SEMESTER III

PPS23301	ELECTRICAL POWER DISTRIBUTION SYSTEM	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	infer the size of feeders and distributors based on economy and efficiency.
2	interpret the concepts of distribution system control and protection.
3	construe the reliable design consideration.
4	understand the requirements of automation system.
5	comprehend the network configuration and planning of distribution system.

UNIT I — DISTRIBUTION SYSTEMS — 9

Distribution systems - Types of distribution systems, section and size of feeders, primary and secondary distribution, distribution substations; Effect of working voltage on the size of feeders and distributors; Effect of system voltage on economy; Voltage drop and efficiency of transmission; Qualitative treatment of rural distribution and industrial distribution.

UNIT II — CONTROL AND PROTECTION — 9

Voltage control - Application of shunt capacitance for loss reduction, harmonics in the system; Static VAR systems; Voltage profile enhancement schemes; System protection - Fuses and section analyzers; Over current protection; Under voltage and under frequency protection; Coordination of protective device.

UNIT III — RELIABILITY ANALYSIS — 9

Primary and secondary system design considerations - Primary circuit configurations, primary feeder loading, secondary networks design; Economic design; Unbalance loads and voltage considerations.

UNIT IV — DISTRIBUTION AUTOMATION — 9

Definitions; Automation switching control; Management information systems (MIS); Remote terminal units – Communication methods for data transfer; Consumer information service (CIS); Graphical information systems (GIS); Automatic meter reading (AMR); Remote control load management; Substation automation – Requirements, control aspects in substations; Feeder automation – Consumer side automation.

UNIT V — EXPANSION PLANNING — 9

Distribution system planning - Short term planning, long term planning, dynamic planning; Sub-transmission and substation design; Sub-transmission networks configurations - Substation bus schemes - Distribution substations ratings, service areas calculations; Distribution system expansion – Planning, load characteristics, load forecasting; Design concepts – Optimal location of substation, design of radial lines; Solution technique.

TOTAL PERIODS	**45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	describe about the size of feeders under economic in electric power distribution system.	Understanding (K2)
CO2	enumerate control and protection schemes for distribution systems.	Applying (K3)
CO3	Explain the reliability of distribution systems.	Understanding (K2)
CO4	demonstrate the methodologies for distribution automation.	Understanding (K2)
CO5	develop strategies for network configuration by expanding the existing distribution systems.	Understanding (K2)

REFERENCES

1. C.L. Wadhwa, "Electrical Power Systems", New Age International Publishers, Sixth Edition, 2019.
2. A.S. Pabla, "Electrical Power Distribution Systems", Tata McGraw Hill Books Company, Sixth Edition, 2017.
3. V. Kamaraju, "Electrical Power Distribution Systems", Tata McGraw Hill Books Company, Sixth Edition, 2019.
4. James A Momoh, "Electric Power Distribution Automation Protection and Control" CRC Press, 2017.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	2	1	3	3	2	2
CO2	3	2	3	3	2	-
CO3	3	2	3	3	-	2
CO4	3	2	3	3	2	2
CO5	3	2	3	3	2	2

PPS23302	PROJECT WORK (PHASE I)	0	0	12	6

COURSE OBJECTIVES

To enable the students to

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

DESCRIPTION

Each PG student can work individually on a selected specific topic in the area which is approved by the head of the department under the supervision of a faculty member (Guide / Supervisor) who is familiar in the selected specific topic. The selected specific topic may be hardware or simulation. The students project work (phase I) shall be evaluated through internal examination and end semester examination. The internal examination must be conducted periodically (zeroth, first, second and third) through project work review presentation meetings followed by questions from the panel of review committee members comprising of two expert faculty members and a project coordinator. At the end of the semester, a detailed report on the work done by the PG student must be submitted with the approval from the Guide/Supervisor and the review committee members. The project work (phase I) report must contain the introduction with clear definition along with detailed review of relevant literature on the selected specific problem; an efficient methodology to solve the selected specific problem along with necessary hypothesis and or experimental setup and or simulation and or case study for carrying out the research project work along with preliminary results; discussions, relevant conclusions and future direction along with specified references. The end Semester examination must be conducted through project work presentation followed by questions from the panel of examiners comprising an external examiner and project coordinator as internal examiner.

	TOTAL PERIODS	180

COURSE OUTCOMES

At the end this course, students will be able to		BT Mapped (Highest Level)
CO1	demonstrate a sound technical knowledge in their selected project topic.	Analyzing(K4)
CO2	select and identify the problem statement along with scope and boundary;	Analyzing(K4)
CO3	assimilate detailed review of relevant literature; formulate an efficient methodology to solve the selected specific problem.	Analyzing(K4)
CO4	propose solutions to complex problems by professional approach.	Analyzing(K4)

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	**Programme Outcomes PO's**					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	2	1	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3

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PPS23401	PROJECT WORK (PHASE II)	0	0	24	12

COURSE OBJECTIVES

To enable the students to

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

DESCRIPTION

The student may continue to work on the project work (phase I) selected topic as per the formulated efficient methodology under the same faculty member (Guide/Supervisor). The students project work (phase II) shall be evaluated through internal examination and end semester examination. The internal examination must be conducted periodically (first, second and third) through project work review presentation meetings followed by questions from the panel of review committee members comprising of two expert faculty members and a project coordinator. At the end of the semester, a detailed report on the work done by the PG student must be submitted with the approval from the Guide/Supervisor and the review committee members. The project work (phase II) report must contain the introduction with clear definition along with detailed review of relevant literature on the selected specific problem; an efficient methodology to solve the selected specific problem along with necessary theoretical hypothesis and or experimentation and or simulation and or case study for carrying out the research project work along with complete results with critical analysis and detail discussions, followed by relevant conclusions, along with specified references. The end semester examination must be conducted through project work presentation followed by questions from the panel of examiners comprising an external examiner and project coordinator as internal examiner.

TOTAL PERIODS 360

COURSE OUTCOMES

At the end this course, students will be able to		BT Mapped (Highest Level)
CO1	demonstrate a sound technical knowledge of their selected project topic	Analyzing
CO2	propose solutions to complex problems using a systematic approach.	Analyzing
CO3	compare hardware results for the proposed methodology by technical knowledge.	Analyzing
CO4	demonstrate the knowledge, skills and attitudes of a professional engineer to take up any challenging practical problem in the field of power systems engineering and find optimum solutions to it.	Analyzing

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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	2	1	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3

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PROFESSIONAL ELECTIVES

PPS23151	ANALYSIS OF POWER CONVERTERS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	analyze and comprehend the various operating modes of different configurations of power converter
2	know the operation of various inverter and their PWM controlling techniques.
3	design different power converters DC to DC converters.
4	learn the types of AC voltage controllers and basics of matrix converters.
5	impart knowledge on different types of multilevel inverter and PWM techniques.

UNIT I	CONVERTERS	9

Single phase half controlled and fully controlled converters – R Load, R-L loads and freewheeling diodes, continuous and discontinuous modes of operation, inverter operation; Effect of source impedance and overlap; Three phase Semi and fully controlled converter with R, R-L loads; Twelve pulse converter.

UNIT II	INVERTERS	9

Principle of operation of half and full bridge inverters; Voltage control of single phase inverters using PWM techniques; Harmonic elimination techniques; 180 degree and 120 degree conduction mode inverters with star and delta connected loads.

UNIT III	DC-DC CONVERTERS	9

Principles of step-down and step-up converters; Analysis of buck, boost, buck-boost and cuk converters; Time ratio and current limit control; Full bridge converter; Resonant and quasi-resonant converters.

UNIT IV	AC VOLTAGE CONTROLLERS	9

Principle of phase control; Single phase and three phase controllers – Analysis with R and R-L loads; Principle of operation single phase and three phase cyclo-converters; Power factor control; Matrix converters.

