KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION – 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM

VII TO VIII SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Electrical and Electronics Engineering of this Institution the unique of its kind in the field of Research and Development activities in this part of the world.

MISSION:

Department of Electrical and Electronics Engineering is committed to impart highly innovative and technical knowledge in the field of Electrical and Electronics Engineering to the urban and unreachable rural student folks through Total Quality Education

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: **Technical Knowledge:** To provide basic knowledge in Physics, Chemistry, Mathematics and necessary foundation in various concepts of Electrical and Electronics Engineering

PEO 2: **Problem Solving:** To impart training to enable the students to envisage the real time problems related to the field of Electrical and Electronics Engineering and allied areas faced by the Industries so as to model, analyze and provide appropriate solutions.

PEO 3: **Personality Development:** To provide an academic environment for the students to develop team spirit, leadership qualities, communication skills and soft skills.

PEO 4: **Life Long Learning:** To motivate students to prepare for competitive examinations enabling them to pursue higher studies, thereby, promoting Research and Development activities.

PROGRAM OUTCOMES:

After going through the four years of study, the Electrical and Electronics Engineering graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : Ability to design and solve engineering problems by applying the fundamental knowledge of Engineering Mathematics, Basic Sciences, Electrical and Electronics Engineering.

PSO2 : Ability to understand the recent technological developments in Electrical & Electronics Engineering and develop products / software to cater the Societal & Industrial needs.

SEMESTER VII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	EE1701	Power Systems Operation and Control	PC	3	3	0	0	3
2	GE1471	Professional Ethics and Human Values	HS	3	3	0	0	3
3	GE1771	Principles of Management	HS	3	3	0	0	3
4		Professional Elective III	PE	3	3	0	0	3
5		Professional Elective IV	PE	3	3	0	0	3
6		Open Elective II*	OE	3	3	0	0	3
7		Online Course II**	OL	3	3	0	0	3
PRACTICALS								
8	EE1711	Power System Simulation Laboratory	PC	4	0	0	4	2
9	EE1721	Mini Project	EEC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER VIII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Online Course II**	OL					
PRACTICALS								
2	EE1821	Project Work	EEC	16	0	0	16	8
			TOTAL	**19**	**3**	**0**	**16**	**11**

***** Course from the Curriculum of other UG programmes.

**The students shall complete the online course from 5th semester and credits would be added in consolidated mark sheet.

PROFESSIONAL ELECTIVES (PEs)

PROFESSIONAL ELECTIVE III (SEMESTER VII)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE1731	Modern Power Converters	PE	3	3	0	0	3
2	EE1732	Nano Technology	PE	3	3	0	0	3
3	EE1733	Smart Grid	PE	3	3	0	0	3
4	EE1734	Soft Computing Techniques	PE	3	3	0	0	3
5	EE1735	Utilization and Conservation of Electrical Energy	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE IV (SEMESTER VII)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE1736	Data Science for Electrical Engineers	PE	3	3	0	0	3
2	EE1737	High Voltage Engineering	PE	3	3	0	0	3
3	EE1738	Introduction to Industrial Automation	PE	3	3	0	0	3
4	EE1739	Power Electronics for Renewable Energy Systems	PE	3	3	0	0	3
5	EE1740	Restructured Power Systems	PE	3	3	0	0	3

OPEN ELECTIVE II (SEMESTER VII)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
Offered to MTR, PT, Mech								
1	OEE171	Battery Management System	OE	3	3	0	0	3
Offered to ECE, MECH, EIE								
2	OEE172	Electric Vehicles	OE	3	3	0	0	3
Offered to all Dept.								
3	OEE173	Electrical Safety	OE	3	3	0	0	3
4	OEE174	Energy Conservation and Management	OE	3	3	0	0	3
Offered to CIVIL, ECE, EIE								
5	OEE175	Wiring Estimation and Costing	OE	3	3	0	0	3

EE1701 POWER SYSTEM OPERATION AND CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know the significance of power system operation and control.
- To identify, formulate, and solve problems in real power control and reactive power control for maintaining the voltage profile.
- To demonstrate various analytical skills in Generation scheduling and economic operation of power system.
- SCADA and its application for real time operation and control of power systems.

UNIT I INTRODUCTION 9

Power scenario in Indian grid – National and Regional load dispatching centers – necessity of voltage and frequency regulation – system load variation, load curves and basic concepts of load dispatching - load forecasting and its model (Similar-day approach and Regression methods) - Basics of speed governing mechanisms and modeling - speed load characteristics - regulation of two generators in parallel.

UNIT II REAL POWER - FREQUENCY CONTROL 9

Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system - tie line modeling – block diagram representation of two area system - static and dynamic analysis - tie line with frequency bias control.

UNIT III REACTIVE POWER – VOLTAGE CONTROL 9

Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis – stability compensation - voltage drop in transmission line - methods of reactive power injection - tap changing transformer, SVC (TCR + TSC) and STATCOM for voltage control.

