Develop control algorithms to PLC using ladder logic etc.(L6)
3. Understand various PLC registers (L2)
4. Manage PLC registers for effective utilization in different applications and Handle data functions and control of two axis and their axis robots with PLC.(L4)
5. Design PID controller with PLC.(L6)

UNIT-I

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Learning outcomes: After completion of this unit students will be able to

- Understand I/O modules and their interfaces(L2)
- Construct the PLC Ladder diagrams (L6)

UNIT-II

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

Learning outcomes: After completion of this unit students will be able to

- Understand logic gates construction(L2)
- Compose ladder diagrams(L2)

UNIT-III

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

Learning outcomes: After completion of this unit students will be able to

- Understand Registers such as counters, Timer in industrial applications(L2)
- Understand the PLC functions (L2)

UNIT-IV

Data handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications.Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

Learning outcomes: After completion of this unit students will be able to

- Understand Data handling functions, bit pattern and bit shift registers (L2)
- Apply the functions in different applications,two axis and three axis robot (L3)

UNIT-V

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Learning outcomes: After completion of this unit students will be able to

- Understand analog input and output applications(L2)
- Understand PID principles(L2)

Text Books

1. Programmable Logic Controller – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

Reference Books

1. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
2. Programmable Logic Controllers –W. Bolton-Elsevier publisher

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1106.4	Modern Control Theory	3	0	3

Course Objectives:

- To facilitate the Evolution of state variable Approach for the Analysis of Control systems.
- To examine the importance of controllability and observability in Modern Control Engineering for Time Variant and Time-invariant systems.
- To enable Students to Analyze various types of nonlinearities and describing function analysis of non-linear systems.
- To construct trajectories using describing functions and phase plane analysis.
- To study the analysis of stability and instability of continuous time invariant system

Course Outcomes:

After completion of this course the students will be able to:

1. Understanding the State variable approach is suitable for higher order.(L2)
2. Analyze the concepts of controllability and observability for Time variant and invariant systems.(L4)
3. Attain knowledge on various nonlinearities through describing functions(L2)
4. Construct trajectories and analyze the various nonlinearities through phase plane analysis.(L5)
5. Generate Lyapunov's functions and understand the typical issues of stability and instability in continuous Time invariant systems.(L5)

UNIT-I

State Variable Analysis: The Concept of state – State Equations for Dynamic systems – State Diagram - Linear Continuous time model for physical Systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

Learning outcomes: Students should be able to:

- Understand the concept of state and state equations. (L2)
- Obtain solutions for linear time invariant continuous systems (L5)
- Find state transition matrix**.**(L5)

UNIT-II

State Variable Techniques: General concept of Controllability - General concept of Observability Controllability tests for Continuous &Time Invariant systems - Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment

Learning outcomes:

- Analyze the concept of Controllability for continuous Time variant and Time invariant systems.(L4)
- Analyze the concept of Observability for continuous Time variant and Time invariant systems.(L4)

.UNIT- III

Non Linear Systems – I: Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear Systems, properties of Non Linear Systems – Describing function – describing function Analysis of nonlinear systems- Stability Analysis of Non – Linear systems through describing functions.

Learning outcomes:

- Attain knowledge on non-linear systems and its types and properties.(L2)
- Analyze describing function and stability analysis of non-linear systems.(L4)

UNIT-IV

Non Linear Systems – II: Introduction to phase – plane Analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

Learning outcomes:

- Construct Trajectories by using the method of Isoclines.(L5)
- Analyze the phase-plane analysis on nonlinear control systems.(L4)

UNIT-V

Stability Analysis: Stability in the sense of Lyapunov,Lyapunov's stability and Lyapunov's instability Theorems, Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method-Generation of Lyapunov functions – Variable gradient method – Krasooviski'smethod.

Learning outcomes:

- Understand Lyapunov's stability and instability theorems.(L2)
- Generate Lyapunov's functions by variable gradient and Krasooviskis method.(L5)

Textbooks

1. Modern Control System Theory by M. Gopal – New Age International –1984
2. Modern Control Engineering by Ogata. K – Prentice Hall –1997

Reference Books

1. Nonlinear systems, Hassan K. Klalil, Prentice Hall,1996
2. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India,2009

I Year -I Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1107	Simulation Laboratory	0	4	2

Course Objectives:

- To understand the modeling of various aspects of Power System analysis and develop the MATLAB programming.

Course Outcomes:

After completing this course the student will be able to:

1. Design and simulate the Load Flow Solution Using different methods (L6)
2. Analyze the formation of Y and Z bus (L4)
3. Analyze the Symmetrical and Unsymmetrical faults using Z-bus (L4)
4. Understand and Simulate the Economic Load Dispatch and Load frequency control of different systems (L6)
5. Understand the Stability analysis of Using Point By Point Method (L2)

List of Experiments

1. Formation of Y- Bus by Direct-Inspection Method.
2. Load Flow Solution Using Gauss Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Load Flow Solution Using Fast Decoupled Method
5. Formation of Z-Bus by Z-bus building algorithm
6. Symmetrical Fault analysis using Z-bus
7. Unsymmetrical Fault analysis using Z-bus
8. Economic Load Dispatch with & without transmission losses
9. Transient Stability Analysis Using Point By Point Method
10. Load Frequency Control of Single Area Control& Two Area Control system with and without controllers.

