SYLLABUS

FOR

SEMESTER SEVENTH

Course Code	PCCEE701			Semester	SEVENTH
Category	Professional Core Course				
Course Title	Power System Protection & Switchgear				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Power System				

Course Objectives:

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.

Unit	Topic	No. of Hours
I	PROTECTIVE RELAYING: Function, fundamental principle, primary and backup relaying, characteristics. CLASSIFICATION OF RELAYS: Operating principles and characteristics of the following electromechanical relays: Current, voltage, directional, current balance, voltage balance, differential relays, and distance relays.	13
II	PROTECTION OF GENERATORS: Short- circuit protection of stator windings, protection against turn-to-turn fault, stator ground-fault protection, stator open circuit protection.	10
III	TRANSFORMER PROTECTION: Short circuit protection, over current and earth-fault protection differential protection. Use of biased relay for differential protection, Buchholz relay, protection of parallel transformer banks	8
IV	PROTECTION OF FEEDERS, BUSBARS AND TRANSMISSION LINES: Protection of feeders, time limit fuse, overcurrent protection for radial feeders, protection of parallel feeders, differential protection for parallel feeders, protection of ring mains, differential pilot wire protection, Circulating current protection, protection for bus-bars, frame leakage protection, differential protection, for bus bars, protection for double bus-bar system, transmission line protection, using over- current relays, using distance relays. Setting of overcurrent and distance relays, coordination of relays. Phase fault and earth fault protection.	10
V	FUSES: Fusing element, classification of fuses, current carrying capacity of fuses, high rupturing capacity, characteristics of H.R.C. fuses, selection of HRC fuses. CIRCUIT BREAKERS: Types of circuit breakers , basic principle of operation, phenomena of arc, initiation,maintenance & arc extinction, d. c. circuit breaking,a.c. circuit breaking, arc voltage and current waveforms in a.c. circuit breaking, restriking and recovery voltages, deionization and current chopping, ratings of circuit breakers, oil circuit breakers, air blast circuit breakers, SF6 Circuit breakers ,Vacuum breakers.	15
Total		**56**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Art and Science of Protective Relaying	Mason	John Wiley & Sons
2	Protective relaying, Principles and Applications	J. L Black Burn	CRC Press

Course Code	**PCCEE702**			**Semester**	**SEVENTH**
Category	**Professional Core Course**				
Course Title	**Power Systems-III**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Power System**				

Course Objectives:

1. Use numerical methods to analyse a power system in steady state
2. Understand the problem of power system stability and its impact on the system.
3. Model different power system components for the study of stability.
4. Understand the methods to improve stability.

Unit	Topic	No. of Hours
I	Load Flows: Nature and importance of the problem, Network model formulation, algorithm for the formulation of Y-bus matrix, formulation of Y-bus by singular transformation, primitive network, Bus incidence matrix; sparsity fundamentals. Flow problem, load flow equations, bus classification – List of variables in load flow equations, Load Flow Solution Techniques:-Gauss - Seidel & Newton-Raphson method for solving load flow problem, comparison of performance load flow methods: De-coupled, Fast decoupled , DC power flow; programming issues and scripting fundamentals.	20
II	Optimal operation of power systems: Introduction to nonlinear optimization. Constrained and unconstrained optimal thermal dispatch; effect of losses. Basic idea of unit-commitment	8
III	Power System Stability: The stability problem, steady state, dynamic and transient stability, rotor dynamics and swing equation, power- angle curve, equal-area criterion of stability, Numerical solution of swing equation, Factors affecting transient stability. Multi-machine transient stability (programming and models).	12
IV	Power system control: Generator control loops; Load frequency control: generator, load, prime-mover, and governor models. Automatic Generation Control: single-area and multi-area systems; tie-line bias control; AGC with optimal dispatch. Reactive power and voltage control: models of amplifiers, exciters, generators, sensors; excitation system stabilizers. AGC includes an excitation system. Basic idea of modern control applications: pole-placement and optimal control design.	16
Total		**56**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Power System Analysis	J.J. Grainger and W.D Stevenson	Tata McGraw-Hill
2	Electrical Power Systems	B.M. Weedy and Cory	John Wiley & sons.
3	Power Systems Engineering	Nagrath and Kothari	McGraw-Hill Education
4	Electric Power Systems	C.L. Wadlhwa	New Age Publications