UNIT IV ECONOMIC OPERATION OF POWER SYSTEM 9

Statement of economic dispatch problem - input and output characteristics of thermal plant -incremental cost curve - optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) - base point and participation factors method - statement of unit commitment (UC) problem -

constraints on UC problem – UC Solution methods - Priority-list methods. Numerical problems only in priority-list method using full-load average production cost

UNIT V COMPUTER CONTROL OF POWER SYSTEMS 9

Need of computer control of power systems-concept of energy control centers and functions - system monitoring, data acquisition and controls - System hardware configurations - SCADA and EMS functions - Various operating states - state transition diagram. State Estimation: State Estimator, Static-State Estimation, Modeling of Uncertainty, Least Squares Estimation

TOTAL: 45 PERIODS

OUTCOMES

CO1: Discuss the load forecasting technique and various control methods in power system.

CO2: Model real power-frequency dynamics and to design frequency controller.

CO3: Apply suitable reactive power compensation technique for effective voltage control.

CO4: Investigate the economic dispatch and unit commitment problem using analytical approach.

CO5: Comprehend the computer control system for real time power system monitoring and control.

TEXT BOOKS:

1. Wood, A.J., Wollenberg, B.F. and Sheblé, G.B., 2013. *Power generation, operation, and control*. John Wiley & Sons.

REFERENCE BOOKS:

1. Sivanagaraju, S., 2009. *Power system operation and control*. Pearson Education India.
2. Kundur, P., Balu, N.J. and Lauby, M.G., 1994. *Power system stability and control* (Vol. 7). New York: McGraw-hill.
3. Wadhwa, C.L., 2006. *Electrical power systems*. New Age International.

GE1471 PROFESSIONAL ETHICS AND HUMAN VALUES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and
- To impart Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES **10**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation –Commitment – Empathy – Self-confidence – Character – Spirituality – Stress management Techniques.

UNIT II ENGINEERING ETHICS **9**

Senses of Engineering Ethics – Variety of moral issues - Types of inquiry – Moral dilemmas – Moral Autonomy - Kohlberg‘s theory - Gilligan‘s theory – Consensus and Controversy - Models of professional roles - Theories about right action – Self-interest - Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics - A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS **9**

Safety and Risk - Assessment of Safety and Risk - Risk Benefit Analysis and Reducing Risk -Respect for Authority - Collective Bargaining - Confidentiality - Conflicts of Interest - Occupational Crime - Professional Rights - Employee Rights – Intellectual Property Rights (IPR) - Discrimination.

UNIT V GLOBAL ISSUES **8**

Multinational Corporations - Environmental Ethics – Computer Ethics - Weapons Development - Engineers as Managers - Consulting Engineers – Engineers as Expert Witnesses and Advisors –Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Summarize the various Morals, Values, Ethics, Integrity and other Human Values

CO2: Describe the Senses of Engineering ethics, its related Theories and Models of Professional Roles

CO3: Explain the Codes of Ethics for various Engineering Experiments.

CO4: Examine the various Risk, Safety and Risk Benefit Analysis for a Product/Service in an Organization

CO5: Explain the Various Global Issues in Ethics and Review the Responsibilities and Rights of Professionals and Employees in an Organization

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, 2017. *Ethics in Engineering*, 4th Edition, McGraw Hill.

REFERENCE BOOKS:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, 2004. *Engineering Ethics*, Prentice Hall of India.
2. Charles B. Fleddermann, 2012. *Engineering Ethics*, 4th Edition, Prentice Hall.
3. Charles E. Harris, Michael S. Pritchard, Raw W. James, Elaine E. Englehardt, and Michael J. Rabins, 2019. *Engineering Ethics –Concepts and Cases*, 12th Edition, Cengage Learning.
4. John R Boatright, Jeffery Smith, 2016. *Ethics and the Conduct of Business*, 8th Edition, Pearson Education.
5. Edmund G Seebauer and Robert L Barry, 2001. *Fundamentals of Ethics for Scientists and Engineers*, South Asia Edition, Oxford University Press.

GE1771 PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give a basic idea about the need of management principles in all kinds of organization
- To understand the managerial functions like planning, organizing, staffing, Directing and controlling
- To gain some knowledge about different structures of organization
- To understand the role played by leader in different levels, and to understand the qualities, skills required for the leader while leading a team globally.
- To gain some knowledge about international management.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management - Nature, Scope and Functions of Management - Evolution of Management - Contributions of FW Taylor (14 principles of Management), Henri Fayol, Elton Mayo, Roethilisberger, H.A.Simon and P.F Drucker - Management theories - Science or Art - Manager Vs Entrepreneur - types of managersmanagerial roles and skills - Evolution of Management - Scientific, human relations , system and contingency approaches - Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose - Formal and informal organization - Organization chart - Organization structure - Types - Line and staff authority - Departmentalization - delegation of authority - Centralization and decentralization - Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

UNIT IV DIRECTING 9

Directing meaning-importance-principles of directing - Motivation - Motivation theories - Motivational techniques – Job satisfaction – Job enrichment - Leadership - types and theories of leadership – Communication - Process of communication, types of communication and its uses - Barrier in communication - Effective

Communication – Communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management - Inventory Management - PERT, CPM – Application - Control and performance – Direct and preventive control.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Explain the trends and challenges of management in global scenario, the different types of organization and its effectiveness.

