PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018
(AUTONOMOUS)
M.E. POWER SYSTEMS ENGINEERING
CURRICULUM AND SYLLABUS
III - IV SEMESTERS
REGULATIONS 2019
CHOICE BASED CREDIT SYSTEM

SEMESTER III

S.No	Course Code	Course Title	L	T	P	C
Theory						
1	PPS1955*	Professional Elective V	3	0	0	3
2	PPS1965*	Professional Elective VI	3	0	0	3
3	*****	Open Elective	3	0	0	3
Practical						
4	PPS19301	Dissertation Phase – I	0	0	20	10
		TOTAL	**9**	**0**	**20**	**19**

SEMESTER IV

S.No	Course Code	Course Title	L	T	P	C
Practical						
1	PPS19401	Dissertation Phase – II	0	0	32	16
		TOTAL	**0**	**0**	**32**	**16**

*** Professional electives of PG programmes**

******* Open Electives from other PG programmes**

LIST OF ELECTIVES

Course Code	Course Title	L	T	P	C
PROFESSIONAL ELECTIVE I (PE)					
PPS19151	Power Electronics for Renewable Energy Systems	3	0	0	3
PPS19152	Smart Grids	3	0	0	3
PPS19153	High Power Converters	3	0	0	3
PPS19154	Wind and Solar Systems	3	0	0	3
PROFESSIONAL ELECTIVE II (PE)					
PMA19152	Mathematical Methods in Power Engineering	3	0	0	3
PPS19251	Electrical Power Distribution System	3	0	0	3
PPS19252	Analysis and Design of Power Converters	3	0	0	3
PPS19253	Electric and Hybrid Vehicles	3	0	0	3
PROFESSIONAL ELECTIVE III (PE)					
PPS19351	Restructured Power Systems	3	0	0	3
PPS19352	Advanced Digital Signal Processing	3	0	0	3
PPS19353	Dynamics of Electrical Machines	3	0	0	3
PPS19354	Solar and Energy Storage Systems	3	0	0	3
PROFESSIONAL ELECTIVE IV (PE)					
PPS19451	Advanced Microcontroller Based Systems	3	0	0	3
PPS19452	SCADA System and Application	3	0	0	3
PPS19453	Power Quality	3	0	0	3
PPS19454	Artificial Intelligence and its Application	3	0	0	3
PROFESSIONAL ELECTIVE V (PE)					
PPS19551	Power System Transients	3	0	0	3
PPS19552	Flexible AC Transmission Systems	3	0	0	3
PPS19553	Industrial Load Modeling and Control	3	0	0	3
PPS19554	System Theory	3	0	0	3
PROFESSIONAL ELECTIVE VI (PE)					
PPS19651	Distributed Generation and Microgrid	3	0	0	3
PPS19652	Soft Computing Techniques	3	0	0	3
PPS19653	Design of Substations	3	0	0	3
PPS19654	Energy Management and Auditing	3	0	0	3

PPS19301 **DISSERTATION PHASE I** **0 0 20 10**

COURSE OBJECTIVES

To enable the students to

- identify a specific problem as per current need of the society.
- carry out literature reviews related to their identified problems.
- analyse the methodology to solve the identified problems.
- acquire knowledge on desire results based on the methodology used and model hardware if required.

The students can work with their project area which is approved by the head of the department and supervisor. The progress of the dissertation phase I is evaluated based on minimum of three reviews. The review committee may be constituted by the head of the department. At the end of the semester, a detailed report on the work done should be submitted which consists of clear definition about the problem identified, detailed literature review related to the area of work, methodology carried out for the work and the result obtained. The students will be evaluated through the project work based on a viva-voce examination by an internal and external examiner.

TOTAL PERIODS : 300

COURSE OUTCOMES

At the end this course, students will be able to

- describe their project based on the proposed system.
- explain about the results obtained by the preferred methodology in simulation.
- compare hardware results for the proposed methodology by technical knowledge.
- analyse the future problems related to current scenario by professional approach.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	3	2	1	-	2	-	3	2	3	3
CO2	3	3	3	2	3	2	1	-	2	-	3	2	3	3
CO3	3	3	3	2	3	2	1	-	2	-	3	2	3	3
CO4	3	3	3	2	3	2	1	--	2	-	3	2	3	3

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SEMESTER IV

PPS19401 **DISSERTATION PHASE II** **0 0 32 16**

COURSE OBJECTIVES

To enable the students to

- identify a specific problem as per current need of the society.
- carry out literature reviews related to their identified problems.
- analyse the methodology to solve the identified problems.
- acquire knowledge on desire results based on the methodology used and model hardware if required.