Course Code	OEC1EE703			Semester	SEVENTH
Category	Open Elective Course				
Course Title	SCADA				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Basic Programming & Automation				

Course Objectives:

1. To understand what is meant by SCADA and its functions
2. To know SCADA communication
3. To get an insight into its application.

Unit	Topic	No. of Hours
I	Introduction to SCADA:-SCADA in power systems, advantages, general structure, Architecture,Classification of SCADA systems..	6
II	Components of SCADA Systems. Remote terminal unit (RTU), Communication subsystem, Protocols, Logic subsystem, termination subsystem, test and power supply subsystem, Master Station(MTU), Human machine interface, data concentrators,IED.	10
III	Supervisory and Control Functions: Overview of the methods of data acquisition systems, commonly acquired data, status indications, majored values, energy values, monitoring alarm and event application processing. Functions of SCADA:-Human-machine interface (HMI) , Electrical communication ,Data acquisition (DAQ) and Transmission , Monitoring , Control , Data collection, storage and retrieval , Calculation and Report generation, Set points and feedback loops, time tagged data. etc	8
IV	SCADA Software, Communication and Protocols:ISO's OSI 7 layers Reference Model, TCP/IP Model, SCADA communication requirements,SCADA communication systems topologies, data communication techniques-Master-Slave,peer-to-peer, broadcast and multicast, Introduction to SCADA and Smart Grid communication protocols- Modbus, IEC61850-5-101/103/194, DNP. Various types of Communication Media (Guided and Unguided)	10
V	Energy Management System: Introduction to EMS, Architecture and working of EMS Operation states of a power system,Power system security, production control and load management, economic dispatch	8
Total		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Electric Power Substation Engineering	John D Mc Donald	CRC Press
2	Power Generation Operation and Control	Wood, A. J and Wollenberg, B. F	John Wiley and Sons
3	SCADA-Supervisory Control And Data Acquisition	Stuart A. Boyer	ISA
4	Practical SCADA for industry	David Bailey and Edwin Wright-	Elsevier

Course Code	OEC2EE703			Semester	SEVENTH
Category	Open Elective Course				
Course Title	Fuzzy Logic and Neural Networks				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Digital Logic				

Course Objectives:

1. Introduction to Neural networks and various neural network models
2. Various important concepts related with neural networks
3. Various learning paradigms in artificial neural networks
4. How fuzzy systems are used to solve problems of uncertainties.
5. How various artificial intelligence methods are clubbed to introduce hybrid systems.

Unit	Topics	No. of Hours
I	Introduction to neural networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch- Pitts Model, Historical Developments, Potential Applications of ANN.	9
II	Essentials of artificial neural networks: Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules.	9
III	Learning Paradigms: Introduction to various learning algorithms, back propagation algorithm, pattern classification, clustering, Kohonen self-organizing feature map, radial basis function network, support vector machines, Hopfield network, Associative memory and BAM, Applications of ANN models to engineering problems.	9
IV	Fuzzy systems: Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions and its types. Fuzzification, defuzzification. Methods of defuzzification. Fuzzy inference systems.	9
V	Hybrid Intelligent Systems: Genetic algorithms, neuro-fuzzy systems, adaptive neuro-fuzzy inference system, evolutionary neural networks, fuzzy evolutionary systems. Illustration of these systems with examples from power systems etc.	6
Total number of Hours		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Introduction to Artificial Neural Systems	Jacek M. Zurada	PWS Publishing Company
2	Neural Networks: A Comprehensive Foundation,	S. S Haykin,	Pearson Education.
3	C++ Neural Networks and Fuzzy Logic,	ValluruRao,	Honary Holt & Co (1998)
4	Neural Networks,	Freeman	Pearson Publication (2003).
5	Genetic Algorithms; Synthesis and applications,	Rajasekaran & Pai	Prentice Hall of India (2004).