CO2: Utilize the strategies and policies which are involved in planning, Steps involved in the process of planning and use it for decision.

CO3: Identify the structure, purpose, selection and recruitment process in organizations.

CO4: Explain the various motivational theories and processes of management including its functions.

CO5: Compare and contrast the various control techniques.

TEXT BOOKS:

1. Harold Koontz and Heinz Weihrich *Essentials of Management*, Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, *Management*, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009

REFERENCE BOOKS:

1. Robert Kreitner and MamataMohapatra, *Management*, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, *Fundamentals of Management*, Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, *Principles of Management*, Tata McGraw Hill, 1999.

EE1711 POWER SYSTEM SIMULATION LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To provide better understanding of modeling of transmission lines in impedance and admittance forms.
- To apply iterative techniques for power flow analysis.
- To carry out short circuit and stability studies on power system.
- To analyze the load – frequency and voltage controls.
- To analyze optimal dispatch of generators and perform state estimation

LIST OF EXPERIMENTS

1. Computation of Transmission Line Parameters (L and C)
2. Formation of Bus Admittance and Impedance Matrices and Solution of Networks
3. Power Flow Analysis using Gauss-Seidel Method
4. Power Flow Analysis using Newton Raphson Method
5. Symmetric and unsymmetrical fault analysis
6. Transient stability analysis of SMIB System
7. Economic Dispatch in Power Systems
8. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
9. State estimation: Weighted least square estimation
10. Study of PLC and SCADA software

TOTAL: 60 PERIODS

EQUIPMENTS NEEDED (FOR 30 STUDENTS)

S.NO.	NAME OF THE EQUIPMENT	QTY.
1	Personal computers (Intel i3, 80GB, 2GB RAM)	30 Nos.
2	Printer laser	1 No.
3	Dot matrix.	1 No.
4	Server (Intel i5, 80GB, 2GBRAM) (High Speed Processor).	1 No.
5	Software: any power system simulation software	5 users
6	Three Compliers: C, C++, VB, VC++	30 users

OUTCOMES

CO1: Develop a program to compute transmission line parameters (L and C) for given conductor configuration and form form network matrices (Ybus and Zbus) for various power system studies.

CO2: Simulate given power system network using available software and obtain its load flow solution and fault analysis

CO3: Develop model for transient stability analysis and load frequency dynamics.

CO4: Develop a program to obtain optimal unit allocation for a given system demand and state estimation.

CO5: Analyze the electromagnetic transients in the given power system network.

EE1721 **MINI PROJECT**

L	T	P	C
0	0	4	2

OBJECTIVES:

- To develop their own innovative prototype of ideas.
- To train the students in preparing mini project reports and examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

OUTCOMES:

CO1: Identify a potential problem based on literature survey and real time needs.

CO2: Categorize various solution methodologies to solve problem taken for study.

CO3: Design and develop solution for the proposed problem.

CO4: Infer the experimental results based on hardware & software implementation.

CO5: Analyse the results with the existing solutions.

EE1821 **PROJECT WORK**

L	T	P	C
0	0	16	8

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 240 PERIODS

OUTCOMES:

CO1: Identifying a potential problem based on literature survey impending industrial/real time needs.

CO2: Categorizing various solution methodologies to solve problem taken for study.

CO3: Design engineering solutions to complex problems utilising a systematic approach.

CO4: Analyze design/experimental results based on hardware & software implementation.

CO5: Draw conclusion based on analysis and prepare a detailed technical report

EE1731 MODERN POWER CONVERTERS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To gain knowledge about harmonics standards and operation of rectifiers in CCM & DCM
- To demonstrate various analytical skills in power factor correction rectifiers for UPS applications and the operation of resonant converters for SMPS applications.
- To introduce the source current shaping methods for rectifiers and carry out dynamic analysis of DC-DC converters

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS 9

Average power-RMS value of waveform–Effect of Power factor-. current and voltage harmonics - Effect of source and load impedance - AC line current harmonic standards

IEC1000-IEEE 519-CCM and DCM operation of single phase full wave rectifier- Behavior of full wave rectifier for large and small values of capacitance - CCM and DCM operation of three phase full wave rectifier- 12 pulse converters - Harmonic trap filters.

UNIT II PULSE WIDTH MODULATED RECTIFIERS 9

Properties of Ideal single phase rectifiers-Realization of nearly ideal rectifier -. Single-phase converter systems incorporating ideal rectifiers - Losses and efficiency in CCM high quality rectifiers - single-phase PWM rectifier - PWM concepts - device selection for rectifiers - IGBT based PWM rectifier, comparison with SCR based converters with respect to harmonic content - applications of rectifiers.

UNIT III RESONANT CONVERTERS 9

Soft Switching - classification of resonant converters - Quasi resonant converters-basics of ZVS and ZCS - half wave and full wave operation (qualitative treatment) - multi resonant converters - operation and analysis of ZVS and ZCS multi resonant converter - zero voltage transition PWM converters - zero current transition PWM converters

UNIT IV DYNAMIC ANALYSIS OF SWITCHING CONVERTERS 9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter and an ideal Cuk Converter. Pulse Width modulation - Voltage Mode PWM Scheme - Current Mode PWM Scheme - design of PI controller.