The students can work with their project area which is approved by the head of the department and supervisor. The progress of the dissertation phase II is evaluated based on minimum of three reviews. The review committee may be constituted by the head of the department. At the end of the semester, a detailed report on the work done should be submitted which consists of clear definition about the problem identified, detailed literature review related to the area of work, methodology carried out for the work and the result obtained. The students will be evaluated through the project work based on a viva-voce examination by an internal and external examiner.

TOTAL PERIODS : 480

COURSE OUTCOMES

At the end this course, students will be able to

- describe their project based on the proposed system.
- explain about the results obtained by the preferred methodology in simulation.
- compare hardware results for the proposed methodology by technical knowledge.
- analyse the future problems related to current scenario by professional approach.

CO/PO MAPPING

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CO1	3	3	3	2	3	2	1	-	2	-	3	2	3	3
CO2	3	3	3	2	3	2	1	-	2	-	3	2	3	3
CO3	3	3	3	2	3	2	1	-	2	-	3	2	3	3
CO4	3	3	3	2	3	2	1	--	2	-	3	2	3	3

SYLLABUS

SEMESTER III

PROFESSIONAL ELECTIVE V

PPS19551	**POWER SYSTEM TRANSIENTS**	**3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the various types of power system transients and its effect on power system.
- accumulate knowledge about the causes of lightning transients and various conventional lightning protection schemes.
- analyze the mathematical model of transients.
- interpret knowledge on switching transients and its types.
- create the modelling of insulation co-ordination and EHV system.

UNIT I INTRODUCTION 9

Review and importance of the study of transients- causes for transients, RL circuit transient with sine wave excitation, double frequency transients, basic transforms of the RLC circuit transients; Different types of power system transients - effect of transients on power systems , role of the study of transients in system planning.

UNIT II LIGHTNING TRANSIENTS 9

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds , mechanism of lightning discharges and characteristics of lightning strokes , model for lightning stroke , factors contributing to good line design ; protection using ground wires - tower footing resistance; Interaction between lightning and power system.

UNIT III TRANSIENT CALCULATION 9

Computation of transients - transient response of systems with series, shunt, lumped parameters and distributed lines; Traveling wave concepts - Telegraphic Equation, reflection and refraction of travelling waves, Bewley's Lattice diagrams for various cases; Analysis in time and frequency domain – Eigen value approach – Z-transform.

UNIT IV SWITCHING TRANSIENTS 9

Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current, load switching and equivalent circuit, waveforms for transient voltage across the load and the switch, normal and abnormal switching transients; Current suppression - current chopping , effective equivalent circuit; Capacitance switching - effect of source regulation, capacitance switching with a restrike, with multiple restrikes; Illustration for multiple restriking transients - ferro resonance.

UNIT V INSULATION CO ORDINATION **9**

Principles of insulation co-ordination – over voltages and insulation coordination in MV and HV recent advancements in insulation coordination; BIL, Design of EHV system, Insulation coordination as applied to transformer, substations , Examples.

TOTAL PERIODS : 45

COURSE OUTCOMES

At the end this course, students will be able to

- convey the various types of power system transients and its effect on power system.
- implement the proper protection scheme to avoid lighting transients in power system.
- design mathematical model of transients.
- apply types of switching transients in power system.
- design the EHV system by using insulation coordination.