Course Code	**OEC3EE703**			**Semester**	**SEVENTH**
Category	**Open Elective Course**				
Course Title	**Energy Management in Buildings**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	2	**1**	**0**	**3**	
Prerequisites	**Risk management, Energy sustainability**				

Course Objectives:

1. To understand the energy use and conservation options in buildings.
2. To understand the concepts of heat transmission in building
3. To learn the lightning fundamentals and day lightning use and estimation.
4. To understand the ASHRAE Methods and standards for estimates of Heating, cooling and Ventilation.

Unit	Topics	No. of Hours
I	Energy use in Buildings: Factors affecting Energy use, Energy Conservation options. External Factors – Climate, Climatic Zone, Building Orientation, Shading, Sizing of Shading Devices. Thermal Comfort: Criteria and various Parameters, Psychrometric Chart, Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.	14
II	Heat Transmission in Buildings: Heat Transmission in Buildings: Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof, Heat Transfer due to ventilation/ infiltration, Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium),	10
III	Lighting Fundamentals & Day Lighting use: Lighting Fundamentals, Visual Performance, Calculations of Lighting Levels, Energy Efficient Lighting. Day Lighting Use: Estimation of available Daylight, Day lighting Systems, Advantages and Limitations of Daylight Use.	8
IV	ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments, Distribution Systems for Conditioned Air, Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems; Building Codes.	10
Total number of Hours		42

Textbooks:

S. No	Name of Book	Author	Publisher
1	Solar Passive: Building Science and Design	M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik	Pergamon Press (1986).
2	Building, Climate and Energy	T.A. Markus and R.N. Morris,	Spottiswoode Ballantyne Ltd-, London U.K. (1980)
3	Energy storage technologies", a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.		
4	Thermal Environment Engineering,	Jamee; L. Threlked	Prentice Hall, INC-, Raglevood Cliffs, New Jersey

Course Code	**PEC1EE704**			**Semester**	**SEVENTH**
Category	**Professional Elective Course**				
Course Title	**Power Quality**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	2	**1**	**0**	**3**	
Prerequisites	**Basic Electrical Circuits, Power Electronics, Control System**				

Course Objectives:

1. Understand the different power quality issues to be addressed
2. Understand the recommended practices by various standard bodies on voltage & frequency, harmonics
3. Understand about compensation and compensators

Unit	Topic	No. of Hours
I	Introduction to Power Quality- Definition, Power Quality Problems, Causes and Consequences,voltage sags, swells, interruptions, flicker, reactive power and harmonics. Load Current Compensation, Reactive power compensation and zero voltage regulation.	10
II	Passive Compensation, Active load compensation- D-STATCOM- Design, Control and Phasor Analysis.	12
III	Source Voltage Compensation, Dynamics of sags and swells, Passive Series Compensation, Active Series Compensation- Dynamic Voltage Restorer (DVR) with and without energy support- Design, Control and Phasor Analysis.	10
IV	Combined Compensation- Unified Power Quality Conditioner (UPQC) , Right Shunt and Left Shunt Topologies	10
Total		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Power Quality Problems and Mitigation Techniques	B. Singh and A. Chandra	Wiley
2	Understanding Power Quality Problems: Voltage Sags and Interruptions .	Math H. Bollen	Wiley
3	Power Quality Enhancement using Custom Power Devices, Springer.	A. Ghosh, G. Ledwich	Springer

Course Code	PEC2EE704			Semester	SEVENTH
Category	Professional Elective Course				
Course Title	FACTS				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Power Electronics, Power System				

Course Objectives:

Students will be able to

1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. Understand the working principles of FACTS devices and their operating characteristics.