I Year -I Semester

Course Code	Course Title	L	P	Credits
AC-ERPW1101	Audit Course 1: English For Research Paper Writing	3	0	3

Course Objectives:

- Study on how to improve your writing skills and level of readability.
- Study about what to write in each section
- Study the skills needed when writing a Title

Course Outcomes:

After completion of this course the students will be able to:

1. Understand that how to improve your writing skills and level of readability(L2).
2. Learn about what to write in each section (L2).
3. Learn about how to do Literature survey (L2).
4. Learn about how to do Abstract(L2).
5. Understand the skills needed when writing a manuscript and article (L2).

UNIT-I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check **.**

UNIT-IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT-V

Skills are needed when writing the Methods, skills needed when writingthe Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly bethe first- time submission

Reference Books

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London,2011.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1201	Power System Dynamics and Stability	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- The model of synchronous machines.
- The stability studies of synchronous machines.
- The solution method of transient stability.
- The effect of governor action and excite on power system stability.
- The effect of different excitations.

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

1. Determine the model of synchronous machines.(L3)
2. Understand the stability studies of synchronous machines.(L2)
3. Learn the different solution methods of transient stability.(L2)
4. Study the effect of governor action and excitation on power system stability.(L2)
5. Understand the effect of different excitation systems.(L2)

UNIT-I

System Dynamics: Synchronous machine model in state space from computer representation for excitation and governor system-modeling of loads and induction machines.

Learning Outcomes: After completion of this unit student will be able to

- Design the synchronous machine model in state space representation for excitation and governor system.(L3)
- Develop the induction machine model in state space representation.(L3)

UNIT-II

Steady state stability-steady state stability limit: Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eighvalue approach.

Learning Outcomes: After completion of this unit student will be able to

- Learn the concept of different stability limits.(L2)
- Study the state space representation of synchronous machine connected to infinite bus.(L2)

UNIT-III

Digital Simulation of Transient Stability: Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method – Runge Kutta method – Concept of multi machine stability

Learning Outcomes: After completion of this unit student will be able to

- Study the different solution methods for transient stability.(L5)
- Understand the Modified Euler and RungeKutta Method applied for multi machine stability.(L2)

UNIT-IV

Effect of governor action and excite on power system stability effect of saturation saliency &automatic voltage regulators on stability.

Learning Outcomes: After completion of this unit student will be able to

- Understand the effect of governor action and excitation on power system stability.(L2)
- Study the automatic voltage regulators on stability.(L2)

UNIT-V

Excitation systems: Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator.Rotating main and Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme brushless excitation system.

Learning Outcomes: After completion of this unit student will be able to

- Study the Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator .(L2)
- Understand the Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator.(L2)
- Study the Rotating Amplifier and Static Voltage Regulator.(L2)
- Understand the brushless excitation system.(L2)

Text Books

1. Power System Stability by Kimbark Vol.I&II, III, Willey.
2. Power System control and stability by Anderson and Fund, IEEE Press

References Books

1. Power Systems stability and control by PRABHA KUNDUR, TMH.
2. Computer Applications to Power System-Glenn. W.Stagg& Ahmed. H.EI.Abiad,TMH.
3. Computer Applications to Power System – M.A.Pai, TMH.
4. Power Systems Analysis & Stability – S.S.VadheraKhanna Publishers.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1202	Flexible AC Transmission Systems	3	0	3

Course Objectives:

- To study the performance improvements of transmission system with FACTS.
- To study the effect of static shunt compensation.
- To study the effect of static series compensation.
- To study the effect of UPFC.

Course Outcomes: After completing this course the student will be able to:

1. Understand the concept of power flow control in transmission lines using FACTS controllers. (L2)
2. Acquire knowledge on operation and control of voltage source and current source converter .(L2)
3. Explain compensation methods to improve stability and reduce power oscillations in the transmission lines.(L5)
4. Identify the methods of compensations by using series compensators.(L3)
5. Explain the operation of modern power electronic controllers.(L2)

UNIT-I

Concepts of Flexible Ac Transmission Systems: FACTS concepts, Transmission interconnections, power flow in an AC System, loadingcapability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers, Applications.

Learning outcomes:

Student should be able to

- Understand the concept of Power flow in transmission systems (L2)
- Classify basic types of FACTS controllers (L2)

UNIT-II

Voltage and Current Sourced Converters: Basic concept of voltage and current source converters, comparison of current sourceconverters with voltage source converters.

Learning outcomes:

Student should be able to

- Understand the concept of Voltage Sourced Converters (L2)
- Compare the performance of voltage sourced and current sourced converters (L2)

UNIT-III

Static Shunt Compensators: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.SVC and STATCOM : The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control.

Learning outcomes:

Student should be able to

- Explain the Objectives of Shunt Compensation (L5)
- Classify the Methods of Controllable VAR Generation (L2)

UNIT-IV

Static Series Compensators: Static series compensators : Concept of series capacitive compensation, improvement oftransient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series

capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

Learning outcomes:

Student should be able to

- Understand the objectives of Series Compensation (L2)
- Identify different Types of series Compensating methods (L3)

UNIT-V

Power Flow Controllers: Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators.