UNIT V SOURCE CURRENT SHAPING OF RECTIFIERS 9

Need for current shaping - power factor - functions of current shaper - input current shaping methods - passive shaping methods -input inductor filter - resonant input filter - active methods - boost rectifier employing peak current control - average current control – Hysteresis Control - Nonlinear carrier control.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply the concept of various types of rectifiers in harmonic analysis.

CO2: Describe the various PWM techniques used in converters.

CO3: Develop a simulation model of different types of resonant converters.

CO4: Discuss on the dynamic analysis of switching converters.

CO5: Explain the need and functions of Source current shaping rectifiers.

TEXT BOOK:

1. Robert W. Erickson and Dragon Maksimovic, *Fundamentals of Power Electronics*, Second Edition, Springer science and Business media, 2001.

REFERENCE BOOKS:

1. William Shepherd and Li zhang, *Power Converters Circuits*, MarceldEkkerin,C, 2005.
2. Simon Ang and Alejandro Oliva, *Power Switching Converters*, Taylor & Francis Group, 2010.
3. Andrzej M. Trzynadlowski, *Introduction To Modern Power Electronics*, John Wiley & Sons, 2016.
4. Marian.K.Kazimierczuk and DariuszCzarkowski, *Resonant Power Converters*, John Wiley & Sons limited, 2011.

5. Keng C .Wu, *Switch Mode Power Converters – Design and Analysis* Elseveir academic press, 2006.
6. Abraham I.Pressman, Keith Billings and Taylor Morey, *Switching Power Supply Design* McGraw-Hill ,2009.
7. V.Ramanarayanan, *Course Material on Switched Mode Power Conversion* IISC, Banglore, 2007.
8. Christophe P. Basso, *Switch-Mode Power Supplies*, McGraw-Hill ,2014.

EE1732 **NANO TECHNOLOGY**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the evolution, uniqueness and basics of nanomaterial science.
- To learn about preparation method, types, properties and application of nanomaterials.

UNIT I INTRODUCTION 9

Background to nano Science and Technology - scientific revolutions - basic principles of nano scale materials - Comparison with bulk materials, Classification of Nanomaterials: zero, one, two, and three dimensional nanostructures and its nature – Surface area and aspect ratio, Length scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal.

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis - Physical vapour Deposition – Chemical vapour Deposition - Atomic Layer Deposition - Molecular Beam Epitaxy - liquid phase methods - colloidal and sol gel methods - methods for templating the growth of nanomaterials – ordering of nano systems - self-assembly - Top-down Approach: Mechanical Milling, Dry etching, Lithography.

UNIT III NANOMATERIALS 9

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis (arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides - ZnO, TiO_2, MgO, nano alumina, CaO, Nano clays functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9

Characterisation Techniques: X-ray diffraction Technique - Scanning Electron Microscopy - Atomic Force Microscopy - Spectroscopy techniques: - Fourier Transform Infrared Spectroscopy - Raman spectroscopy - Ultraviolet-visible Spectroscopy- surface analysis and depth profiling - Luminescence: Photoluminescence - Thermoluminescence.

UNIT V APPLICATIONS 9

NanoInfoTech: Information storage - nanocomputer, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Nano Electro Mechanical Systems (NEMS) - Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery - Nano materials in communication - Case studies of nanobased PV System and Electrical Machineries.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Describe the background, basic principles, properties and classification of nano materials.

CO2: Demonstrate the preparation of nano materials using various methods.

CO3: Choose appropriate nanomaterial for a given specific applications

CO4: Characterize the nano materials using various techniques.

CO5: Illustrate the application nano materials in various systems.

TEXT BOOKS:

1. Edelstein, A.S. and Cammearata, R.C., 1996. *Nanomaterials: Synthesis, Properties and Applications.* Institute of Physics Publishing, Bristol and Philadelphia.

REFERENCE BOOKS:

1. John Dinardo, N., 2000. *Nanoscale Charecterisation of surfaces & Interfaces*. 2nd edition, Wiley-VCH.
2. Timp, G., 1999. *Nanotechnology*. AIP press/Springer.
3. Akhlesh Lakhtakia, 2007. *The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations*. Prentice-Hall of India (P) Ltd, New Delhi.
4. Koch C, 2008. *Nanostructured materials: processing, properties and applications*. William Andrew Publication.
5. Guozhong Cao, 2011. *Nanostructures and nanomaterials: Synthesis, properties and applications.* Imperial College Press.
6. Charles P. Poole, Jr., Frank J. Owens, 2008. *Introduction to Nanotechnology*. John Wiley and Sons Publishers.

EE1733 **SMART GRID**

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge about the following topics:

- Importance of Smart Grid over conventional grid and various international policy frame work in Smart Grid.
- Smart Grid technologies, different smart meters and advanced metering infrastructure.
- The high performance computing for Smart Grid applications.

UNIT I INTRODUCTION TO SMART GRID **9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES- TRANSMISSION SYSTEMS **9**

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: phasor measurement units, Wide area monitoring, Protection and control.