UNIT V	MULTILEVEL AND BOOST INVERTERS	9

Multilevel concept – Diode clamped, flying capacitor, cascade type multilevel inverters, comparison of multilevel inverters; Application of multilevel inverters; PWM techniques for multilevel inverters; Single phase and three phase impedance source inverters.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to	BT Mapped (Highest Level)

CO1	apply the different converter configuration based on the application.	Applying (K3)
CO2	describe the single and three phase inverter.	Understanding (K2)
CO3	design a suitable DC-DC converter for given load specification.	Analyzing(K4)
CO4	apply different types AC voltage controller based on the application.	Applying (K3)
CO5	analyze the multilevel inverter for power system application.	Analyzing(K4)

REFERENCES

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2014.
2. Bimal K.Bose, "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2013.
3. Ned Mohan,T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons, Wiley India Edition, 2016.
4. P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2013.
5. Power Electronics by Vedam Subramanyam, New Age International publishers, New Delhi Second Edition, 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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	3	3
CO2	2	2	2	2	3	3
CO3	3	3	2	2	3	3
CO4	2	2	3	1	3	3
CO5	3	3	2	1	3	3

PPS23152	SYSTEM THEORY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	train on modeling and representing systems in state variable form.
2	educate to solve linear and non-linear state equations.
3	illustrate the properties of control system.
4	identify non–linearities and examine stability of systems in the sense of Lyapunov's theory.
5	educate on modal concepts, design of state, output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION 9

Concept of state-space equations for dynamic systems -Time invariance and linearity, non-uniqueness of state model; Physical systems and state assignment - Free and forced responses; State diagrams.

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; State transition matrix and its properties; Evaluation of matrix exponential-System modes, role of eigen values and eigen vectors.

UNIT III PROPERTIES OF THE CONTROL SYSTEM 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 NON-LINEARITIES AND STABILITY ANALYSIS 9

Equilibrium points-Stability in the sense of Lyapunov, BIBO stability, stability of LTI systems; Types of nonlinearity – Phase plane analysis ,singular points, limit cycles; Construction of phase trajectories – Describing function method, derivation of describing functions; Equilibrium stability of nonlinear continuous time autonomous systems - Direct method of Lyapunov and the linear continuous-time autonomous systems, Lyapunov Functions for nonlinear continuous time autonomous systems, Krasovskii and variable-gradiant method.

UNIT V MODAL ANALYSIS 9

Controllable and observable companion forms - SISO and MIMO systems, 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 of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concept of state-state representation for dynamic systems.	Applying (K3)
CO2	explain the solution techniques of state equations.	Understanding (K2)
CO3	realize the properties of control systems in state space form.	Analyzing(K4)
CO4	identify non-linearities and evaluate the stability of the system using lyapnov notion.	Analyzing(K4)
CO5	perform modal analysis and design controller and observer in state space form.	Analyzing(K4)

REFERENCES

1. M. Gopal, "Modern Control System Theory", New Age International, Third Edition, Reprint 2015.
2. Z. Bubnicki, "Modern Control Theory", Springer, 2018.
3. K. Ogatta, "Modern Control Engineering", PHI, 2017.
4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2015.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	3	3
CO2	3	3	2	2	3	3
CO3	3	3	2	2	3	3
CO4	3	3	3	1	-	3
CO5	3	3	2	1	3	3

PPS23153	POWER SYSTEM RELIABILITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know the basic concepts of reliability engineering.
2	understand about the probability methods in generating capacity.
3	know the concept of frequency and duration methods in generating capacity.
4	study the formation of system model.
5	learn the importance of reliability indices in power system planning, expansion, operation and control.

UNIT I	INTRODUCTION	9

Definition of reliability and failure; Bathtub curve, concepts of probability; Evaluation techniques-Markov process, recursive technique; Security levels of system – Reliability cost, adequacy indices, functions of system security; Contingency analysis; Linear sensitivity factors, hierarchical levels in power system reliability assessment.

UNIT II	GENERATING CAPACITY: BASIC PROBABILITY METHODS	9

Generation system models – capacity outage probability tables, loss of load indices, equivalent forced outage rate, capacity expansion analysis, scheduled outages, evaluation methods on period basis, loss of energy indices.

UNIT III	GENERATING CAPACITY: FREQUENCY AND DURATION METHOD	9

Introduction – Generation model with no derated states, system risk indices with individual and cumulative load model; Practical system studies.

UNIT IV	COMPOSITE GENERATION AND TRANSMISSION SYSTEM	9

Introduction – Radial configurations, conditional probability approach, network configurations, state selection, system and load point indices; Application to practical system; Data requirements for composite system reliability evaluation.

UNIT V	DISTRIBUTION SYSTEM	9

Introduction – Evaluation techniques; Interruption indices: customer oriented, load and energy oriented; Application to radial systems – Effects of lateral distributor protection, disconnects, protection failures and transferring loads; Probability distribution of reliability indices.

	TOTAL PERIODS	45

COURSE OUTCOMES

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

		BT Mapped (Highest Level)
CO1	acquire design knowledge of system components in reliability point of view.	Understanding (K2)
CO2	understand the importance of customer oriented and system oriented indices.	Understanding (K2)
CO3	illustrate the concept of frequency and duration methods in generating capacity.	Understanding (K2)
CO4	familiarize with reliability evaluation methodologies.	Understanding (K2)
CO5	analyse the system performance with proper remedial strategies.	Analyzing(K4)

REFERENCES

1. Dr. K. Uma Rao, "Power system operation & control", Wiley-India, First edition, 2013.
2. Ali Chowdhury, Don Koval, "Power Distribution System Reliability: Practical Methods and Applications", Wiley-IEEE Press, 2019.
3. Cepin, Marko, "Assessment of Power System Reliability", Springer, 2017.
4. Roy Billinton, R.N. Allan, "Reliability Evaluation of Power Systems", Springer, 2018.

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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	3	3
CO2	3	3	2	2	3	3
CO3	3	3	2	2	3	3
CO4	3	3	3	1	3	3
CO5	3	3	2	1	3	3

PPS23154	DESIGN OF SUBSTATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	gather knowledge about air insulated (AI) and gas insulated (GI) substations.
2	aware of substation equipment and their arrangements.
3	understand the concepts of insulation coordination and standards of substation.
4	comprehend substation grounding system and shielding.
5	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 of this course, students will be able to	**BT Mapped (Highest Level)**

CO1	express the fundamentals of air insulated (AI) and gas insulated (GI) substations.	Understanding (K2)
CO2	describe the assembly of substation equipment's.	Understanding (K2)
CO3	deliver standards of insulation coordination.	Understanding (K2)
CO4	design the substation grounding system and shielding.	Analyzing(K4)
CO5	implement the effects of fast transients in AIS and GIS.	Analyzing(K4)

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. Pritindra Chowdhuri, "Electromagnetic Transients in Power Systems", PHI Learning Private Limited, New Delhi, Second edition, 2014.

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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	2	2	3	3
CO4	3	3	3	1	3	3
CO5	3	3	2	1	3	3

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PPS23155	ANALYSIS OF ELECTRICAL MACHINES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	provide knowledge about the fundamentals of magnetic circuits.
2	recognize the steady state and dynamic state operation of DC machine.
3	impart knowledge on theory of transformation of three phase variables to two phase variables.
4	analyze the steady state operation of three-phase induction machines using transformation theory based mathematical modeling.
5	familiarize on steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling.

UNIT I	ELECTROMAGNETIC ENERGY CONVERSION	9

Magnetically coupled circuits - Linear magnetic system, nonlinear magnetic system; Electromechanical energy conversion - Energy relationships, energy in coupling fields; Machine winding and air gap magneto motive force; Winding inductance and voltage equations.

UNIT II	DIRECT- CURRENT MACHINES	9

Elementary direct current (DC) machine - Voltage and torque equations, Basic types of direct current machines, separate winding excitation, shunt connected DC machine, series connected dc machine and compound connected dc machine; Dynamic characteristics of permanent magnet and shunt DC motor; Time domain block diagrams and state equations.

UNIT III	REFERENCE FRAME THEORY	9

Equations of transformation - Changes of variables; Stationary circuit variables transformed to the arbitrary reference frame; Commonly used reference frames; Transformation between reference frames; Transformation of a balanced set; Balanced steady state phasor relationships; Balanced steady state voltage equations.

UNIT IV	SYMMETRICAL INDUCTION MACHINES	9

Voltage equations in machine variables; Torque equation in machine variables; Equations of transformation for rotor circuits; Voltage equations in arbitrary reference frame variables; Torque equation in arbitrary reference frame variables; Analysis of steady-state operation; Free acceleration characteristics - Free acceleration characteristics viewed from various reference frames; Dynamic performance during sudden changes in load torque.