REFERENCES

1. Allan Greenwood, "Electrical Transients in Power Systems", Willey Interscience, New York, 2017.
2. C.S.Indulkar, DP Kothari, "Power System Transients – A Statistical approach", Prentice Hall 2017.
3. Subir Ray, "Electrical Power Systems – Concepts, Theory and Practice", Prentice Hall of India, New Delhi, 2015.
4. Rakosh das Begamudre, "Extra High Voltage AC Transmission Engineering", Wiley Eastern Ltd, New Delhi, 2016.
5. Chakrabarthy.A.,Soni.M.L., Gupta.P.V. and Bhatnagar.U.S., "A Text Book on Power System Engineering" ,Dhanpat Rai & Co New Delhi, 2016.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
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CO's	PO's												PSO's	
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CO1	2	2	2	1	2	1	-	-	-	-	2	2	3	3
CO2	2	1	3	-	2	1	-	-	-	-	1	2	3	3
CO3	2	2	2	1	2	1	-	-	-	-	1	2	3	3
CO4	2	2	2	1	2	1	-	--	-	-	1	2	3	3
CO5	2	1	2	1	2	1	-	-	-	-	2	2	3	3

PPS19552 **FLEXIBLE AC TRANSMISSION SYSTEMS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- recognize the concepts of transmission networks and control of power flow with compensation.
- conjecture knowledge on static compensator and distribution static compensator models and analysis.
- enlighten the knowledge on modeling and multifunction of series compensators.
- confer various aspects of unified power flow controller and its characteristics.
- portray the various model of interline power flow and optimum power flow studies with FACTS

UNIT I INTRODUCTION 9

Review of basics of power transmission networks - Control of power flow in AC transmission line, Analysis of uncompensated AC Transmission line; Passive reactive power compensation- Effect of series and shunt compensation at the mid-point of the line on power transfer; Need for FACTS controllers, Types of FACTS controllers.

UNIT II SHUNT COMPENSATORS 9

Mid-point voltage regulation - Method of controlled Volt-Ampere Reactive (VAR) generation, Principle of operation, Control and characteristics of Static VAR Compensator (SVC) and Static Compensator (STATCOM), Multi-control functional model of STATCOM for power flow analysis; Implementation of STATCOM models in Newton power flow, STATCOM in Optimal Power Flow (OPF), STATCOM in distribution system (DSTATCOM), DSTATCOM performance in various modes including harmonic mitigation.

UNIT III SERIES COMPENSATORS 9

Series compensation and voltage stability; Variable impedance type series compensators -Thyristor controlled series capacitor (TCSC), and switching converter type series converter, static synchronous series compensator (SSSC), configurations, control and characteristics, general applications; Modelling of multi-control functional model of SSSC in power flow analysis- Implementation of SSC models in Newton power flow, SSSC in OPF, dynamic voltage restorer (DVR) in distribution system, sub synchronous resonance problem.

UNIT IV UNIFIED POWER FLOW CONTROLLERS 9

Objectives and principle of operation of voltage and phase angle regulations; Static phase shifter and its operating characteristics, Unified Power Flow Controller (UPFC) control and characteristics; UPFC as generalized SSSC, Modelling of UPFC for power flow and OPF studies; Implementing UPFC in Newton power flow, power oscillations control with UPFC.

UNIT V INTERLINE POWER FLOW CONTROLLER AND CO-ORDINATION OF FACTS CONTROLLERS **9**

Principle of operation, control and characteristics, Model of interline power flow controller (IPFC) for power flow and optimum power flow studies; FACTS Controller interactions - SVC–SVC interaction, SVC-TCSC interaction, TCSC-TCSC interaction and SSSC- STATCOM interaction.

TOTAL PERIOD: 45

COURSE OUTCOMES

At the end this course, students will be able to

- acquainted with the basic concepts of transmission networks and compensation in FACTS controller.
- compose out the issues of damping to power system oscillations, real and reactive power control by shunt compensators.
- determine the characteristics and configuration of multi-control functional model of series compensators.
- evaluate UPFC power oscillation control with series compensators and phase shifter.
- reveal the concepts of interline power flow controller and FACTS controllers interactions.

REFERENCES

1. Hingorani, N.G. and Gyragyi,L. "Understanding FACTS :Concepts and Technology of Flexible AC Transmission System", Standard Publishers and Distributors reprint 2013.
2. Sang, Y.H. and John, A.T., "Flexible AC Transmission Systems", IEEE Press, reprint 2016.
3. Ghosh, A. and Ledwich,G., "Power Quality Enhancement Using Custom Power Devices",Kluwer Academic Publishers 2016.
4. Mathur, R.M. and Verma, R.K., "Thyristor Based FACTS Controllers for Electrical Transmission Systems", IEEE Press 2017.
5. K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited Publishers (formerly Wiley Eastern Limited), 2016, New Delhi.