Learning outcomes:

Student should be able to

- Explain the operation of Unified Power Flow Controller(L2)
- Explain the operation of Interline Power Flow Controller (L2)

Text Books

1. Understanding FACTS – Concepts and technology of Flexible AC Transmission systems, Narain G. Hingorani, Laszlo Gyugyi, IEEE Press, WILEY, 1st Edition, 2000, Reprint 2015.
2. FACTS Controllers in Power Transmission and Distribution, Padiyar K.R., New Age International Publishers, 1st Edition, 2007.

Reference Books

1. Flexible AC Transmission Systems: Modelling and Control, Xiao – Ping Zhang, Christian Rehtanz, Bikash Pal, Springer, 2012, First Indian Reprint, 2015.
2. FACTS – Modelling and Simulation in Power Networks, EnrigueAcha, Claudio R. Fuerte – Esquival, Huge Ambriz – perez, Cesar Angeles – Camacho, WILEY India Private Ltd., 2004, Reprint 2012.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1203	Real Time Control of Power Systems	3	0	3

Course Educational Objectives: The objectives of the course are to make the students learn about

- The importance of state estimation in power systems.
- The importance of security and contingency analysis.
- SCADA, its objectives and its importance in power systems.
- The voltage stability in powers system.
- The applications of AI to power systems problems.

Course Outcomes:

At the end of the course students will be able to

1. Understand the concept of state estimation and different state estimation techniques.(L2)
2. Apply security and contingency analysis for Generator and line outages.(L3)
3. Understand about Supervisory control and data acquisition in power systems.(L2)
4. Analyze the voltage stability in mature power systems.(L4)
5. Analyze Real time software application to state estimation and application of AI in power system.(L4)

UNIT-I

State Estimation : Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

Learning Outcomes: After completion of this unit student will be able to

- Understand the importance of state estimation and different methods of state estimation in power systems(L2).
- Understand the concepts of Bad data observability, Bad data detection, identification and elimination.(L2)

UNIT-II

Security and Contingency Evaluation: Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

Learning Outcomes: After completion of this unit student will be able to

- Understand the need and methods of analyzing security in power systems.(L2)
- Apply Security and Contingency Analysis for Generator and line outages.(L3)

UNIT-III

Computer Control of Power Systems: Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres, software requirements for implementing the above functions

Learning Outcomes: After completion of this unit student will be able to

- Understand the operating states of a power system and need of real time and computer control.(L2)
- Understand the operation of SCADA and software requirements for implementing it. (L2)

UNIT-IV

Voltage Stability Analysis: Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability, Voltage stability analysis. Introduction to voltage stability analysis `P-V' curves and `Q-V' curves, voltage stability in mature power systems,

long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices and Research Areas.

Learning Outcomes: After completion of this unit student will be able to

- Understand the basic concepts of voltage stability.(L2)
- Relate the voltage stability to rotor angle stability.(L6)
- Apply the power flow analysis for voltage stability, voltage stability static indices.(L3)

UNIT-V

Application of AI and ANN in Power System: Basic concepts and definitions, algorithms for load flow, short term load forecasting, fault diagnosis and state estimation.

Learning Outcomes: After completion of this unit student will be able to

- Apply AI techniques for load forecasting in power systems.(L3)
- Apply AI techniques for fault diagnosis and state estimation.(L3)

Text Books

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. PrabhaKundur : Power System Stability and Control -, McGraw Hill,1994

Reference Books

1. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation and control, John Wiley & Sons,1984
2. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
3. L.P.Singh : Advanced Power System Analysis and Dynamics, Wiley Eastern Ltd.1986
4. P.D.Wasserman : `Neural Computing : Theory and Practice' VanNostrandFeinhold, NewYork.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1204	Advanced Power System Protection	3	0	3

Course Objectives: The objectives of the course are to make the students

- To learn about classification and operation of static relays.
- To understand the basic principles of amplitude and phase comparators.
- To learn about static version of different types of relays.
- To assess the basic pilot relaying protection schemes.
- To understand about numerical protection techniques.

Course Outcomes:

After completion of this course the students will be able to:

1. Explain the operation and applications of static relays.(L2)
2. Understand the Operation and application of Amplitude and phase comparators.(L2)
3. Analyze the static version of different types of relays.(L4)
4. Analyze the various PILOT relaying protection schemes.(L4)
5. Apply the concepts of microprocessor based protective relays and digital relaying algorithms. (L3)

UNIT-I

Static Relays classification and Tools: Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristors and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays, Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Understand the classification and operation of static relays.(L2)
- Understand the significance of various electronic circuits in static relays.(L2)

UNIT-II

Amplitude and Phase comparators:

Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators, Phase Comparison comparators:

Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices, Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Develop the generalized equations for Amplitude and Phase comparison.(L6)
- Understand the principle and operation of different Amplitude comparators. (L2)

UNIT-III

Static over current (OC) relays: Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings, , Applications, Numerical Problems.