UNIT III SMART GRID TECHNOLOGIES- DISTRIBUTION SYSTEMS **9**

DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Demand Response Management, Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE **9**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS **9**

Local Area Network(LAN),House Area Network(HAN), Wide Area Network(WAN),

Broad band over Power line(BPL),IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Compare the benefits of smart grid over conventional electric grid.

CO2: Describe the automation features involved in transmission systems of smart grid network.

CO3: Exemplify the various smart grid technologies incorporated in distribution system.

CO4: Explain the operation of smart meters and various intelligent electronic devices.

CO5: Elucidate the concept of high performance computing and cyber security in smart grid application.

TEXT BOOKS:

1. Keyhani, A. and Albaijat, M. eds., 2012. *Smart power grids 2011*. Springer Science & Business Media.
2. Momoh, J.A., 2012. *Smart grid: fundamentals of design and analysis* (Vol. 63). John Wiley & Sons.

REFERENCE BOOKS:

1. Borlase, S. ed., 2016. *Smart grids: infrastructure, technology, and solutions*. CRC press.
2. Ekanayake, J.B., Jenkins, N., Liyanage, K., Wu, J. and Yokoyama, A., 2012. *Smart grid: technology and applications*. John Wiley & Sons.
3. Berger, L.T. and Iniewski, K., 2012. *Smart grid applications, communications, and security*. John Wiley & Sons.

EE1734 SOFT COMPUTING TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To illustrate the basics of artificial neural network and various algorithms.
- To apply the concepts of neural network to model a given system.
- To discuss the concept of fuzzy logic and its associated terms.
- To apply fuzzy logic to model a given system.
- To analyse the features of hybrid control schemes.

UNIT I ARTIFICIAL NEURAL NETWORK 9

Review of fundamentals - Biological neuron, artificial neuron, activation function, single layer perceptron - Limitation - Multi layer perceptron - Back Propagation Algorithm (BPA) - Recurrent Neural Network (RNN) - Adaptive Resonance Theory (ART) based network – Radial basis function network - online learning algorithms, BP through time – RTRL algorithms – Reinforcement learning.

UNIT II NEURAL NETWORKS FOR MODELING AND CONTROL 9

Modelling of non-linear systems using ANN - Generation of training data - Optimal architecture - Model validation - Control of non-linear systems using ANN - Direct and indirect neuro control schemes - Adaptive neuro controller - Familiarization with neural network toolbox- Neural Network based controller.

UNIT III FUZZY SET THEORY 9

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, cylindrical extension, fuzzy relation - Fuzzy membership functions.

UNIT IV FUZZY LOGIC FOR MODELING AND CONTROL 9

Modelling of non-linear systems using fuzzy models - TSK model - Fuzzy logic controller - Fuzzification - Knowledge base - Decision making logic - Defuzzification - Adaptive fuzzy systems - Familiarization with fuzzy logic toolbox - Fuzzy logic applications.

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN - Neuro fuzzy systems - ANFIS - Fuzzy neuron - GA - Optimization of membership function and rule base using Genetic

Algorithm - Introduction to other evolutionary optimization techniques, support vector machine - Case study - Familiarization with ANFIS toolbox - Applications of hybrid systems to engineering problems.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Describe the fundamentals of ANN and various types of networks and their algorithms.

CO2: Design ANN controller for the given non-linear system.

CO3: Interpolate the basic concepts involved in fuzzy logic & various terminologies.

CO4: Control and model fuzzy logic for a given system.

CO5: Design and analyse hybrid control system for simple applications.

TEXTBOOKS:

1. Sivanandam, S.N. and Deepa, S.N., 2007. *Principles of soft computing (with CD)*. John Wiley & Sons.

REFERENCE BOOKS:

1. Laurence Fausett, *Fundamentals of Neural Networks,* Prentice Hall, Englewood Cliffs, N.J., 1992
2. Timothy J. Ross, *Fuzzy Logic with Engineering Applications,* McGraw Hill Inc., 2000.
3. Goldberg, *Genetic Algorithm in Search, Optimization and Machine learning*, Addison Wesley Publishing Company Inc. 1989
4. Millon W.T., Sutton R.S. and Webrose P.J., *Neural Networks for Control*, MIT press, 1992
5. Zhang Huaguang and Liu Derong, *Fuzzy Modeling and Fuzzy Control Series: Control Engineering*, 2006
6. Ethem Alpaydin, *Introduction to Machine learning (Adaptive Computation and Machine Learning series)*, MIT Press, Second Edition, 2010.

EE1735 **UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To discuss on various electric drives and traction motors with applications
- To introduce the energy saving concept by different ways of illumination.
- To understand the different methods of electric heating and electric welding.
- To describe the conservation of electrical power and energy efficient equipments.
- To outline on the domestic wiring connections and faults debugging.

UNIT I TRACTION **9**

Merits of electric traction - requirements of electric traction system - supply systems, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - train movement and energy consumption - traction motor control - track equipment and collection gear- electric braking- recent trends in electric traction.

UNIT II ILLUMINATION **9**

Introduction - definition and meaning of terms used in illumination engineering - photometry -classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – LED lighting and energy efficient lamps.