UNIT V	SYNCHRONOUS MACHINES	9

Voltage equations in machine variables; Torque equation in machine variables; Stator voltage equations in arbitrary reference frame variables; Voltage equations in rotor reference frame variables -

Park's equations; Rotor angle and angle between rotors; Analysis of steady state operation; Dynamic performance during a sudden change in input torque; Dynamic performance during three phase fault at the machine terminals.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the fundamentals of magnetic circuits.	Understanding (K2)
CO2	learn the steady state and dynamic state operation of dc machine.	Understanding (K2)
CO3	known the theory of transformation of three phase variables to two phase variables.	Understanding (K2)
CO4	understand the steady state operation of three-phase induction machines using transformation theory based mathematical modeling.	Understanding (K2)
CO5	learn the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling.	Understanding (K2)

REFERENCES

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, reprint 2018.
2. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2021.
3. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 6th Edition, reprint 2015.
4. Hamid A. Toliyat, Subhasis Nandi,Seungdeog Choi,Homayoun Meshgin-Kelk, "Electric Machines: Modeling, Condition Monitoring, and Fault Diagnosis", CRC Press, 2013.

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	Programme Outcomes PO's					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	2	2	-	-
CO4	3	3	3	1	-	-
CO5	3	3	2	1	-	-

PPS23156	IOT FOR SMART SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study about internet of things(IoT) technologies and its basics.
2	introduce the network architecture and design required for IoT.
3	familiarize the principles behind the internet connectivity principles for IoT.
4	provide insight about the data acquiring, processing, organizing and analytics.
5	discuss the applications and case study of IoT.

UNIT I — INTRODUCTION TO INTERNET OF THINGS — 9

Internet of Things - Definition, vision, smart and hyper connected devices; IoT conceptual framework; IoT architectural view; Technology behind IoT - Server end technology, major components of IT system, API's and device interfacing components, platforms and integration tools; Sources of IoT - Popular IoT development boards, role of RFID and IoT Applications, wireless sensor networks (WSNs); M2M Communication - M2M to IoT, M2M architecture, software and development tools.

UNIT II — IOT NETWORK ARCHITECTURE AND DESIGN — 9

Drivers behind new network architectures - Scale, security, constrained devices and networks, data, legacy device support; Comparing IoT architectures - One M2M IoT standardized architecture, IoT world forum (IoT WF) standardized architecture; IoT data management and compute stack - Fog computing, edge computing, hierarchy of edge, fog and cloud.

UNIT III — INTERNET CONNECTIVITY PRINCIPLES — 9

Internet connectivity; Internet based communication - Internet protocols, 6LoWPAN; IP addressing in the IoT - IP address, IPv6 address; Media access control; Application layer protocols - HTTP and HTTPS ports.

UNIT IV — DATA ACQUIRING, ORGANISING, PROCESSING AND ANALYTICS — 9

Data acquiring and storage - Data generation, data acquisition, data validation, data store, data centre management, server management, spatial storage; Organizing the data - Query processing, SQL, NOSQL, extract, transform and load; Analytics - Event analytics, In-memory data processing and analytics, real-time analytics management; Knowledge acquiring, managing and storing process.

UNIT V — IOT APPLICATIONS AND CASE STUDY — 9

IoT applications - Smart home, smart city, smart environment-monitoring, smart agriculture; Case study – Smart city streetlights control and monitoring.

	TOTAL PERIODS	**45**

COURSE OUTCOMES

	At the end of this course, students will be able to	BT Mapped (Highest Level)
CO1	analyze the basic concepts of IoT and its present developments.	Analyzing(K4)
CO2	compare and contrast about different architecture of IoT.	Analyzing(K4)
CO3	explain different internet connectivity principles.	Understanding (K2)
CO4	analyze the data analytic and data acquiring, organising, processing of IoT.	Analyzing(K4)
CO5	implement IoT solutions for smart applications.	Analyzing(K4)

REFERENCES

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, First Edition, 2017.
2. Rajkamal, "Internet of Things: Architecture, Design Principles and Applications", McGraw Hill Higher Education, Standard Edition, 2022.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key applications and Protocols" Wiley, First Edition, 2012.
4. JanHoller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, David Boyle "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Elsevier, First Edition, 2014.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	-	-
CO2	2	3	2	2	-	-
CO3	3	3	2	2	-	-
CO4	2	3	3	1	-	-
CO5	3	3	2	1	-	2

PPS23157	POWER ELECTRONICS APPLICATION TO WIND AND SOLAR ENERGY SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	impart knowledge on wind energy conversion.
2	familiarize on different types of power converters used in wind energy conversion systems.
3	understand the process of solar energy conversion using photovoltaic (PV) system.
4	impart detailed knowledge on grid connected PV system and MPPT (maximum power point tracking) algorithms.
5	recognize the different configuration of hybrid energy system and their control.

UNIT I	WIND ENERGY CONVERSION SYSTEMS	9

Power in the Wind; Wind turbine design considerations; Grid connected wind farms; Hybrid power systems; Classification of wind turbine rotors; Common generator types in wind turbines; Different configurations for connecting wind turbines to the grid - Economic analysis of wind systems.

UNIT II	POWER ELECTRONICS FOR WIND TURBINES	9

Development of wind power generation; Wind power conversion; Power converters for wind turbine - Two level power converter, multilevel power converter, multi cell converter; Power semiconductors for wind power converter; Controls and grid requirements for modern wind turbines - Active power control - Reactive power control - Total harmonic distortion - Fault ride through capability; Emerging reliability issues for wind power system.

UNIT III	SOLAR ENERGY CONVERSION SYSTEMS	9

PV modules - Shading effects on PV modules - Performance of solar cells and modules; Types of PV systems - Grid connected system, off grid system; Solar thermal systems; Concentrating solar power systems; Low temperature solar thermal approaches; Environmental impact.

UNIT IV	POWER ELECTRONICS FOR PHOTOVOLTAIC SYSTEMS	9

Power curves and maximum power point of PV systems - Electrical model of a PV cell, Photovoltaic module I-V and P-V curves, MPP under partial shading; Grid connected PV system configurations - centralized configuration, string configuration, multi string configuration, AC (alternating current) module configuration; Control of grid-connected PV systems - Maximum power point tracking control methods, DC-DC (Direct Current) stage converter control, grid tied converter control, anti-islanding detection; Recent developments in multilevel inverter based PV systems.

UNIT V	POWER ELECTRONICS FOR HYBRID ENERGY SYSTEMS(HES)	9

Renewable energy based hybrid power system; PV diesel battery system overview; AC bus connected

HES; DC-bus connected HES; DC-side integration of HES; Three port converters; DC-DC converter; High-frequency link; Neutral-point-clamped multilevel converters with multiple energy sources; Cascaded and modular multilevel converters; Solid state transformers.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the basics of wind energy conversion system.	Understanding (K2)
CO2	elucidate power conversion in wind energy conversion system.	Understanding (K2)
CO3	describe the process of solar energy conversion system.	Understanding (K2)
CO4	use the converters for solar energy conversion.	Understanding (K2)
CO5	implement the concept of hybrid renewable energy conversion using power converters.	Analyzing(K4)

REFERENCES

1. Ahmed F Zobaa and Ramesh Bansal, "Handbook of Renewable Energy Technology", World Scientific Publishing Co. Pvt. Ltd., First Edition, 2017.
2. Haitham Abu-Rub, Mariuz Malinowski, Kamal AL-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", IEEE Press and John Wiley & Sons Ltd, First edition, 2014.
3. Ersan Kabalci, "Hybrid Renewable Energy Systems and Microgrids", Academic Press, First Edition, 2021.
4. Mukund R.Patel, "Wind and Solar Power Systems Design, Analysis and Operation", CRC Press, Third Edition, 2021.

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

	Programme Outcomes PO's					
CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	2
CO3	3	3	2	2	2	2
CO4	3	3	3	1	2	-
CO5	3	3	2	1	3	2

PPS23158	SOLAR AND ENERGY STORAGE SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know about the photovoltaic systems.
2	understand the basic knowledge on power conditioning for photovoltaic power system.
3	recognize the measurement and characterization of solar cells and modules.
4	identify the electrochemical storage for photovoltaics.
5	get knowledge on energy collected and delivered by PV modules.