Learning Outcomes: At the end of this unit, the student is able to

- Analyze the operating characteristics of different types of Static over current relays.(L4)
- Understand the operation of different Static over current relays during fault conditions.(L2)

UNIT-IV

PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels, , Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Analyze the concept of static distance protection and pilot relaying schemes.(L4)
- Analyze Different types of carrier current protection schemes.(L4)

UNIT-V

Microprocessor based relays and Numerical Protection: Introduction – over current relays-impedance relay – directional relay – reactance relay.

Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann- morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection. , Applications.

Learning Outcomes: At the end of this unit, the student is able to

- Explain and apply the principles of digital protection to electrical apparatus.(L2)
- Apply the digital relaying algorithms for power system protection.(L3)

Text Books:

1. Power System Protection with Static Relays – by TSM Rao,TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma,TMH.

Reference Books :

1. Protective Relaying Vol-II Warrington,Springer.
2. Art & Science of Protective Relaying - C R Mason,Willey.
3. Power System Stability KimbarkVol-II,Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright-Springer
5. Protection & Switchgear–BhaveshBhalaja, R.PMaheshwari, NileshG.Chothani-Oxford publisher

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1205.1	Smart Grid Technologies	3	0	3

Course Objectives: The objectives of the course are to make the students learn about:

- To understand concept of smart grid and developments on smart grid.
- Understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid.

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

1. Understand smart grid concept and choose the smart grid policies (L1 & L2)
2. Apply smart grid technologies in hybrid electrical vehicles with automation design(L3 & L6)
3. Understand the operation of smart substations and identify the importance of GIS, IED etc., (L2 & L3)
4. Importance of micro grids and application of solar cells of renewable energy sources (L2 & L3)
5. Explain and analyze the power quality management in smart grid (L2 & L4)

UNIT-I

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

Learning Outcomes: After completion of this unit, students will be able to

- Understand Concept and opportunities of Smart Grid (L2)
- Choose the international policies on smart grid (L1)
- Compare the conventional and smart grid (L2)

UNIT-II

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers, Applications.

Learning Outcomes: After completion of this unit, students will be able to

- Understand the importance of Smart Meters (L2)
- Apply the smart grid concept in electric hybrid vehicles (L3)
- Design Automation, Phase Shifting Transformers (L6)

UNIT-III

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU), Applications.

Learning Outcomes: After completion of this unit, students will be able to

- Understand the operation of smart substations and automation (L2)
- Identify the importance of GIS, IED for monitoring & protection on smart grid (L3)
- Classify the smart storage like Battery, SMES etc., (L2)

UNIT-IV

Micro grids and Distributed Energy Resources: Concept of micro grid, need &applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources, Applications.

Learning Outcomes: After completion of this unit, students will be able to

- Understand the importance of micro grid (L2)
- Apply the various cells of renewable energy sources (L3)

UNIT-V

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN), Applications.

Learning Outcomes: After completion of this unit, students will be able to

- Understand the power quality issues of grid connected renewable energy sources (L2)
- Analyze thepower quality Audit in smart grid (L4)
- Examine the Advanced Metering Infrastructure (AMI), Home Area Network (HAN) (L4)
- Examine the Neighborhood Area Network (NAN), Wide Area Network (WAN)(L4)

Text Books

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

Reference Books

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication.
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1205.2	Power Quality	3	0	3

Course Objectives: The objectives of the course are to make the students

- To understand significance of power quality and power quality parameters.
- To know about the concepts of transients and their protection schemes.
- To understand harmonic minimization techniques.
- To understand long duration voltage variation and flicker
- To know power quality aspects in distributed generation.

Course Outcomes:

After completion of this course the students will be able to:

1. Explain the causes of power quality issues and power quality parameters.(L2)
2. Understand the sources of transient over voltages and provide protection to transient over voltages.(L2)
3. Understand the effects of harmonic distortion and harmonic minimization.(L2)
4. Analyze the long duration voltage variations and regulation of voltage L4)
5. Analyze the power quality issues and operating conflicts when DG is interconnected to the grid. (L4)

UNIT-I

Introduction: Overview of Power Quality - Concern about the Power Quality - General Classes of Power Quality Problems – Transients -Long-Duration Voltage Variations - Short-Duration Voltage Variations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions – Nonlinear loads, Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand the various power quality Issues in power system (L2)
- Understand the significance of power quality (L2)

UNIT-II

Transient Over Voltages: Source of Transient over Voltages - Principles of Over Voltage Protection - Devices for Over Voltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection - Load Switching Transient Problems - Computer Tools for Transient Analysis,Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand sources of transient over voltages and providing protection to transient over voltages. (L2)
- Apply Computer Tools for Transient Analysis.(L3)

UNIT-III

Harmonic Distortion and solutions: Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Non sinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources of Harmonics – System Response Characteristics,Effects of Harmonic Distortion – Inter harmonics Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion - Harmonic Filter Design - Standards on Harmonics, Numerical Problems Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand the Concept of harmonic distortion and sources of harmonics.(L2)
- Identify the effects of harmonics and locate the Sources of Harmonics.(L3)
- Understand the concepts of harmonic distortion and Devices for Controlling Harmonic Distortion.(L2)

UNIT-IV

Long Duration Voltage Variations: Principles of Regulating the Voltage - Device for Voltage Regulation - Utility Voltage Regulator Application - Capacitor for Voltage Regulation - End-user Capacitor Application - Regulating Utility Voltage with Distributed Resources – Flicker, Applications.