CO/PO MAPPING

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CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	3	2	-	-	-	-	1	2	3	3
CO2	3	2	-	-	3	2	-	-	-	-	1	2	3	3
CO3	3	2	-	-	3	3	-	-	-	-	1	2	3	3
CO4	3	2	-	-	3	2	-	-	--	-	1	2	3	3
CO5	3	2	-	-	3	3	-	-	-	-	1	2	3	3

PPS19553 INDUSTRIAL LOAD MODELLING AND CONTROL 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the energy demand scenario
- realize the modeling of load and its ease to study load demand industrially
- know Electricity pricing models
- impart knowledge on load management
- comprehend about energy saving strategies

UNIT I INTRODUCTION TO ENERGY DEMAND 9

Electric Energy Scenario; Demand side management, industrial load management, load curves, load shaping objectives, methodologies, barriers; Classification of industrial loads- Continuous and batch processes, load modeling.

UNIT II ELECTRICITY PRICING MODELS 9

Electricity pricing – Dynamic and spot pricing, models, direct load control; Interruptible load control, bottom up approach, scheduling; Formulation of load models- Optimization and control algorithms; Case studies.

UNIT III REACTIVE POWER MANAGEMENT 9

Reactive power management in industries- Controls, power quality impacts application of filters Energy saving in industries; Cooling and heating loads- Load profiling, modeling, cool storage; Types- Control strategies; Optimal operation-Problem formulation; Case studies.

UNIT IV LOAD MANAGEMENT 9

Captive power units- Operating and control strategies, power pooling operation models; Energy banking-Industrial Cogeneration.

UNIT V ENERGY SAVING STRATEGIES 9

Selection of schemes optimal operating strategies- Peak load saving, Constraints; Problem formulation-Case study; Integrated load management for industries.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end this course, students will be able to

- implement load control techniques in industries and its application.
- elaborate different types of industrial processes and optimize the process.
- describe electricity pricing models and reactive power management.
- apply load management to reduce demand of electricity during peak time.
- practice different energy saving opportunities in industries.

REFERENCES

1. C.O. Bjork "Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,2016.
2. C.W. Gellings and S.N. Talukdar, "Load management concepts," IEEE Press, New York, 2017, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 2016.
4. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.
5. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 2015.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
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CO's	PO's												PSO's	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	3	-	-	2	-	-	-	1	-	1	2	3	3
CO2	2	3	-	-	2	-	-	-	1	-	1	2	3	3
CO3	2	3	-	-	2	-	-	-	1	-	1	2	3	3
CO4	2	3	-	-	2	-	-	-	1	-	1	2	3	3
CO5	2	3	-	-	2	-	-	-	1	-	1	2	3	3

PPS19554 **SYSTEM THEORY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- educate on modeling and representing systems in state variable form.
- educate on solving linear and non-linear state equations.
- illustrate the role of controllability and observability.
- familiarize with the stability analysis of systems usig Lyapunov"s theory.
- infer knowledge on modal concepts and design of state and output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION **9**

Introduction-Concept of state, state equation for dynamic systems, time invariance and linearity; Non uniqueness of state model-State diagrams, physical system and state assignment.

UNIT II SOLUTION OF STATE EQUATIONS **9**

Existence and uniqueness of solutions to continuous-time state equations; Solution of nonlinear and linear time varying state equations; Evaluation of matrix exponential system modes; Role of eigenvalues and eigenvectors.

UNIT III CONTROLLABILITY AND OBSERVABILITY **9**

Controllability and observability; Stabilizability and detectability; Test for continuous time systems-Time varying and time invariant case; Output controllability-reducibility system realizations.

UNIT IV STABILTY **9**

Introduction-Equilibrium points, stability in the sense of Lyapunov, BIBO stability, stability of LTI systems; Equilibrium stability of nonlinear continuous time autonomous systems; The direct method of Lyapunov and the linear continuous; Time autonomous systems-Finding Lyapunov functions for nonlinear continuous time autonomous systems, Krasovskii and variable-gradiant method.