UNIT I	PHOTOVOLTAIC SYSTEMS	9

Introduction to photovoltaic (PV) Systems; Principles of photovoltaic power system configuration and their application; Components for PV Systems; Future developments in photovoltaic system technology.

UNIT II	POWER CONDITIONING FOR PHOTOVOLTAIC POWER SYSTEM	9

Charge controllers and monitoring systems for batteries in PV power systems - Charge controllers, Charge equaliser for long battery strings; Inverters- General characteristics of PV inverters, grid-connected systems, stand-alone operation, power quality, active quality control and safety aspects.

UNIT III	MEASUREMENT AND CHARACTERIZATION OF SOLAR CELLS AND MODULES	9

Rating PV performance; Current versus voltage measurements; Spectral responsivity measurements - Filter-based systems, grating-based systems; Module qualification and certification.

UNIT IV	ELECTROCHEMICAL STORAGE FOR PHOTOVOLTAICS	9

General concept of electrochemical batteries; Typical operation conditions of batteries in PV applications; Secondary electrochemical accumulators with internal storage; Secondary electrochemical battery systems with external storage; Investment and lifetime cost considerations.

UNIT V	ENERGY COLLECTED AND DELIVERED BY PV MODULES	9

Introduction; Movement between sun and earth; Solar radiation components; Radiation on inclined surfaces; Diurnal variations of the ambient temperature; Effects of the angle of incidence and of the dirt; Irradiation on most widely studied surfaces; PV generator behaviour under real operation conditions; Reliability and sizing of stand-alone PV systems.

TOTAL PERIODS 45

COURSE OUTCOMES

	At the end of this course, students will be able to	**BT Mapped (Highest Level)**
CO1	illustrate the the photovoltaic systems.	Understanding (K2)
CO2	explain the basic knowledge on power conditioning for	Understanding (K2)

	photovoltaic power system.	
CO3	describe about the measurement and characterization of solar cells and modules.	Understanding (K2)
CO4	use the electrochemical storage for photovoltaics.	Understanding (K2)
CO5	apply the knowledge on energy collected and delivered by PV modules.	Applying(K3)

REFERENCES

1. Hegedus, S. and Luque, A. eds.,, "Handbook of Photovoltaic Science and Engineering", John Wiley & Sons 2015.
2. Solanki C.S., "Solar Photovoltaics: Fundamentals, Technologies And Applications", PHI Learning Pvt. Ltd.,2015.
3. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, "Applied Photovoltaics", ,Earthscan, UK, 2017.
4. Frank S. Barnes & Jonah G. Levine, "Large Energy Storage Systems Handbook", CRC Press, 2015.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	3	1	1	2
CO5	3	3	2	1	3	2

PPS23159	PYTHON FOR POWER SYSTEMS ENGINEERING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	use the basic programming principles such as data types, variable, conditionals, loops, recursion and function calls
2	use basic data structures and manipulate text files and images.
3	familiar with machine learning concepts and techniques.
4	understand the process and will acquire skills necessary to effectively attempt a machine learning problem and implement it using python.
5	familiarizing the concepts acquired to improve research/employability skills.

UNIT I — INTRODUCTION TO MACHINE LEARNING AND PYTHON — 9

Introduction to machine learning- Significance, advantage and applications; Categories of machine learning; Basic steps in machine learning - Raw data collection, pre-processing, training a model, evaluation of model, performance improvement; Introduction to python and its significance; Difference between C, C++ and Python Languages; Compiler and interpreters; Python3 installation and running; Basics of Python programming syntax - Variable types, basic operators, reading input from user; Arrays/list, dictionary and set, conditional statements, control flow and loop control statements.

UNIT II — PYTHON FUNCTIONS AND PACKAGES — 9

File Handling- Reading and writing data; Errors and exceptions handling; Functions and modules; Package handling in python; Pip installation and exploring functions in python package; Installing the numpy library and exploring various operations on arrays - Indexing, slicing, multi-dimensional arrays, joining numpy arrays, array intersection and difference, saving and loading numpy arrays; Introduction to SciPy package and its functions; Introduction to object oriented programming with python.

UNIT III — IMPLEMENTATION OF MACHINE LEARNING USING PYTHON — 9

Description of standard datasets - Coco, imagenet, MNIST (handwritten digits) dataset, Boston housing dataset; Introducing the concepts of regression; Linear, polynomial and logistic regression with analytical understanding; Introduction to SciPy package and its functions; Python application of linear regression and polynomial regression using SciPy; Interpolation, overfitting and underfitting concepts and examples using SciPy.

UNIT IV — CLASSIFICATION AND CLUSTERING CONCEPTS OF ML — 9

Introduction to ML concepts of clustering and classification; Types of classification algorithms; Support vector machines (SVM) ; Decision tree; Random forest; Introduction to ML using scikitlearn; Using scikit-learn, loading a sample dataset, learning and prediction, interpolation and fitting, multiclass fitting; Implementation of SVM using blood cancer dataset, decision tree using data from csv. Types of clustering algorithms and techniques; K-means algorithm, mean shift algorithm and hierarchical clustering algorithm; Introduction to python visualization using Matplotlib - Plotting 2- dimensional, 3-dimensional graphs, formatting axis values, plotting multiple rows of data in same graph.

UNIT V	INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING	9

Introduction to neural networks and significance – Neural network architecture, single layer perceptron and multi-layer perceptron (MLP), commonly used activation functions; Forward propagation, back propagation, and epochs, gradient descent; Introduction to convolution neural networks; Implementation of digit classification using MNIST dataset ML for embedded systems

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	implement skill in system administration and network programming by learning python.	Applying(K3)
CO2	demonstrate the concepts of machine learning and implement using python.	Understanding (K2)
CO3	relate Pythons highly powerful processing capabilities for primitives, modelling etc.,	Applying(K3)
CO4	improve the employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded systems design.	Understanding (K2)
CO5	apply the concepts acquired over the advanced research/employability skills.	Applying(K3)

REFERENCES

1. Mark Lutz, "Learning Python, Powerful OOPs",O'reilly,2017.
2. Zelle, John "M. "Python Programming: An Introduction to Computer Science.", Franklin Beedle & Associates, 2013.
3. Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly, 2016.
4. Sebastian Raschka , Vahid Mirjalili, "Python Machine Learning - Third Edition", Packt, December 2019.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	2	2	-	-
CO4	3	3	3	1	-	-
CO5	3	3	2	1	-	-

PPS23160	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	recognize the basic of electromagnetic compatibility and its application.
2	impart knowledge on cabling and grounding fundamentals.
3	know about the importance of balancing and filters.
4	acquire knowledge on electromagnetic interface (EMI) from apparatus and circuits.
5	understand the process of electrostatic discharge (ESD).

UNIT I ELECTROMAGNETIC COMPATIBILITY AND APPLICATIONS 9

Noise and interface; Designing for electromagnetic compatibility; Regulatory process; Methods of noise coupling; Miscellaneous noise sources; Use of network theory; Power supply decoupling; Transient power supply currents; Decoupling capacitors; Effective decoupling strategies.

UNIT II CABLING AND GROUNDING 9

Capacitive coupling; Effect on shield on capacitive coupling; Inductive coupling; Mutual inductance calculations; Effect of shield on magnetic coupling; Shielding to prevent magnetic radiation; Shielding a receptor against magnetic fields; common impedance shield coupling; AC power distribution and safety grounds; Signal grounds; Equipment grounding; Ground loops.

UNIT III BALANCING AND FILTERING 9

Balancing – Common mode rejection ratio, cable balance, system balance, balanced loads; Filtering – Common mode filters, parasitic effects in filters; Power supply decoupling – Low frequency analog circuit decoupling, amplifier decoupling; Driving capacitive loads; System bandwidth; Modulation anding.

UNIT IV EMI FROM APPARATUS AND CIRCUITS 9

Electromagnetic emissions – Systems, appliances; Noise from relays and switches – Circuit model, Noise characteristics, effects of interfaces; Nonlinearities in circuits – Amplifier nonlinearity, modulation, intermodulation, cross modulation; Passive intermodulation; Cross talk in transmission lines – Multiconductor line, three conductor line; Transients in power supply lines – Calculation of induced voltages and currents, surges on main power supply; Electromagnetic interface – Radiation coupling, Conduction coupling, combination of radiation and conduction.