Learning Outcomes: At the end of this unit, student is able to

- Analyze the long duration voltage variations and regulation of voltage (L4)
- Analyze the applications of capacitors for Voltage Regulation.(L4)

UNIT-V

Distributed Generation and Power Quality: Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System - Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems, Applications**.**

Learning Outcomes: At the end of this unit, student is able to

- Analyze power quality aspects in distributed generation, connected to the grid.(L2)
- Understand the reasons for grounding, wiring and to describe the various associated problems & their solutions (L2)

Text Books

1. **Electrical Power** Systems Quality, Dugan R C, McGranaghan M F, SantosoS,andBeaty H W, Second Edition, McGraw-Hill,2002.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press;2000.

Reference Books

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill,2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons,2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Power Quality c.shankaran, CRC Press,2001
5. HarmonicsandPower Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
6. Power Quality inPower systems and Electrical Machines-EwaldF.fuchs,MohammadA.S. Masoum-Elsevier

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1205.3	Power System Reliability	3	0	3

Course Objectives: The objectives of the course are to make the students learn about:

- To understand the basic probability theory.
- To analyze the different networks and apply the different measure techniques.
- To evaluate the different probabilities by the concept of markov chains.
- To understand the reliability analysis of generation systems and load modeling.
- To analyze the effects on transmission lines and understand the reliability by decomposition techniques.

Course Outcomes:

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

1. Understand the basic probability theory applied to the power system.(L2)
2. Analyze the different networks and apply the different measure techniques.(L4)
3. Evaluate the different probabilities by the concept of markov chains.(L5)
4. Understand the reliability analysis of generation systems and load modeling.(L2)
5. Analyze the effects on transmission lines and understand the reliability by decomposition techniques. (L2 & L4)

UNIT-I

Basic probability theory – rules for combining probabilities of events – Bernoulli`s trials– probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution.

Learning outcomes: After completion of this unit, students will be able to

- Apply the probability theory and rules for combining probabilities of events.(L3)
- Understand the Bernoulli`s trials– probability density and distribution functions.(L2)
- Understand the standard deviation of binomial distribution.(L2)

UNIT-II

Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks– complex networks – decomposition method. Reliability functions F(t), F(t), R(t), h(t) and their relationship – exponential distributions –Expected value and standard deviation of exponentional distribution – Bath tub curve –reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF.

Learning outcomes: After completion of this unit, students will be able to

- Analyze the reliability of different networks.(L4)
- Analyze the reliability of series and parallel networks using exponential distribution. (L4)

UNIT- III

Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models.Frequency and duration concept– Evaluation of frequency of encountering state, mean cycle time, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states.

Learning outcomes: After completion of this unit, students will be able to

- Understand the concept of stochastic transitional probability Matrix by markov chain.(L2)
- Evaluate the dependent probability using Laplace transform approach.(L5)
- Determine the limiting state probabilities using STPM.(L5)

- Determine the frequency of encountering state and mean cycle time for one, two component repairable models.(L5)

UNIT-IV

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modeling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

Learning outcomes: After completion of this unit, students will be able to

- Analyze the generation system reliability. (L4)
- Develop the reliability load model merging of a generation system.(L6)

UNIT-V

Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Learning outcomes: After completion of this unit, students will be able to

- Analyze the reliability of Composite and distribution system by decomposition method.(L4)
- Evaluate the load and energy indices of power system.(L5)

Text Books

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. An Introduction to Reliability and Maintainability Engineering. Sharies E Ebeling, TATA.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1205.4	Energy Audit, Conservation & Management	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- To understand energy efficiency, scope, conservation and technologies.
- To design energy efficient lighting systems.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To understand energy conservation in HVAC systems.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Course outcomes:

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

1. Understand the concept of energy audit, energy management, energy conservation schemes and representation of energy consumption (L2).
2. Design energy efficient lighting systems (L3).
3. Design suitable power factor correcting equipment in electrical system and energy monitoring system to analyze the energy consumption in an organization. (L3).
4. Understand energy conservation in HVAC systems; improve the thermal efficiency for heat recovery and co-generation (L2).
5. Study economic and financial analysis of energy efficient technologies investment (L2).

UNIT–I

Basic Principles of Energy Audit and management: Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Piecharts –Sankey diagrams – Load profiles – Energy conservation schemes and energy savingpotential – Numerical problems – Principles of energy management – Initiating, planning,controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions –Language – Questionnaire – Check list for top management.

Learning Outcomes:

- Understand energy efficiency, scope, conservations and technologies(L2).
- Understand energy conservation act-2001(L2).
- Develop the energy flow diagram of an industry and identify the energy wasted or a waste stream, Energy monitoring system to analyze the energy consumption in an organization (L6).

UNIT–II

Lighting: Modification of existing systems – Replacement of existing systems – Priorities**:** Definitionof terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED and conducting Polymers – Energy conservation measures.