UNIT V MODAL CONTROL **9**

Introduction-Controllable and observable companion forms, SISO and MIMO systems; The effect of state feedback on controllability and observability; Pole placement by state feedback for both SISO and MIMO systems, full order and reduced order observers.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end this course, students will be able to

- represent the system in state variable form
- solve linear and non-linear state equation.
- analyse the controllability and observability of the system.

- apply the stability analysis of linear and non-linear continuous system in real time applications.
- analyse the effects of state feedback systems

REFERENCES

1. M. Gopal, “Modern Control System Theory”, New Age International, 2015.
2. K. Ogatta, “Modern Control Engineering”, PHI, 2012
3. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999.
4. D. Roy Choudhury, “Modern Control Systems”, New Age International, 2015.
5. John J. D.Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, reprint 2013.

CO/PO MAPPING

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	PO’s												PSO’s	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	-	2	-	1	-	-	-	-	2	2	3	3
CO2	3	2	-	2	-	1	-	-	-	-	1	2	3	3
CO3	3	2	-	2	-	1	-	-	-	-	1	2	3	3
CO4	3	2	-	2	-	1	-	-	-	-	2	2	3	3
CO5	3	2	-	2	-	1	-	-	-	-	1	2	3	3

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PROFESSIONAL ELECTIVE VI

PPS19651 DISTRIBUTED GENERATIONS AND MICROGRID 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand about various power generation systems.
- acquire knowledge on the concept of distributed generation, its parameters and energy storage elements.
- attain knowledge on grid integration parameters requirements.
- study the structure of micro grid, its configuration and protecting issues.
- acquire knowledge on various power quality issues and stability of microgrids.

UNIT I INTRODUCTION 9

Conventional power generation- Introduction, types, advantages and disadvantages; Energy crises, non-conventional energy (NCE) resources; Review of solar PV, wind energy systems, micro-turbines, biomass, and tidal sources, ocean, hydro, geothermal.

UNIT II DISTRIBUTED GENERATIONS 9

Concept of distributed generations- topologies, selection of sources, regulatory standards/ framework; Standards for interconnecting distributed resources to electric power systems: IEEE 1547 DG installation classes, security issues in DG implementations; Energy storage elements - Batteries, fuel cells, ultra-capacitors, supercapacitors, flywheels; Captive power plants.

UNIT III GRID INTEGRATION IN DISTRIBUTED GENERATIONS 9

Requirements for grid interconnection, limits on operational parameters; Voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues; Impact of grid integration with NCE sources on existing power system; reliability, stability and power quality issues.

UNIT IV MICROGRIDS 9

Concept and definition of microgrid- microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids; Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid; grid connected and islanded mode, active and reactive power control, protection issues, anti-islanding schemes.

UNIT V STABILITY ANALYSIS OF MICROGRIDS 9

Power quality issues in micro grids; Modeling and stability analysis of microgrid, regulatory standards, microgrid economics; Introduction to smart micro grids.

TOTAL PERIODS : 45

COURSE OUTCOMES

At the end this course, students will be able to

- interpret the concept of various power generation system
- summarize about distributed generations, its parameters and energy storage elements.
- analyze the impact of grid integration parameters with non-conventional energy sources on existing power system.
- deduce the structure of micro grid, its configuration and protecting issues which related with mode of operation.
- Diagnose the power quality issues and stability in microgrids and its regulatory standards.

REFERENCES

1. AmirnaserYezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, reprint 2016.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2016
3. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi, reprint 2017.
4. J.F. Manwell, "Wind Energy Explained, theory design and applications," J.G. McGowan Wiley publication, reprint 2017.
5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, reprint 2016.

CO/PO MAPPING

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	PO's												PSO's	
CO's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1	-	-	2	1	1	-	-	-	1	2	3	3
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CO3	2	1	-	-	2	1	1	-	-	-	1	2	3	3
CO4	2	1	-	-	2	1	1	-	-	-	1	2	3	3
CO5	2	1	-	-	2	1	1	-	-	-	1	2	3	3

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PPS19652 SOFT COMPUTING TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the fundamentals of artificial neural network (ANN) and fuzzy set theory.
- Apply the concepts of ANN for modelling and control of nonlinear system and to get using ANN tool box.
- use Fuzzy logic for modelling and control of non-linear systems and get familiarized with the FLC toolbox
- understand the use of optimization techniques.
- familiarize the various hybrid control schemes, PSO and ANFIS tool box.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC 9