UNIT III HEATING AND WELDING **9**

Introduction - advantages of electric heating - modes of heat transfer - Role of electric heating for industrial applications -methods of electric heating- resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – resistance welding - arc welding - radiation welding- welding generator, welding transformer.

UNIT IV REFRIGERATION AND AIR CONDITIONING **9**

Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Various types of air-conditioning system and their applications, smart air conditioning units - Energy Efficient motors: Standard motor efficiency, need for efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor.

UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 9

Domestic utilization of electrical energy - House wiring. Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects - nonlinear and domestic loads – Earthing – Domestic, Industrial and Substation.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Realize the appropriate type of electric supply system and evaluate the performance of a traction unit.

CO2: Design the different schemes of illumination for energy saving.

CO3: Identify appropriate method of heating and welding for a given industrial application.

CO4: Interpret the conservation of electrical power and energy efficient equipments.

CO5: Construct an electric connection for any domestic appliance like refrigerator and design a battery charging circuit for a specific household application.

TEXTBOOKS:

1. Suryanarayana, N.V., 1994. *Utilisation of electric power: Including electric drives and electric traction*. New Age International

REFERENCE BOOKS:

1. Wadhwa, C.L., 1989. *Generation, distribution and utilization of electrical energy*. New Age International.
2. Gupta, J.B., 2000. *Utilisation Electric power and Electric Traction*, S.K.Kataria and sons
3. Partab.H, 2004. *Art and Science of Utilisation of Electrical Energy*, DhanpatRai and Co, New Delhi,
4. Energy Efficiency in Electric Utilities, BEE Guide Book, 2010.

EE1736 DATA SCIENCE FOR ELECTRICAL ENGINEERS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To explain Data Analytics Life Cycle and Business Challenges
- To discuss on the Analytical Techniques and Statically Models
- To comprehend Statically Modeling Language.

UNIT I INTRODUCTION TO BIG DATA 9

Business Intelligence, Decision Support Systems, Data Warehousing; Definition of Big Data, Big data characteristics & considerations, Introduction to Hadoop

UNIT II BIG DATA ANALYTICS 9

Big data analytics, Drivers of Big data analytics, Big Data Stack, Typical analytical architecture, Virtualization & Big Data, Virtualization Approaches, Business Intelligence Vs Data science, Big data analytics in Smart Grid.

UNIT III DATA ANALYTICS LIFECYCLE 9

Need of Data analytic lifecycle, Key roles for successful analytic projects, various phases of Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalization, Data Analytic in Power System.

UNIT IV MACHINE LEARNING: SUPERVISED LEARNING 9

Machine Learning, Applications of Machine Learning; Supervised Learning: Structure of Regression Model, Linear Regression, Logistics Regression, Time series analysis, Support Vector Machine, Analysis of power consumption.

UNIT V CLASSIFICATION & UNSUPERVISED LEARNING 9

Classification Problem, Classification Models, Classification Trees, Bayesian Method; Association Rule: Structure of Association Rule, Apriori Algorithm, General Association; Clustering: Clustering Methods, Partition Methods, Hierarchical Methods and Applications of Unsupervised learning in Electrical Engineering, identifying malfunctions in transmission and distribution.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Deploying the Data Analytics Lifecycle to address big data analytics projects

CO2: Reframing a business challenge as an analytics challenge.

CO3: Illustrate appropriate analytic techniques and tools to analyze big data, create statistical models, and identify insights that can lead to actionable results

CO4: Selecting appropriate data visualizations to clearly communicate analytic insights to business sponsors and analytic audiencessss

CO5: Explain how advanced analytics can be leveraged to create competitive advantage.

TEXT BOOKS:

1. David Dietrich, Barry Hiller, *Data Science & Big Data Analytics*, EMC education services, Wiley publications, 2012
2. Roy, S.S., Samui, P., Deo, R. and Ntalampiras, S. eds., 2018. *Big data in engineering applications* (Vol. 44). Berlin/Heidelberg, Germany: Springer.
3. Khalid, S. ed., 2017. *Applied Computational Intelligence and Soft Computing in Engineering*. IGI Global.

REFERENCE BOOKS:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning*, Springer, Second Edition, 2011.
2. Mulrennan, K., Donovan, J., Tormey, D. and Macpherson, R., 2018, October. *A Data Science Approach to Modelling a Manufacturing Facility's Electrical Energy Profile from Plant Production Data*. In *2018 IEEE 5th International Conference on Data Science and Advanced Analytics (DSAA)* (pp. 387-391). IEEE.
3. King, S.O., 2019, April. *How electrical engineering and computer engineering departments are preparing undergraduate students for the new big data, machine learning, and AI paradigm: A three-model overview*. In *2019 IEEE Global Engineering Education Conference (EDUCON)* (pp. 352-356). IEEE.
4. Chen, R., 2019, February. *Application of intelligent technology in electrical engineering automation*. In *AIP Conference Proceedings* (Vol. 2073, No. 1, p. 020066). AIP Publishing LLC.

5. Zhang, Y., Ma, J., Zhang, J. and Wang, Z., 2009. *Applications of data mining theory in electrical engineering.* Engineering, *1*(3), p.211.
6. Masone, A., Dal Sasso, V. and Morandi, V., *Optimization and Data Science: Trends and Applications.*
7. Leonowicz, Z. and Jasinski, M., 2022. *Machine Learning and Data Mining Applications in Power Systems*. Energies, *15*(5), p.1676.