Learning Outcomes:

- Evaluate the techno economic feasibility of the energy conservation technique adopted in lighting (L5).
- Design of energy efficient lighting systems (L6).

UNIT–III

Power Factor and energy instruments: Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor –

Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer.

Learning Outcomes:

- Estimate/Calculate power factor of systems and propose suitable compensation Techniques(L5)
- Utilize suitable energy monitoring equipment to monitor various quantities in an organization.(L3)

UNIT–IV

Space Heating and Ventilation: Ventilation – Air–Conditioning (HVAC) and Water Heating**:** Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation–Cooling load – Electric water heating systems – Energy conservation methods.

Learning Outcomes:

- Improve the thermal efficiency by designing suitable systems for heat recovery and co generation (L6)
- Understand energy conservation in HVAC systems (L2).

UNIT–V

Economic Aspects and Financial Analysis: Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motorsand systems.

Computation of Economic Aspects: Need of investment, appraisal and criteria - Calculation of simple payback period–Return on investment – Net present value – Internal rate of return – numerical examples – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment –Numerical examples.

Learning Outcomes:

- Calculation of life cycle costing analysis and replacement analysis and Depreciation methods (L5)
- Understand return on investment on energy efficient technologies (L2)
- Understand Cash flow diagram and Calculate life cycle costing analysis and return on investment on energy efficient technologies.(L2,L5)
- Calculate most economical power factor and economic analysis on Power Factor correcting devices(L5)

Text Books

1. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

Reference Books

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
3. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
4. Energy management hand book by W.C.Turner, John wiley and sons.
5. Energy management and conservation –k v Sharma and p.venkataseshaiah-I K International Publishing House pvt.ltd,2011.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1206.1	Power System Deregulation	3	0	3

Course Objectives: The objectives of the course are to make the students learn about:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To examine typical issues in electricity markets and how these are handled world – wide in various markets.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

Course Outcomes:

After completion of this course the students will be able to:

1. Understand of operation of deregulated electricity market systems(L2)
2. Typical issues in electricity markets(L4)
3. To analyze various types of electricity market operational and control issues using new mathematical models.(L4)
4. Understand trading and Congestion management in deregulated power system(L2)
5. Understand ancillary services and Technical, economic&regulatory issues involved in deregulated power system(L2)

UNIT-I

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements.Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation.Power System Operation.

Learning Outcomes

- Understand Market Architecture(L2)

UNIT-II

Electricity sector structures and Ownership / management, the forms of Ownership and Management.Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Learning Outcomes

- Understand ownerships in deregulated power system(L2)
- Understand competition in deregulated power system(L2)

UNIT-III

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices

Learning Outcomes

- Understand electricity markets in deregulated power system(L2)

UNIT-IV

Transmission network and market power.Power wheeling transactions and marginal costing, transmission costing.Congestion management methods-market splitting, counter-trading; Effect of congestion on LMPs-country practices

Learning Outcomes

- Understand concept of trading in Deregulated power system(L2)
- Understand Congestion management in deregulated power system(L2)

UNIT-V

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

Learning Outcomes

- Understand ancillary services need in deregulated power system(L2)
- Understand Technical, economic,&regulatory issues involved in the deregulation system(L2)

Text Books:

1. Power System Economics: Designing markets for electricity - S. Stoft, wiley.
2. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.

Reference Books:

1. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.
2. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li,Wiley.
3. Fundamentals of power system economics - S. Kirschen and G. Strbac, Wiley.
4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineering.
5. Competition and Choice in Electricity - Sally Hunt and Graham Shuttle worth, Wiley.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1206.2	High Voltage Testing Techniques	3	0	3

Course Educational Objectives:

- To Measure resistivity, Dielectric loss and dielectric constant of insulating materials using non-destructive testing methods.
- To understand commercial and technical testing of different HV power applications.
- To study the different High voltage AC testing methods
- To understand Artificial Contamination Tests.
- To analyze Impulse Testing
- To analyze Partial Discharge Measurement phenomenon

Course Outcomes:

After completion of this course the students will be able to:

1. Calculate the DC resistivity , loss factor and dielectric constant of different insulation mediums used in power system .(L5).
2. Understand High Voltage Testing for for cap and pin porcelain/Glass insulators.(L2)
3. Analyze High voltage AC testing methods on Isolators, Circuit Breakers and power cables(L4)
   and understand the methods of Artificial Contamination Tests (L2).
4. Analyze the need of Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.(L4).
5. Analyze the methods to measure the partial discharge in a power equipment(L4).

UNIT-I

Non Destructive Testing Techniques: Measurement of DC Resistivity – Dielectric loss and dielectric constant of insulating materials – Schering bridge method – Transformer ratio arm bridge for high voltage and high current applications – null detectors, Numerical Problems.

Learning Outcomes: At the end of this unit, student is able to

- Understand Various Non Destructive Testing Techniques(L2)
- Calculate the DC resistivity , loss factor and dielectric constant of different insulation mediums used in power system(L5)

UNIT-II

High Voltage Testing of Power Apparatus: Need for testing standards – Standards for porcelain/Glass insulators-Classification of porcelain/glass insulator tests – Tests for cap and pin porcelain/Glass insulators,Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand the Need for High Voltage Testing of Power Apparatus(L2)
- Classify porcelain/glass insulator tests(L2)

UNIT-III

High voltage AC testing methods: Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables Applications.