Review of fundamentals - Biological neuron, artificial neuron, activation function, single layer perceptron, limitations, multilayer perceptron, back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets, operation on fuzzy sets, scalar cardinality, fuzzy cardinality, union and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, fuzzy relation, fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL 9

Generation of training data - optimal architecture, Model validation; Control of nonlinear system using ANN- Direct and indirect neuro control schemes, adaptive neuro controller, case study; Familiarization of neural network control tool box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL 9

Modeling of nonlinear systems using fuzzy models (Mamdani and Sugeno) –TSK model; Fuzzy logic controller – Fuzzification, knowledge base , decision making logic, defuzzification, adaptive fuzzy systems, Case study; Familiarization of fuzzy logic tool box.

UNIT IV EVALUTIONARY ALGORITHM 9

Basic concept of genetic algorithm and detail algorithmic steps, adjustment of free parameters; Solution of typical control problems using genetic algorithm; Concept on some other search techniques like Tabu search, ant-colony search and particle swarm optimization.

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN, neuro fuzzy systems, ANFIS; Optimization of membership function and rule base using genetic algorithm and particle swarm optimization, case study; Familiarization of ANFIS tool box

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end this course, students will be able to

- understand the basic ANN architectures, algorithms and their limitations.
- develop ANN based models and control schemes for non-linear system.
- apply fuzzy logic concepts for modeling and control of non-linear systems.
- perform different operations using various GA techniques
- use hybrid control schemes for non-linear system.

REFERENCES

1. Laurene V.Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Pearson Education, 2008.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", Wiley, Third Edition, 2010.
3. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
4. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.
5. George J.Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall, First Edition, 1995.

MAPPING

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	PO's												PSO's	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	-	1	2	-	-	-	-	-	1	2	3	3
CO2	2	2	--	1	2	-	-	-	-	-	1	2	3	3
CO3	2	2	-	1	2	-	-	-	-	-	1	2	3	3
CO4	2	2	-	2	2	-	-	-	-	-	1	2	3	3
CO5	2	2	-	2	2	-	-	-	-	-	1	2	3	3

PPS19653 **DESIGN OF SUBSTATIONS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- gather knowledge about air insulated (AI) and gas insulated (GI) substations.
- aware of substation equipment and their arrangements.
- understand the concepts of insulation coordination and standards of substation.
- comprehend substation grounding system and shielding.
- know about the source and effect of fast transients in air insulated, gas insulated substations.

UNIT I INTRODUCTION **9**

Introduction – characteristics, comparison of air insulated substation (AIS) and gas insulated substation (GIS), main features of substations; Environmental considerations, planning and installation; Gas insulated line (GIL),gas insulated busducts (GIB).

UNIT II MAJOR EQUIPMENT AND LAYOUT **9**

Major equipment of AIS and GIS - Design features, equipment specification, types of electrical stresses, mechanical aspects of substation design, substation switching schemes; single feeder circuits- single or main bus and sectionalized single bus, double main bus-main and transfer bus- main, reserve and transfer bus, breaker and half scheme, ring bus.

UNIT III INSULATION COORDINATION **9**

Introduction to insulation coordination of AIS and GIS – stress at the equipment, insulation strength and its selection, standard basic impulse level (BIL); Application of simplified method, Comparison with IEEE and IEC guides.

UNIT IV GROUNDING AND SHIELDING **9**

Definitions – soil resistivity measurement, ground fault currents, ground conductor; Design of substation grounding system – shielding of substations, shielding by wires and masts.

UNIT V FAST TRANSIENTS PHENOMENON IN AIS AND GIS **9**

Introduction – Disconnector switching in relation to very fast transients overvoltage, origin of VFTO, propagation and mechanism of VFTO, VFTO characteristics, effects of VFTO.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end this course, students will be able to

- express the fundamentals of air insulated (AI) and gas insulated (GI) substations.
- assemble substation equipment's.
- deliver standards of insulation coordination.
- design the substation grounding system and shielding.
- implement the effects of fast transients in AIS and GIS

REFERENCES

1. Andrew R. Hileman, “Insulation coordination for power systems”, Taylor and Francis, 2015.
2. M.S. Naidu, “Gas Insulation Substations”, I.K. International Publishing House Private Limited, 2018.
3. Klaus Ragallar, “Surges in high voltage networks” Plenum Press,New York, 2016.
4. “Power Engineer’s handbook”, TNEB Association.
5. Pritindra Chowdhuri, “Electromagnetic transients in power systems”, PHI Learning Private Limited, New Delhi, Second edition, 2004.