UNIT V ELECTROSTATIC DISCHARGE 9

Static generation – Inductive charging, energy storage; Human body model; Static discharge – Decay time; ESD protection in equipment's design; Preventing ESD entry; Hardening sensitive circuits; ESD grounding; Non grounded products; Field induced upset; Transient hardened software design; Time windows.

	TOTAL PERIODS	**45**

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basics of electromagnetic compatibility and its application.	Understanding (K2)
CO2	describe the process of on cabling and grounding fundamentals.	Understanding (K2)
CO3	elucidate the importance of balancing and filters.	Understanding (K2)
CO4	examine the effect of electromagnetic interface (EMI) from apparatus and circuits.	Understanding (K2)
CO5	implement the concept electrostatic discharge in various applications.	Applying(K3)

REFERENCES

1. Henry W.Ott, "Electromagnetic Compatibility Engineering", First Edition, John Wiley & Sons, Inc., Second Edition, Reprint 2019.
2. V.Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press and John Wiley & Sons Ltd, First Edition, Reprint 2017.
3. David A. Weston, "Electromagnetic Compatibility: Methods, Analysis, Circuits and Measurement", CRC Press, Third Edition, 2016.
4. Clayton Paul, "Introduction to Electromagnetic Compatibility", John Wiley & Sons, Inc., Third Edition, 2022.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	2	2	-	-
CO4	3	3	3	1	-	-
CO5	3	3	2	1	-	-

PPS23161	POWER QUALITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	provide knowledge about various power quality issues.
2	understand the concept of power and power factor in single phase and three phase systems supplying nonlinear loads.
3	equip with required skills to design conventional compensation techniques for power factor correction and load voltage regulation.
4	introduce the control techniques for the active compensation.
5	understand the mitigation techniques using custom power devices such as DSTATCOM, DVR and UPQC.

UNIT I	INTRODUCTION	9

Characterization of electric power quality - Transients, short duration and long duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power frequency variation, power acceptability curves; Power quality problems - Poor load power factor, non-linear and unbalanced loads, DC offset in loads, notching in load voltage; Disturbance in supply voltage – Power quality standards.

UNIT II	ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM	9

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source; Supplying linear and nonlinear loads – Three phase balanced system, three phase unbalanced system, three phase unbalanced and distorted source supplying non-linear loads; Concept of power factor; Three phase-three wire, three phase - four wire system.

UNIT III	CONVENTIONAL LOAD COMPENSATION METHODS	9

Principle of load compensation and voltage regulation; Classical load balancing problem - Open loop balancing, closed loop balancing, current balancing, harmonic reduction and voltage sag reduction; Analysis of unbalance – Instantaneous of real and reactive powers; Extraction of fundamental sequence component from measured.

UNIT IV	LOAD COMPENSATION USING DSTATCOM	9

Compensating single-phase loads; Ideal three phase shunt compensator structure; Generating reference currents using instantaneous PQ theory; Instantaneous symmetrical components theory; Generating reference currents when the source is unbalanced; Realization and control of DSTATCOM – DSTATCOM in voltage control mode.

UNIT V	SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM	9

Rectifier supported DVR; DC capacitor supported DVR; DVR structure; Voltage restoration; Series

active filter; Unified power quality conditioner.			
		TOTAL PERIODS	**45**

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	comprehend the consequences of power quality issues.	Understanding (K2)
CO2	conduct harmonic analysis of single phase and three phase systems supplying non-linear loads	Understanding (K2)
CO3	design passive filter for load compensation.	Analyzing(K4)
CO4	design active filters for load compensation.	Analyzing(K4)
CO5	understand the mitigation techniques using custom power devices such as distribution static compensator DSTATCOM, dynamic voltage restorer DVR and UPQC.	Understanding (K2)

REFERENCES

1. .Arindam Ghosh and Gerad Ledwich "Power Quality Enhancement Using Custom Power Devices",Kluwer Academic Publishers, First Edition, Reprint 2019.
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, Second Edition, Reprint 2016.
3. R.C.Duggan "Electric Power Systems Quality", Tata MC Graw Hill Publishers, Third Edition Reprint, 2019.
4. Derek A.Paice "Power Electronic Converter Harmonics" IEEE Press, 2014.

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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	3	1	2	3
CO5	3	3	2	1	2	3

PPS23162	APPLICATION OF DSP TO POWER SYSTEM PROTECTION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	expose the students to learn about DFT and wavelet transforms.
2	provide an in-depth knowledge on the components used for the implementation of digital protection.
3	impart knowledge on different algorithms for digital protection of power system components.
4	implement digital protection for transformer.
5	understand different decision making methodologies in protective relays.

UNIT I **DIGITAL SIGNAL PROCESSING TECHNIQUES** **9**

Sampling-Principle of scaling-aliasing, decimation, interpolation; Fourier and discrete fourier transforms; Fast fourier transforms; Wavelet transform; Numerical algorithms.

UNIT II **DIGITAL PROTECTION** **9**

Digital protection - Performance and operational characteristics of digital protection; Basic components of digital relays -Signal conditioning systems, conversion subsystem, digital relay subsystem; Numerical relay for generator, transformer, feeder, busbar protection.

UNIT III **ALGORITHMIC TECHNIQUES** **9**

Finite difference techniques- Interpolation, numerical differentiation, curve fitting and smoothing; Sinusoidal wave based algorithms -First and second derivative method, two and three sample technique; Walsh function analysis- Least squares based methods, differential equation based techniques; Travelling wave protective schemes; FIR based algorithms; Least square curve fitting algorithm.

UNIT IV **DIGITAL PROTECTION TECHNIQUES** **9**

Transformer protection; Fourier based algorithm - Basic hardware of microprocessor based transformer protection; Digital line differential scheme; Measurement algorithms for digital protection – Power, voltage, current, impedance, phase shift; Short window Wavelet based fault identification techniques-Sliding window, FWHT, signal analysis and synthesis; AC/DC cable fault location; Intrinsic and extrinsic fault; Harmonic filtering in fault analysis.

UNIT V **DIGITAL PROTECTIVE RELAYS** **9**

Decision making in protective relays- Deterministic decision making; Statistical hypotheses testing; Decision making with multiple criteria; Adaptive decision schemes; Elements of fuzzy logic in protective relays, fuzzy sets and fuzzy numbers, Boolean versus fuzzy logic, fuzzy reasoning, fuzzy logic applications for protection and control.

TOTAL PERIODS **45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	apply DSP techniques for digital protection.	Applying(K3)
CO2	make decision to implement suitable algorithm for digital relaying applications.	Understanding (K2)
CO3	employ FIR based algorithms for digital relaying.	Applying(K3)
CO4	do transformer protection using digital techniques.	Understanding (K2)
CO5	perform coordinated operation of relays for specific purposes.	Applying(K3)

REFERENCES

1. J.L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, Seventh Edition 2016.
2. A.G. Phadke and J.S. Thorp, "Computer Relaying for Power Systems", John Wiley & Sons, New York, Reprint 2013.
3. J.G. Proakis and D.G. Manolakis, "Digital Signal Processing Principles, Algorithms", 2017.
4. Y.G. Paithankar and S.R Bhide, "Fundamentals of Power System Protection", PHI Learning, Second Edition Reprint 2018.

CO-PO MAPPING

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CO's	Programme Outcomes PO's					
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CO1	3	3	2	2	3	2
CO2	3	3	2	2	3	2
CO3	3	3	2	2	2	2
CO4	3	3	3	1	2	2
CO5	3	3	2	1	2	2

PPS23163	SCADA SYSTEM AND APPLICATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know about the functional requirements of SCADA.
2	infer the system components of SCADA.
3	understand the communication protocols used in SCADA.
4	interpret the monitoring and control process of SCADA.
5	identify the SCADA application in power system.

UNIT I **INTRODUCTION TO SCADA** **9**

Evolution of SCADA, SCADA definitions, SCADA functional requirements and components, SCADA hierarchical concept, SCADA architecture, general features, SCADA applications, benefits.

UNIT II **SCADA SYSTEM COMPONENTS** **9**

Remote terminal unit (RTU); Interface units - Human-machine interface units (HMI); Display monitors/data logger systems; Intelligent electronic devices (IED); Communication network, SCADA server, SCADA control systems and control panels.