Artificial Contamination Tests: Contamination flashover phenomena-Contamination Severity-Artificial contamination tests- Laboratory Testing versus in-Service Performance-Case study, Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand the need and procedure of Power frequency tests (L2)
- Analyze power frequency tests on various electrical apparatus.(L4)
- Understand the Contamination flashover phenomena using Artificial contamination

tests.(L2)

- Compare Laboratory Testing ,in-Service Performance.(L4)

UNIT-IV

Impulse Testing: Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers, Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand the need and procedure of impulse testing.(L2)
- Apply Impulse testing for transformers, insulators, Surge diverters, Bushings, cables, circuit breakers (L3)

UNIT-V

Partial Discharge Measurement: PD equivalent model-PD currents-PD measuring circuits-Straight and balanced detectors-Location and estimation of PD in power apparatus-PD measurement by non electrical methods-Calibration of PD detectors. RIV Measurements : Radio Interference – RIV – Measurement of RI and RIV in laboratories and in field. Different test arrangements and their limitations. , Applications.

Learning Outcomes: At the end of this unit, student is able to

- Understand the phenomenon of partial discharge in power apparatus (L2).
- Measure RI and RIV in laboratories and in field (L5).
- Analyze the Different test arrangement (L4).

Text Books

1. High Voltage Engineering – by E.KUFFEL and W.S.ZAENGL, Pergamon press, Oxford 1984.
2. High Voltage Engineering – byM.S.Naidu and V.Kamaraju, Tata McGraw Hill Publishing Company Limited, New Delhi –2001.

Reference Books

1. Discharge Detection in H.V. Equipment – by KREUGER, F.H. Haywood London – 1964.
2. Hyltencavallius. N. High voltage laboratory planning EnileHaefely&Co. Ltd. Based Switzerland1988
3. Ryan H.M. and Whiskand: design and operation perspective of British UHV Lab IEE pre 133 H.V. Testing Techniques.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1206.3	Power System Transients	3	0	3

Course Objectives: The objectives of the course are to make the student learn about

- The effect of over voltages on power system.
- the severity of over voltages due to faults on a given power system
- The propagation, reflection and refraction of travelling waves on power system.
- The phenomenon and effect of switching and lightning transients on power systems.

Course Outcomes:

After completion of this course the students will be able to:

1. Explain the Transients Analysis of Three-Phase power Systems (L5)
2. Analyze the Reflection and Refraction of Travelling Waves (L4)
3. Understand the concept of Switching Transients in circuit breaker (L2)
4. Understand the standards of power system transients (L2).
5. Analyze lighting transient over voltages and their effects on power system (L4)

UNIT-I

Basic Concepts and Simple Switching Transients;-Switching an LR,LC,RLC circuits Transients Analysis of Three-Phase power Systems: – Symmetrical components in three-phase Systems, Sequence Components for Unbalanced Network Impedances, the Sequence Networks, analysis of Unsymmetrical Three-Phase Faults-single line-to-Ground Fault, Three phase-to-ground fault.

Learning Outcomes:

After completion of this unit students will be able to

- Explain the Transients in Three-Phase power Systems (L5)
- Analysis of Unsymmetrical Three-Phase Faults (L4)

UNIT-II

Travelling Waves:- Velocity of Travelling waves and Characteristic Impedance, Energy Contents of Travelling Waves, Attenuation and Distortion of Electromagnetic Waves, telegraph equations-lossless line, distortion less line.Reflection and Refraction of Travelling Waves, Reflection of Travelling Waves against Transformer-and-Generator-windings, the Origin Transient Recovery voltages, bewley-lattice diagram.travelling waves and multi conductor system.

Learning Outcomes:

After completion of this unit students will be able to

- Understand the Velocity of Travelling waves and Characteristic Impedance (L2)
- Explain the Attenuation and Distortion of Electromagnetic Waves (L2)
- Analyze Reflection and Refraction of Travelling Waves (L4)
- Explain the travelling waves and multi conductor system.(L2)

UNIT-III

Switching Transients:-arc interruption in circuit breaker , transient recovery voltage, arc-circuit interaction, interruption of capacitive currents, interruption of inverse currents, interruption of fault current in transmission line and transformers.

Learning Outcomes:

After completion of this unit students will be able to

- Understand the switching transients in circuit breaker (L2)
- Explain the interruption of fault current in transmission line and transformers (L2)

UNIT-IV

Power System Transient Recovery Voltages:- Characteristics of the Transient Voltage-Short-circuit test duties based on IEC 60056 (1987),ANSI/IEEE Standards, the Harmonization between IEC and ANSI/IEEE Standards with respect to Short-circuit Test duties, transient recovery voltage for Different types of faults.

Learning Outcomes:

After completion of this unit students will be able to

- Demonstrate Characteristics of the Transient Voltage (L2)
- Classify different types of faults based on transient recovery voltage(L2)

UNIT-V

Lightning –Induced Transients: Mechanism of Lightning, wave shape of the lightning current, Direct lighting Stroke to transmission line towers, direct lightening stroke to a line, lightning protection scheme. Numerical simulation of electrical transients, The Electromagnetic Transient Program, principles of numerical techniques used in transient simulation.