CO/PO MAPPING

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	PO’s												PSO’s	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	2	-	-	-	-	-	-	-	1	2	3	3
CO2	2	2	2	-	-	-	-	-	-	-	1	2	3	3
CO3	2	2	2	-	-	-	-	-	-	-	1	2	3	3
CO4	2	2	2	1	-	-	-	-	-	-	1	2	3	3
CO5	2	2	2	1	-	-	-	-	-	-	1	2	3	3

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Electrical & Electronics Engineering
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PPS19654 ENERGY MANAGEMENT AND AUDITING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the concepts behind economic analysis and load management.
- analyse the material and energy balance.
- learn the methods to improve the energy efficiency in thermal utilities.
- understand the concept of compressed air system and its energy efficiency.
- emphasize the energy management on various electrical equipment's and metering

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT 9

Commercial and non-commercial energy - energy needs of growing economy, energy pricing, energy conservation and its importance; Re-structuring of the energy supply sector - Energy conservation act-2001 and its features, electricity tariff, need and types of energy audit, energy management/audit approach.

UNIT II MATERIAL AND ENERGY BALANCE 9

Methods for preparing process flow - material and energy balance diagrams; Energy policy purpose - location of energy management - roles and responsibilities of energy manager, employees training and planning, financial analysis techniques.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9

Introduction to fuels - principles of combustion, combustion of oil, coal and gas; Boilers- Types, combustion in boilers, performances evaluation, analysis of losses; Steam system- Properties of steam, assessment of steam distribution losses, steam trapping, condensate and flash steam recovery system; Furnaces - temperature control, draft control, waste heat recovery, refractory.

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM 9

Compressed air system- Types of air compressors, compressed air system components, savings opportunities; Refrigeration System- Vapour compression refrigeration cycle, refrigerants, factors affecting refrigeration and air conditioning system; Vapour absorption refrigeration system- Working principle, types, cooling tower, flow control strategies and energy saving.

UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES 9

Electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, automatic power factor controllers; Transformer losses, losses in induction motors, factors affecting motor performance, rewinding and motor replacement issues; Soft starters with energy saver , variable speed drives; Fans and blowers- Types , efficient system operation, flow control strategies ; Pumps and pumping system- System operation, flow control methods; Lighting system- Light source, choice of lighting, luminance requirements ,energy efficient lighting controls.

TOTAL PERIODS : 45

COURSE OUTCOMES

At the end this course, students will be able to

- develop the ability to learn about the need for energy management and auditing process.
- describe the basic concepts of materials and energy balance.
- enumerate the energy management in thermal utilities.
- designate about the compressed air system and its efficiency improvement.
- explain about the concept of lighting systems, light sources and various forms of cogeneration.

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1. Sawhney, A.K., "A Course in Electrical Machine Design", Dhanpat Rai & Sons, New Delhi, Fifth Edition, reprint 2016.
2. M.V.Deshpande, "Design and Testing of Electrical Machines", PHI learning Pvt Lt, reprint 2016
3. Sen, S.K., "Principles of Electrical Machine Designs with Computer Programmes", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Second Edition, reprint 2017.
4. A.Shanmugasundaram, G.Gangadharan, R.Palani, "Electrical Machine Design Data Book", New Age International Pvt. Ltd., Reprint 2015.
5. Balbir Singh, "Electrical Machine Design", Vikas Publishing House Private Limited, 2016.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	2	1	1	-	-	-	-	1	2	3	3
CO2	3	2	-	2	1	1	-	-	-	-	1	2	3	3
CO3	3	2	-	2	1	1	-	-	-	-	1	2	3	3
CO4	3	2	-	2	1	1	-	--	--	-	1	2	3	3
CO5	3	2	-	2	1	1	-	-	-	-	1	2	3	3

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