UNIT III **SCADA COMMUNICATION** **9**

SCADA communication requirements; Communication protocols - Past, present and future, structure of a SCADA communications protocol, comparison of various communication protocols; IEC61850 based communication architecture; Communication media - Fiber optic, PLCC; Interface provisions and communication extensions, synchronization with NCC and DCC.

UNIT IV **SCADA MONITORING AND CONTROL** **9**

Online monitoring the event and alarm system, trends and reports, blocking list, event disturbance recording; Control function - Station control, bay control, breaker control and disconnector control.

UNIT V **SCADA APPLICATIONS IN POWER SYSTEM** **9**

Applications in generation, transmission and distribution sector; Substation SCADA system - Functional description, system specification, system selection such as substation configuration; IEC61850 ring configuration; SAS cubicle concepts, gateway interoperability list, signal naming concept; System installation, testing and commissioning.

TOTAL PERIODS **45**

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	enumerate the functional requirements and architecture of SCADA.	Understanding (K2)

CO2	explain the various system components and control panels in SCADA.	Understanding (K2)
CO3	analyze the SCADA communication protocols.	Analyzing(K4)
CO4	investigate the control and monitoring functions of SCADA.	Applying(K3)
CO5	describe the SCADA application in power system.	Understanding (K2)

REFERENCES

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2014.
2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2014.
3. William T. Shaw, "Cyber Security for SCADA systems", Penn Well Books, 2016.
4. David Bailey, Edwin Wright, "Practical SCADA for Industry", Newnes, 2018.

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

CO's	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	2	1
CO4	3	3	3	1	2	3
CO5	3	3	2	1	2	3

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
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PPS23164	FACTS AND CUSTOM POWER DEVICES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	infer the basic concept of transmission systems and FACTS controllers.
2	identify the suitable compensator and its control.
3	review various series compensation techniques.
4	know about unified power flow controller.
5	understand the modelling of interline power flow controller.

UNIT I BASICS OF TRANSMISSION SYSTEM AND FACTS CONTROLLERS **9**

Reactive power flow control in power systems; Control of dynamic power un-balances in power system; Power flow control; Constraints of maximum transmission line loading; Benefits of FACTS transmission line compensation; Uncompensated line -Shunt compensation, series compensation; Phase angle control; Reactive power compensation.- Shunt and series compensation principles, reactive compensation at transmission and distribution level.

UNIT II SVC AND STATCOM **9**

Static versus passive VAR compensator; Static shunt compensators - SVC and STATCOM, operation and control of TSC, TCR and STATCOM, compensator control; Comparison between SVC and STATCOM.

UNIT III STATIC SERIES COMPENSATION **9**

TSSC, SSSC; Static voltage and phase angle regulators; TCVR and TCPAR operation and control, applications; Static series compensation – GCSC, TSSC, TCSC and their control.

UNIT IV UNIFIED POWER FLOW CONTROLLER **9**

SSR and its damping; Unified power flow controller - Circuit arrangement, operation and control of UPFC; Basic principle of P and Q control; Independent real and reactive power flow control, applications.

UNIT V INTERLINE POWER FLOW CONTROLLER **9**

Introduction to interline power flow controller; Modeling and analysis of FACTS controllers; Simulation of FACTS controllers; Power quality problems in distribution systems, harmonics; Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering; Shunt, series and hybrid and their control; Power quality issues - Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners; IEEE standards on power quality.

	TOTAL PERIODS	**45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	distinguish the performance of transmission line with and without FACTS devices	Understanding (K2)
CO2	compare the SVC and STATCOM.	Analyzing(K4)
CO3	describe the operation and control of various static series compensators.	Understanding (K2)
CO4	explain the operation and control of unified power flow controller.	Understanding (K2)
CO5	distinguish various power quality issues and how are they mitigated by various FACTS devices.	Understanding (K2)

REFERENCES

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2017.
2. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, Reprint 2019.
3. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control", Springer Verlag, Berlin, Reprint 2017.
4. K.S.Suresh Kumar, S.Ashok, "FACTS Controllers & Applications", E-book edition, Nalanda Digital Library, NIT Calicut, 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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	1	1
CO2	3	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	3	3	3	1	2-	3
CO5	3	3	2	1	1	3

PPS23165	COMPUTER RELAYING AND WIDE AREA MEASUREMENT SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	discriminate conventional relays and computer relays.
2	comprehend the operating values of a computer relays.
3	provide exposure to wide area measurement systems through the computer hierarchy in the substation, system relaying and control.
4	inculcate knowledge on phasor measurement unit and its application to power system.
5	enhance the conventional power system studies with wide area measurement techniques.

UNIT I — INTRODUCTION — 9

Historical background - Expected benefits; Computer relay architecture; Analog to digital converters; Anti-aliasing filters; Substation computer hierarchy; Fourier series, exponential fourier series, sine and cosine fourier series, phasor.

UNIT II — FILTERS IN COMPUTER RELAYING — 9

Walsh functions; Fourier transforms; Discrete fourier transform; Random processes; Filtering of random processes; Kalman filtering; Digital filters - Windows and windowing; Linear phase approximation - Filter synthesis; Wavelets; Elements of artificial intelligence.

UNIT III — COMPUTATION OF PHASORS — 9

Introduction - Phasor representation of sinusoids, fourier series and fourier transform and DFT Phasor representation; Phasor Estimation of nominal frequency signals; Formulas for updating phasors; Non-recursive updates - Recursive updates; Frequency estimation.

UNIT IV — PHASOR MEASUREMENT UNITS — 9

A generic PMU - The global positioning system; Hierarchy for phasor measurement systems; Functional requirements of PMUs and PDCs; Transient Response - Phasor measurement units, instrument transformers, filters; Transient response during electromagnetic transients and power swings.

UNIT V — PHASOR MEASUREMENT APPLICATIONS — 9

State Estimation - History, operator's load flow; Weighted least square - Least square, linear weighted least squares, nonlinear weighted least squares; Static state estimation - State estimation with Phasors measurements, linear state estimation; Protection system with phasor inputs - Differential and distance protection of transmission lines - Adaptive protection, adaptive out-of-step protection.

TOTAL PERIODS	**45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate knowledge of fundamental theories, principles and practice of computer relaying, wide area measurement system.	Understanding (K2)
CO2	analyze the power system with computer relaying and wide area measurement system.	Analyzing(K4)
CO3	validate the recent relaying technologies which work towards smart grid.	Understanding (K2)
CO4	design wide area measurement systems for smart grid.	Analyzing(K4)
CO5	compare the performance of modern relaying schemes and measurement techniques with the conventional one.	Analyzing(K4)

REFERENCES

1. A.G. Phadke, J.S. Thorp, "Computer Relaying for Power Systems", John Wiley and Sons Ltd., Research Studies Press Limited, Second Edition, Reprint 2019.
2. A.G. Phadke, J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer, First Edition, Reprint 2018.
3. Antonello Monti, Carlo Muscas, FerdinandaPonci, "Phasor Measurement Units and Wide Area Monitoring Systems" Academic Press, 2016.
4. Stanley H. Horowitz, Arun G. Phadke, "Power System Relaying", John Wiley & Sons, 2013.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	3	1	1	1
CO5	3	3	2	1	3	3

PPS23166	ENERGY MANAGEMENT AND AUDITING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the present energy scenario and role of energy managers.
2	comprehend the economic models for cost and load management.
3	configure the demand side energy management through its control techniques, strategy and planning.
4	understand the process of energy auditing.
5	know energy conservation aspects in industries.

UNIT I	ENERGY SCENARIO	9

Basics of energy and its various forms - Conventional and non-conventional sources; Energy policy - Energy conservation act 2001, amedments (India) in 2010; Need for energy management; Designing and starting an energy management program; Energy managers and energy auditors; Roles and responsibilities of energy managers; Energy labelling and energy standards.

UNIT II	ENERGY COST AND LOAD MANAGEMENT	9

Important concepts in an economic analysis - Economic models, time value of money; Utility rate structures; Cost of electricity; Loss evaluation; Load management - Demand control techniques; Utility monitoring and control system; HVAC and energy management; Economic justification.