EE1737 **HIGH VOLTAGE ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To explain over voltage phenomenon and insulation coordination in electrical power systems.
- To impart knowledge on breakdown mechanisms of different dielectrics
- To discuss about high voltage and high current generation techniques
- To understand the different measurements techniques of high voltages & currents
- To describe on conduct of dielectric tests on various electrical equipment and safety precautions in HV Labs.

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS **9**

Introduction to High voltage AC / DC system – Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages – Estimation of over voltages- Reflection and Refraction of Travelling waves- Bewley lattice diagram -Protection against over voltages. Insulation Coordination.

UNIT II DIELECTRIC BREAKDOWN **9**

Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipments.

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS **9**

Generation of High DC voltage: Rectifiers, voltage multipliers, vandigraff generator-generation of high AC voltages: cascaded transformers, resonant transformer and tesla coil -generation of high impulse voltage: single and multistage Marx circuits – generation of switching surges – generation of impulse currents - Triggering and control of impulse generators.

UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS **9**

High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.

UNIT V HIGH VOLTAGE TESTING OF EQUIPMENT AND HIGH VOLTAGE LABORATORY PRACTICES 9

High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, bushing, isolators, circuit breakers and transformers, high voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H.V. Labs.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Comprehend the causes and effects of over voltages in power system and devise appropriate protection scheme.

CO2: Summarize the different breakdown mechanisms in solid, liquid and gaseous dielectrics.

CO3: Organize the diverse generation methods of high voltages and currents.

CO4: Analyze the various measurement techniques of high voltages and high currents.

CO5: Interpret the high voltage testing procedures of electrical power apparatus and laboratory practices.

TEXT BOOK:

1. Naidu, M.S., and NAIDU, M.K., 2013. *High voltage engineering*. Tata McGraw-Hill Education.

REFERENCE BOOKS:

1. Kuffel, J. and Kuffel, E., 2000. *High voltage engineering fundamentals*. Elsevier.
2. Wadhwa C.L, 2010. *High voltage Engineering*, New Age International Publishers.
3. Rakosh Das Begamudre, 2010. *High Voltage Engineering*, Problems and Solutions, New Age International Publishers, New Delhi.
4. Hugh M. Ryan, 2001. *High Voltage Engineering and Testing*, 2nd edition, The Institution of Electrical Engineers, London, United Kingdom.
5. Ryan, H.M. ed., 2001. *High voltage engineering and testing* (No. 32). Iet.
6. Various IS standard for HV Laboratory Techniques and Testing.

EE1738 INTRODUCTION TO INDUSTRIAL AUTOMATION

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on

- To give an overview of the automation technologies such as PLCs, SCADA and DCS used in industries.
- To provide a fundamental understanding of the different languages used for PLC Programming
- To provide insight into some of the advanced principles those are evolving for present and future automation.

UNIT I PLC & SCADA 9

PLC: Evolutions of PLCs – Programmable Controllers – Architecture, I/O modules – Comparative study of Industrial PLCs. SCADA: Remote terminal units- Master station - Communication architectures.

UNIT II BASICS OF PLC PROGRAMMING(LADDER) 9

Basics of PLC programming – Ladder Logic – Relay type instructions – Timer/Counter instructions – Program control instructions – Data manipulation and math instructions – Programming Examples

UNIT III PLC PROGRAMMING (OTHER LANGUAGES) 9

Functional block programming - Sequential function chart – Instruction list – Structured text programming – PLC controlled sequential Process Examples.

UNIT IV DISTRIBUTED CONTROL SYSTEM 9

DCS: Evolution & types – Hardware architecture – Field control station – Interfacing of conventional and smart field devices (HART and FF enabled) with DCS Controller – Communication modules – Operator and Engineering Human interface stations – Case Study-Siemens DCS.

UNIT V ADVANCED TOPICS IN AUTOMATION 9

Introduction to Networked Control systems – Plant wide control – Internet of things – Cloud based Automation – OLE for Process Control – Safety PLC – Case studies: PLC – SCADA

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Describe basic automation components and systems in PLC/SCADA

CO2: Develop programs for simple applications using Ladder Programming

CO3: Illustrate the different paradigms available for programming a PLC Unit

CO4: Explain the basic architecture of DCS and its types

CO5: Discuss on the recent developments in industrial automation with Case Studies

TEXT BOOK:

1. F.D. Petruzella, *Programmable Logic Controllers*, Tata Mc-Graw Hill, Third edition, 2010

REFERENCE BOOKS:

1. Michael P. Lukas, *Distributed Control Systems: Their Evaluation and Design*,Van Nostrand Reinhold Co., 1986
2. D. Popovic and V.P.Bhatkar, *Distributed computer control for industrial Automation*, Marcel Dekker, Inc., Newyork , 1990.

EE1739	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To describe the principle of generation of different renewable energy sources.
- To model the electrical machines used for renewable energy conversion systems.
- To explain the power converters used for renewable energy systems.
- To describe the operation of standalone and grid integrated renewable energy systems.
- To explain the hybrid operation of wind and PV systems and features of MPPT tracking.