Unit	Topic	No. of Hours
I	Introduction to FACTS Technology, Types of FACTS controllers, FACTS vs. HVDC, Benefits of FACTS Technology, Performance Equations and Parameters of Transmission Lines, Transfer of Active and Reactive Power over a Transmission Line, Uncompensated Transmission, Need for Compensation, Definition and Functions of compensation.	10
II	Compensation Techniques: Ideal Shunt compensation, Ideal Series compensation, Phase-Angle control (Regulator), Advantages of Series compensation (voltage support, Transient stability improvement, Power oscillation damping), Advantages of shunt compensation, Thyristor Controlled Reactor (TCR), Thyristor-Switched Capacitor (TSC).	10
III	Analysis of various types of Static Var compensators (SVC), Static Synchronous Compensator (STATCOM): Analysis and comparison with SVC, Series compensators: GTO-Controlled Series Capacitor (GCSC),Thyristor-Switched Series Capacitor (TSSC), Thyristor-Controlled Series Capacitor (TCSC),Static Synchronous Series Compensator (SSSC).	10
IV	Voltage & Phase-Angle Regulation, Thyristor-Controlled Voltage Regulator (TCVR), Thyristor Controlled Phase-Angle Regulator (TCPAR), Introduction to Series-Shunt compensator & Series-Series compensator,Thyristor Controlled Braking Resistor (TCBR)	12
Total		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Understanding FACTS	N. G. Hingorani, Laszlo Gyugyi,	Wiley
2	FACTS Controllers In Power Transmission and Distribution	K R Padiyar	New Age International

Course Code	PEC3EE704			Semester	SEVENTH
Category	Professional Elective Course				
Course Title	Power Plant Engineering				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Nil				

Objectives:

1. Understand the layout, construction and working of the components inside a thermal power plant.
2. Understand the layout, construction and working of the components Diesel, Gas and Combined cycle power plants.
3. Understand the layout, construction and working of the components inside nuclear power plants.
4. Understand the layout, construction and working of the components inside Renewable energy power plants.

Unit	Topic	No. of Hours
I	COAL BASED THERMAL POWER PLANTS: Rankine cycle – improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.	15
II	DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS: Otto, Diesel, Dual & Brayton Cycle – Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.	10
III	Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.	10
IV	HydroElectric Power Plants – Classification, Typical Layout and associated components including Turbines and Principle of operation	7
Total		42

Textbooks:

S. No	Name of Book	Author	Publisher
1	Power Plant Engineering, Third edition	Nag.P.K	Tata McGraw Hill Publishing Company Ltd., 2008.

Course Code	PEC1EE705			Semester	SEVENTH
Category	**Professional Elective Course**				
Course Title	**Electric Drives**				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Machines and Power Electronics				

Course Objectives:

1. Understand the characteristics of dc motors and induction motors.
2. Understand the principles of speed-control of dc motors and induction motors.
3. Understand the power electronic converters used for dc motor and induction motor speed control.