UNIT III	ENERGY MANAGEMENT	9

Demand side management (DSM) - DSM planning, DSM techniques, load management as a DSM strategy; Energy conservation; Tariff options for DSM.

UNIT IV	ENERGY AUDITING	9

Definition; Energy audit methodology - Audit preparation, execution and reporting; Financial analysis, sensitivity analysis, project financing options; Instruments for energy audit; Energy audit for generation, distribution and utilization systems; Economic analysis.

UNIT V	ENERGY EFFICIENT TECHNOLOGIES	9

Energy saving opportunities in electric motors - Power factor improvement benefit and techniques; Shunt capacitor, synchronous condenser and phase advancer; Energy conservation in industrial drives, electric furnaces, ovens and boilers; Lighting techniques - Natural, CFL, LED lighting sources and fittings.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to	BT Mapped (Highest Level)

CO1	identify the energy policy and roles of energy managers.	Analyzing(K4)
CO2	enumerate the cost and load management on economic models.	Understanding (K2)
CO3	explain the energy management on demand side.	Understanding (K2)
CO4	describe the process of energy auditing.	Understanding (K2)
CO5	implement energy conservation aspects in industries.	Analyzing(K4)

REFERENCES

1. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC press, Taylor & Francis group, Eighth Edition, 2016.
2. Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, Fifth Edition, Reprint 2017.
3. Anil Kumar, Om Prakash ,Chauhan Prashant Singh, "Energy Management: Conservation and Audits", CRC Press, 2020.
4. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC press, Taylor & Francis group, Eighth Edition, 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	Programme Outcomes PO's					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	3	1	2	3
CO5	3	3	2	1	1	1

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
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PPS23167	COMPUTATIONAL INTELLIGENCE TECHNIQUES TO POWER SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	learn the concept of optimization techniques for power systems.
2	know the performance of optimal controllers for power systems.
3	interpret the linear quadratic tracking problems and implement dynamic programming application for discrete and continuous systems.
4	infer filtering and estimation techniques for power systems applications.
5	deduce Kalman filter for power systems protection application.

UNIT I	INTRODUCTION	9

Application of genetic algorithm to power system load forecasting, participle swam optimization for reactive power optimization, optimization techniques for emission dispatch of power plant, differential evolution algorithm, optimization techniques for pole placement and state feed-back algorithms; Problem formulation and forms of optimal control – Selection of performance measures; Necessary conditions for optimal control; State inequality constraints; Minimum time problem.

UNIT II	LINEAR QUADRATIC TRACKING PROBLEMS AND NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL	9

Linear tracking problem – LQG problem; Computational procedure for solving optimal control problems; Characteristics of dynamic programming solution – Dynamic programming application to discrete and continuous systems – Hamilton Jacobi Bellman equation; Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method - Solution of Ricatti equation by negative exponential and interactive methods.

UNIT III	MODEL DECOMPOSITION AND CONVOLUTIONAL NEURAL NETWORK	9

CNN classification, CNN algorithm model decomposition techniques, application of model decomposition and CNN based techniques for various power system fault diagnosis problems, model predictive controllers for power system for power system stabilizers.

UNIT IV	FILTERING AND ESTIMATION	9

Filtering – Linear system and estimation; System noise smoothing and prediction; Gauss Markov discrete time model – Estimation criteria; Minimum variance estimation; Least square estimation – Recursive estimation.

UNIT V	KALMAN FILTER	9

Filter problem and properties – Linear estimator property of Kalman filter, time invariance and asymptotic stability of filters, time filtered estimates and signal to noise ratio improvement; Extended Kalman filter; Kalman filter for power system protection applications

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	describe the concept of optimization techniques for power systems.	Understanding (K2)
CO2	identify, formulate and measure the performance of optimal controllers for power systems.	Applying (K3)
CO3	explain the linear quadratic tracking problems and implement dynamic programming application for discrete and continuous systems.	Understanding (K2)
CO4	apply filtering and estimation techniques for power systems applications.	Applying (K3)
CO5	describe Kalman filter for power system protection application.	Understanding (K2)

REFERENCES

1. Ajith Abraham and Swagatham Das.,"Computaional Intelligence in Power Engineering", 2010 Springer Verlag.
2. Yong Hua Song, Johns Allen, Aggarwal Raj, 'Computational Intelligence Application to Power System', Springer Netherlands.,Fourth Edition Reprint 2020.
3. Dipu Sarkar, Chandan Kumar Chanda, "Computational Techniques for Power Systems Analysis", BS Publications / BSP Books 2020.
4. Nagendra Singh, Sitendra Tamrakar, Arvind Mewada, Sanjeev Kumar Gupta, "Artificial Intelligence Techniques in Power Systems Operations and Analysis", Auerbach Publications 2023.

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	Programme Outcomes PO's					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	1	2	1	-	1	-
CO2	2	3	3	-	2	-
CO3	2	-	3	1	3	2
CO4	3	2	1	2	-	1
CO5	2	2	2	-	3	-

PPS23168	MACHINE LEARNING AND DEEP LEARNING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	learn about the learning problem and algorithms.
2	provide insight about neural networks.
3	know about the machine learning fundamentals and significance.
4	acquire knowledge about pattern recognition.
5	apply deep learning algorithms for solving real life problems.

UNIT I	LEARNING PROBLEMS AND ALGORITHMS	9

Various paradigms of learning problems; Supervised, semi-supervised and unsupervised algorithms.

UNIT II	NEURAL NETWORKS	9

Differences between biological and artificial neural networks - Typical architecture, common activation functions, multi-layer neural network, linear separability, Hebb Net, perceptron, adaline, standard back propagation training algorithms for pattern association; Hebb rule and Delta rule; Hetero associative, auto associative, Kohonen self organising maps, examples of feature maps, learning vector quantization, Gradient descent, Boltzmann machine learning.

UNIT III	MACHINE LEARNING – FUNDAMENTALS, FEATURE SELECTIONS AND CLASSIFICATIONS	9

Classifying samples - The confusion matrix, accuracy, precision, recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance; Feature selection, normalization, dimensionality reduction, Classifiers - KNN, SVM, Decision trees, Naïve bayes, binary classification, multi class classification, clustering.

UNIT IV	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	9

Feed forward networks, activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, examples of CNNs.

UNIT V	DEEP LEARNING: RNNS, AUTOENCODERS AND GANS	9

State, structure of RNN Cell, LSTM and GRU, time distributed layers, generating text, 65; Autoencoders - Convolutional autoencoders, denoising autoencoders, variational autoencoders; GANs - The discriminator, generator, DCGANs.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	illustrate the categorization of machine learning algorithms.	Understanding (K2)
CO2	compare and contrast the types of neural network architectures, activation functions	Applying (K3)

CO3	acquaint with the pattern association using neural networks	Understanding (K2)
CO4	elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks	Understanding (K2)
CO5	construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.	Understanding (K2)

REFERENCES

1. J. S. R. Jang, C. T. Sun, E. Mizutani, "Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence", 2019, PHI learning.
2. Ian Good fellow, YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press, ISBN: 9780262035613, 2016.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, "The Elements of Statistical Learning" Second Edition Reprint 2019.
4. Shai Shalev-Shwartz and Shai Ben-David. "Understanding Machine Learning". Cambridge University Press. 2020.

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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	1	3	1	1	-	-
CO2	2	3	2	1	-	-
CO3	3	-	3	-	-	-
CO4	2	3	3	-	-	-
CO5	2	3	3	-	-	-

PPS23169	CLOUD COMPUTING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know the principles of cloud computing.
2	study the various cloud service models.
3	understand the basics of virtualization.
4	familiarize with the programming models available in cloud.
5	get an insight on some applications and prospects of cloud computing.

UNIT I	AN OVERVIEW	9

Cloud Computing – Definition, motivation, characteristics; Past, present, and future cloud computing methodologies; The cloud architecture; Cloud deployment techniques; Cloud services; Cloud applications; Issues with cloud computing, comparison between cloud computing and grid computing benefits, limitations, and concerns associated with cloud computing, prospects and implications.

UNIT II	CLOUD SERVICES	9

Cloud services, classification, software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS), data storage as a service, other services- security as a service (SeaaS), knowledge as a service, and analytics as a service (AaaS), service providers, cloud deployment models, private cloud, public cloud, community cloud, hybrid cloud.