Learning Outcomes:

After completion of this unit students will be able to

- Understand the Mechanism of Lightning strokes, transients and wave shape of the lightning current (L2)
- Explain the Direct lighting Stroke to transmission line towers (L2).

Text Books

1. Electrical Transients in Power System by Allen Greenwood, McGraw Hill 1990
2. Power system grounding & transients by A.P.SakisMeliopolous.
3. “Transients in power systems” by Lou Van Sluis

Reference Books

1. Bewley LV “travelling waves on transmission system” Dover publications Inc.,
2. Walter Diesendorf, Insulation co-ordination in high-voltage electric power systems, Butterworths, London, (1974),
3. J. G. Anderson: EHV Transmission Line Reference Book (Edison Electric Institute, New York, 1968) p. 126.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1206.4	Electrical and Hybrid Vehicles	3	0	3

Course Objectives:

- Understand the models to describe hybrid vehicles and their performance.
- Analyze the topologies of drive trains and their controls.
- Analyse electric propulsion units of electric and hybrid vehicles.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

Course outcomes:

After completion of this course the students will be able :

1. To understand the Performance characteristic and model dynamics of hybrid electric vehicles. (L2)
2. To Analyze the topologies of drive trains,electric propulsion units and their controls for electric and hybrid vehicles.(L4)
3. To Analyse various energy storage devices for hybrid and electric vehicles (L4)
4. To Analyseand evaluate various energy storage devices and their sizes and selection of Energy storage system for hybrid and electric vehicles (L4,L5)
5. To Analyze the energy management strategies used in hybrid and electric vehicles.(L4)

UNIT I

Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Learning outcomes:

- Module outcome: To understand the Performance characteristic and model dynamics of hybrid electric vehicles. (L2)

UNIT II

Drive trains and their controls: Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Learning outcomes:

- To Analyze the topologies of drive trains and their controls.(L4)
- To Analyse electric propulsion units of electric and hybrid vehicles.(L4)

UNIT III

Energy Storage: Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Learning outcomes:

- To Analyse various energy storage devices for hybrid and electric vehicles (L4)

UNIT IV

Sizing and Selection of Energy storage system: Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Learning outcomes:

- To evaluate the size and selection of Energy storage system for hybrid and electric vehicles (L5)

UNIT V

Energy Management Strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Learning outcomes:

- To Analyse the energy management strategies used in hybrid and electric vehicles.(L4)

Text Books

1. C. Mi, M. A. Masrur and D. W. Gao, " Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, " Hybrid Electric Vehicles: Energy Management Strategies" , Springer, 2015.

Reference Books

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

I Year -II Semester

Course Code	Course Title	L	P	Credits
EE-PSCA1207	Power Systems Laboratory	3	0	3

Course Objectives: The objectives of the course are to make the students learn about

- The practical knowledge about sequence impedance of Alternator and Transformer.
- The practical knowledge of transmission line parameters and Ferranti Effect.
- Experiment on 3-winding transformer.
- The knowledge about Design and simulation for power angle characteristics of a salient pole synchronous machine.
- Experiment on 3-single phase transformers.
- The practical knowledge of transmission line without and with shunt compensation.

Course Outcomes:

After completion of this course the students will be able to:

1. Determine the sequence impedance of alternator and transformer.(L5)
2. Determine the transmission line parameters ,voltage regulation of transmission lines without and with shunt regulation and study the Ferranti effect.(L5)
3. Perform the experiment on 3-winding transformer and calculate the parameters of transformer.(L4)
4. Design and simulation of the power angle characteristics of a salient pole synchronous machine.(L6)
5. Perform the experiment on 3-single phase transformer and measure the phase displacement(L4).

List of Experiments

1. Determination of Sequence Impendence of an Alternator by direct method.
2. Measurement of sequence impedance of a three phase transformer by application of sequence voltage using fault analysis.
3. Power angle characteristics of a salient pole Synchronous Machine.
4. Poly-phase connection on three single phase transformers and measurement of phase displacement.
5. Determination of equivalent circuit of 3-winding Transformer.
6. Measurement of ABCD parameters on transmission line model.
7. Performance of long transmission line without compensation.
8. Study of Ferranti effect in long transmission line.
9. Performance of long transmission line with shunt compensation.
10. Short circuit analysis for L-G and L-L fault using MATLAB

I Year -II Semester

Course Code	Course Title	L	P	Credits
AC-RMIP1201	Audit Course 2: Research Methodology and IPR	3	0	3

Course Objectives:

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

- Study the research problem formulation.
- Study the research related information.
- Study the research ethics.

Course Outcomes:

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

1. Understand research problem formulation (L2)
2. Analyze research related information (L4)
3. Understand the research ethics and today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity (L2).
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general &engineering in particular (L2).
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits (L2).

UNIT –I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT –II

Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT –III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT –IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.

5. Mayall , “Industrial Design”, McGraw Hill,1992.
6. Niebel , “Product Design”, McGraw Hill,1974.
7. Asimov , “Introduction to Design”, Prentice Hall,1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”,2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand,2008