Units	Topic	No. of Hours
I	Types of Drives and Load:Introduction, advantages of electric drives, components of electric drives, modes of operation, characteristic of different types of mechanical load, steady state stability of motor load system, fluctuating loads and load equalization, thermal loading of motor,estimation of motor rating for continuous, intermittent and short time duty loads.	8
II	DC Drives I: Characteristics of DC motors. Conventional methods of speed control: rheostatic, field and armature control. Electric braking of DC drives: Regenerative braking, Plugging and dynamic braking. Phase control of fully controlled DC drives, continuous and discontinuous conduction modes of operation	9
III	DC Drives II: Chopper controlled drives. Comparison of phase and chopper controlled drives. Review of feedback control, closed loop configurations in electric drives: current limit control, torque control, speed control of multi-motor drives and position control. Closed loop control of phase and chopper controlled dc drives.	9
IV	AC Drives I: Review of three phase induction motor characteristics. Electric braking of induction motor drives: Regenerative, Plugging, AC and DC dynamic braking. Methods of speed control of induction motors: stator voltage control, variable frequency control, and pole changing and pole amplitude modulation.	8
V	Speed control of wound rotor induction motor: Rotor resistance control (conventional and static), slip power recovery schemes. Closed loop control of induction motor drives: VSI control, static rotor resistance control, static Scherbius and Kramer drives, current regulated VSI drives. Introduction to vector control.	8
Total		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Fundamentals of Electric Drives	G. K. Dubey	Narosa Publications
2	Modern Power Electronics and AC Drives	Bimal. K. Bose	Prentice Hall PTR
3	Electric Motor Drives: Modeling, Analysis and Control	R. Krishnan	Pearson
4	High Performance AC Drives: Modelling, Analysis and Control	M. Ahmad	Springer.

Course Code	PEC2EE705			Semester	SEVENTH
Category	Professional Elective Course				
Course Title	Design of Photovoltaic Systems				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Power Electronics				

Course Objectives:

1. Understand the basics of Solar PV System
2. Understand the working principles of standalone and grid connected PV systems.

Units	Topic	No. of Hours
I	A historical perspective, PV cell characteristics and equivalent circuit, Model of PV cell, Short Circuit, Open Circuit and peak power parameters, Datasheet study, Cell efficiency, Effect of temperature, Fill factor, PV cell simulation	3
II	Series & Parallel interconnection: Identical cells in series, Load line, Non-identical cells in series, Protecting cells in series, Interconnecting modules in series, Simulation of cells in series, Identical cells in parallel, Non-Identical cells in parallel, Protecting cells in parallel, Interconnecting modules, Simulation of cells in parallel, Practicals - Measuring i-v characteristics	9
III	Energy from Sun: Introduction, insolation & irradiance,Insolation variation with time of day,Earth centric viewpoint and declination, Solar geometry, Insolation on a horizontal flat plate, Energy on a horizontal flat plate, Sunrise and sunset hour angles Incident energy estimation: Energy on a tilted flat plate, Energy plots in octave, Atmospheric effect, Energy with atmospheric effects, Clearness index and energy scripts in Octave	7
IV	Sizing PV: Sizing PV for applications without batteries, Battery capacity, C-rate, efficiency,energy & power density,comparison,battery selection, Sizing PV for applications without batteries, Other energy storage methods, PV system design- Load profile, Days of autonomy and recharge, Battery size, PV array size. MPPT concept, Input impedance of DC-DC converters - Boost converter,Buck Converter & Buck Boost converter	8
V	MPPT Algorithms,PV battery interface,Peltier cooling, Pv & water pumping, Pv & Grid Interface and life cycle costing	15
Total		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Solar Photovoltaic Technology and Systems	Chetan Singh Solanki	Prentice Hall India
2	Solar Photovoltaics - Fundamentals, Technologies and Applications	Chetan Singh Solanki	Prentice Hall India
3	Design of Photovoltaic Systems	L Umanand	NPTEL

Course Code	**PEC3EE705**			**Semester**	**SEVENTH**
Category	**Professional Elective Course**				
Course Title	**Special Electric Machines**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	2	**1**	**0**	**3**	
Prerequisites	**Electrical Machines**				

Course Objectives:

1. Familiarize with Construction features of various special electric machines, their mode of excitation and characteristics
2. Familiarize with control of special electric machines