UNIT III	VIRTUALIZATION	9

Introduction- Virtualization opportunities; Processor virtualization, memory virtualization, storage virtualization, network virtualization, data virtualization, application virtualization, approaches to virtualization, full virtualization, para virtualization, hardware-assisted virtualization; Types of hypervisors; From virtualization to cloud computing – IaaS, PaaS, SaaS.

UNIT IV	PROGRAMMING MODELS FOR CLOUD COMPUTING	9

Existing and extended programming models for cloud - BSP model, map reduce model, cloud Haskell; Multi MLton, Erlang; SORCER – Object oriented programming; Programming models in Aneka; New programming models proposed for cloud; Orleans; BOOM and bloom; Grid batch - Simple API for grid applications.

UNIT V	APPLICATIONS AND PROSPECTS	9

Cloud applications - Engineering applications, educational applications, personal applications; Cloud gaming; Cloud prospects; Impact of the cloud on IT professionals and the IT industry; Cloud computing in emerging markets; Research topics in cloud computing; The future of the clouds.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	conceptualize the basic ideas and motivation for cloud	Understanding (K2)

	computing.	
CO2	describe the cloud services offered by the companies.	Understanding (K2)
CO3	explain the concept of virtualization.	Understanding (K2)
CO4	discuss the suitability of each programming model to different kinds of application.	Understanding (K2)
CO5	identify the areas of application and explore future prospects.	Understanding (K2)

REFERENCES

1. K. Chandrasekaran, "Essentials of Cloud Computing", CRC press, 2020
2. RajkumarBuyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley, 2019.
3. Dan C. Marinescu, "Cloud Computing: Theory and Practice, Morgan Kaufmann,2019.
4. San Murugesan, Irena Bojanova, "Encyclopedia of Cloud Computing", Wiley-IEEE press, 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

	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	1	2	1	-	-	-
CO2	1	1	2	-	-	-
CO3	2	-	1	-	-	-
CO4	1	2	1	-	-	-
CO5	3	3	1	-	-	-

PPS23170	HIGH VOLTAGE AND INSULATION SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know the various insulating materials used in power system.
2	infer breakdown mechanism of solid, liquid and gaseous dielectrics.
3	interpret the high voltage generation methods and measurements
4	construe insulation testing of electrical equipments.
5	understand the various Non-destructive testing in high voltage.

UNIT I	INSULATING MATERIALS IN POWER SYSTEM	9

Review of insulating materials gases, vacuum, liquids and solids; Characterization of insulation condition – permittivity, capacitance, resistivity and insulation resistance, dielectric dissipation factors; Partial discharges sources, forms and effects, ageing effects, electrical breakdown and operating stresses, standards relating to insulating materials.

UNIT II	BREAKDOWN MECHANISMS OF SOLID, LIQUID AND GASEOUS DIELECTRICS	9

Introduction to insulation systems used in high voltage power apparatus - Breakdown mechanisms of solid, liquid, gas and vacuum insulation.

UNIT III	BASIC METHODS OF GENERATION AND MEASUREMENT OF TEST HIGH VOLTAGES	9

Generation of high alternating voltages - Cascaded transformers and series resonant circuit; Generation of high dc voltages - Rectifier circuit and voltage multiplier circuit; Generation of impulse voltages- Multistage impulse generator circuit; Generation of impulse currents; Measurement of high ac, dc and impulse voltages - Voltage divider circuits; Digital storage oscilloscope for impulse voltage and current measurements.

UNIT IV	INSULATION TESTING OF ELECTRICAL EQUIPMENTS	9

Necessity for high voltage testing - Testing of distribution and power transformers ; Voltage transformers; Current transformers; Bushings; Overhead line and substation insulators; Surge arresters; High voltage cables; Circuit breakers and isolators; IEC and Indian standards.

UNIT V	NON-DESTRUCTIVE TESTING	9

Insulation resistance measurement- Measurement of tan delta and capacitance of dielectrics; Grounded objects like transformers and alternators; Measurement of PARTIAL discharges; Location and measurement of discharges in electrical equipment; Dissolved gas in oil measurement.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	describe the various insulating materials used in power system.	Understanding (K2)
CO2	illustrate breakdown mechanism of solid, liquid and gaseous dielectrics.	Understanding (K2)

CO3	explain the high voltage generation methods and measurements.	Understanding (K2)
CO4	evaluate insulation testing of electrical equipments.	Understanding (K2)
CO5	describe the various Non-destructive testing in high voltage.	Understanding (K2)

REFERENCES

1. Adrianus,J.Dekker, "Electrical Engineering Materials", Prentice Hall of India Pvt. Ltd., New Delhi, 2018.
2. Kuffel,E. and Zaengl, W.S., "High Voltage Engineering Fundamentals", Pergamon Press, Oxford,New York 2018.
3. Naidu,M.S. and Kamaraju,V., "High Voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2019.
4. Gallagher,T.J., and Permain,A., "High Voltage Measurement, Testing and Design", John Wiley Sons, New York, 2020.

CO-PO MAPPING

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CO's	Programme Outcomes PO's					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	2	1	3	3	2	2
CO2	3	2	3	3	2	-
CO3	3	2	3	3	-	2
CO4	3	2	3	3	2	2
CO5	3	2	3	3	2	2

PPS23901	ALTERNATE ENERGY SOURCES	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1	know about solar radiation and its measurement system.
2	learn about the components of wind energy conversion system.
3	understand the concept of geothermal energy and its conversion process.
4	acquire knowledge about biomass energy and its classifications.
5	identify different energy sources and working principles.

UNIT I	**SOLAR RADIATION AND ITS MEASURMENT**	**9**
Solar constant; Solar radiation at the earth surface - Beam and diffuse solar radiation, sun at zenith, air mass, alteration of beam radiation; Solar radiation geometry; Local solar time; Solar radiation measurements- Pyrheliometers, pyranometers.		
UNIT II	**WIND ENERGY**	**9**
Basic principles of wind energy conversion – The nature of wind, forces on the blades, wind energy conversion; Basic components of wind energy conversion system; Classification of wind energy conversion system; Performance of wind machines.		
UNIT III	**GEOTHERMAL ENERGY**	**9**
Estimates of geothermal power; Natural geothermal fields; Geothermal sources; Geo pressured resources; Hot dry rock resources petro-thermal systems; Prime movers for geothermal energy conversion- Impulse reaction machines, positive displacement machines, impulse machine ; Material selection for geothermal power plants; Applications of geothermal energy.		
UNIT IV	**BIOMASS ENERGY**	**9**
Biomass conversion technologies – Wet process, dry processes; Classification of biogas plants; Materials used for bio-gas generation; Selection of site for a biogas plant; Fuel properties of bio-gas; Methods for obtaining energy from bio mass.		
UNIT V	**OTHER ENERGY SOURCES**	**9**
Ocean thermal energy conversion (OTEC) –Methods of ocean thermal electric power generation, open cycle OTEC system; Energy from tides – Basic principle of tidal power, components of tidal power plant; Small scale hydroelectric – Nature of small hydro development, classification of small hydro power stations, Components of a hydroelectric scheme.		
	TOTAL PERIODS:	**45**

COURSE OUTCOMES	
At the end of this course, students will be able to	**BT Mapped (Highest Level)**

CO1	describe the solar radiation and its measurement.	Understanding (K2)
CO2	elucidate the performance of wind energy conversion system.	Applying (K3)
CO3	interpret energy conversion process for acquiring geothermal energy.	Understanding (K2)
CO4	enumerate the biomass energy in a useful way.	Understanding (K2)
CO5	describe the components of energy sources ocean, tidal and hydro.	Understanding (K2)

REFERENCES

1. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, Seventh Edition, Reprint 2019.
2. Twidell and Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), Nineth Edition 2020.
3. Mittal K M, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, Fourth Edition Reprint 2018.
4. Kothari D.P, Singhal, K.C., "Renewable energy sources and emerging technologies", P.H.I, New Delhi, Nineth Edition 2020.

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	Programme Outcomes PO's					
CO's	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	2	1	3	3	-	2
CO2	3	2	3	3	2	2
CO3	3	2	3	-	2	2
CO4	3	2	3	3	2	-
CO5	3	2	3	3	2	2