Units	Topic	No. of Hours
I	SYNCHRONOUS RELUCTANCE MOTORS: Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors– Voltage and Torque Equations - Phasor diagram - performance characteristics – Applications	10
II	STEPPER MOTORS: Constructional features – Principle of operation – Variable reluctance motor– Hybrid motor – Single and multi-stack configurations – Torque equations – Modes of excitation – Characteristics – Drive circuits – Microprocessor control of stepper motors – Closed loop control-Concept of lead angle – Applications	10
III	PERMANENT MAGNET BRUSHLESS D.C. MOTORS: Permanent Magnet materials – Minor hysteresis loop and recoil line-Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation - Power Converter Circuits and their controllers – Motor characteristics and control– Applications.	11
IV	PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM): Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements– Applications.	11
Total		42

Textbooks:

S. No	Name of Book	Author	Publisher
1	Electric Machinery	Fitzgerald, Kingslay, Umans	Tata McGraw-Hill
2	Electric Machinery Fundamentals	Chapman	McGraw-Hill Higher Education
3	Electric Machines	Nagrath and Kothari	Tata McGraw-Hill

Course Code	PEC4EE705			Semester	SEVENTH
Category	Professional Elective Course				
Course Title	Industrial Drives & Control				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	2	1	0	3	
Prerequisites	Electrical Machines, Control and Power Electronics				

Course Objectives:

1. Understand the principles of open loop & closed loop speed control of dc motors and Ac motors.
2. Simplification of Analysis by use of transformations from one reference frame to another in AC drives
3. Understand vector control & sensorless control.

Units	Topic	No. of Hours
I	Electrical Drives: Introduction, AC & DC Drives, Advantages, components, General applications, Modelling of DC Machines: Theory of operation, Torque-speed characteristics revision,State-Space Modelling, Block Diagram & Transfer Function	11
II	Control of DC Drives: Revision of speed control methods of DC motors, Controlled rectifier based drives,Modes of operation, Speed control & Drive classification,Closed Loop speed control of Drives	7
III	Chopper Controlled DC Motor Drive: Introduction,Principle of operation of the Chopper, Four-quadrant Chopper Circuit, and Closed Loop Operation.	6
IV	Modelling of Induction Motor: Introduction,Park's transformation, stator, rotor and synchronously rotating reference frame models, State Space Equations	9
V	Induction motor drive control: Introduction to scalar and vector control, direct and indirect vector control ,principle of operation and control strategy (VSI, VSI fed drive, block diagram, controllers, etc.), Direct torque control, Sensorless control of AC drives	9
Total		**42**

Textbooks:

S. No	Name of Book	Author	Publisher
1	Fundamentals of Electric Drives	G. K. Dubey	Narosa publications
2	Modern Power Electronics and AC Drives	Bimal. K. Bose	Prentice Hall PTR
3	Electric Motor Drives: Modeling, Analysis and Control	R. Krishnan	Pearson
4	Sensorless Vector and Direct Torque Control	Peter Vas	Oxford science publications

Course Code	PSIEE706			Semester	SEVENTH
Category	Project, Seminar and Internship				
Course Title	Pre-project				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	0	0	6	3	
Prerequisites	All core courses				
The pre-project work is carried out by students in a group. The group comprises a minimum of three and a maximum of five students. The number of students in a group depends on the type and scale of the project being undertaken. In the pre project work students shall choose a specific topic/area for the project. The selected areas shall encompass recent and emerging trends in technologies that prove beneficial for society in general and humanity in particular. Supervisors will be assigned to each group in the beginning of the 7th semester of their course. Each student at the end of the course will submit a Project report and a working prototype or simulation regarding the project and the same will be evaluated for final award of the course. The pre-project can be a full-fledged project or a part of a major project.					

Course Code	PCCEE701L			Semester	Seventh
Category	Professional Core Course				
Course Title	Pre-project				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	0	0	2	1	
Prerequisites	Nil				

S. No.	Experiment
1	Study of various types of relays.
2	Characteristics of fuses.
3	Characteristics of inverse time over current relays
4	Time graded protection using inverse time O/C relay
5	Study of circuit breakers.
6	Study of differential protection schemes.
7	Study of an oil circuit breaker.