UNIT I INTRODUCTION **9**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) –Qualitative study of different renewable energy resources: Geothermal, Ocean(wave, Tidal, OTECS), Solar, Wind and Biomass.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEM **9**

Construction and Working Principle of: Permanent Magnet Synchronous Generator, Squirrel Cage Induction Generator and Doubly Fed Induction Generator. Block diagram of WECS (SCIG, DFIG and PMSG).

UNIT III POWER CONVERTERS FOR RENEWABLE ENERGY APPLICATIONS **9**

Solar: Line commutated converters (inversion-mode) - Boost and buck-boost converters-Bidirectional converter- selection of inverter, battery sizing, array sizing.

Wind: Three phase AC voltage controllers- Bidirectional converter- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, 1 phase and 3 phase Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS **9**

Standalone operation of fixed and variable speed wind energy conversion systems - Grid integrated PMSG, SCIG & DFIG Based WECS, Standalone and grid Integrated solar system- Grid connection Issues.

UNIT V MODERN RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV, Maximum Power Point Tracking (PSO & IC).

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Outline the various renewable energy generation and impacts of renewable energy generation onenvironment.

CO2: Interpret and model the various Electrical machines used in Renewable Energy Conversion.

CO3: Elucidate various power converters used in Solar PV System and Wind Energy Conversion Systems.

CO4: Analyse the performance of standalone/grid connected PV system and WECS

CO5: Illustrate Hybrid renewable Energy systems with suitable Case studies.

TEXT BOOK:

1. S. N. Bhadra, D.Kastha, S.Banerjee, *Wind Electrical Systems*, Oxford University Press 2005.

REFERENCE BOOKS:

1. Rashid .M. H *power electronics Hand book,* Academic press, 2001.
2. Ion Boldea, *Variable speed generators*, Taylor & Francis group, 2006.

EE1740 RESTRUCTURED POWER SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the restructuring and deregulation of power sector in different countries
- To introduce the fundamental concepts relevant to OASIS and various operation in power market.
- To enable the students to understand the factors related with ATC, Pricing and Congestion Management

UNIT I POWER SYSTEM RESTRUCTURING: AN OVERVIEW 9

Introduction to various institutions in Indian Power sector: Ministry of Power, Planning Commission, CEA, central utilities, state utilities, PGCIL, PFC, state and central governments, REC, ERCs, Traders, SO, LDCs, Power Exchanges, and their roles, Electricity act 2003 Deregulation-International Scenario-Milestones of Deregulation in the World -Indian Power Sector: Past and Present status -Growth of Power Sector in India-Research and Professional Bodies

UNIT II OPERATIONS IN POWER MARKET 9

A Time Line of the Indian Power Sector-Players in the Indian Power Sector Power pools explanation of power pool operation with multi-utility test systems-OASIS-Single Auction Power Pool Example-Double Auction Power Pool Example-Transmission networks and Electricity markets-Operations in power market using Power World Simulator

UNIT III AVAILABLE TRANSFER CAPABILITY 9

Introduction-Definitions –Principles-Methods of Static ATC Determination-ATC Determination considering the effect of Contingency Analysis-ATC calculation using Power World Simulator- Senstivity of Network Uncertainties on ATC Determination

UNIT IV TRANSMISSION OPEN ACCESS AND PRICING 9

Transmission Open Access-Cost Components Of Transmission System - Transmission Pricing Methods-Postage stamp method-Contract path method-MW-Mile Method-Marginal Participation (MP) Method-Incremental Cost Based Transmission Pricing-Formulation-Unit commitment in restructuring (profit based or price based)

UNIT V TRANSMISSION CONGESTION MANAGEMENT 9

Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management–Classification of congestion management methods-Cluster/Zone based Approach

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Identify various institutions of Power sector in India, and Relate the concepts of deregulation in world.

CO2: Describe important concepts related with deregulation such as market power, OASIS, power pools and Auction.

CO3: Determine the Available Transfer Capability under different contingencies

CO4: Estimate the pricing for Transmission system by applying various methods.

CO5: Relate Congestion management with ATC and Analyze the various congestion management methods.

TEXT BOOK:

1. Shahidehpour, M. and Alomoush, M., 2017. *Restructured electrical power systems: Operation: Trading, and volatility* (Vol. 1). CRC Press

REFERENCE BOOKS:

1. Bhattacharya, K., Bollen, M.H. and Daalder, J.E., 2012. *Operation of restructured power systems*. Springer Science & Business Media.
2. https://www.iexindia.com/
3. https://mnre.gov.in/

OEE171 BATTERY MANAGEMENT SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on basics of energy storage systems, various parameters relevant to batteries
- To realize the fundamentals of advanced batteries, super capacitors and fuel cells
- To inferring about battery charging and charge controllers
- To discuss on Battery Management Systems (BMS)

UNIT I INTRODUCTION TO BATTERIES 9

Construction and working of Basic Electrochemical cell& Batteries –Theoretical cell voltage and capacity-Losses in a cell-Battery parameters: Battery capacity, Battery Voltage, Depth of discharge-Battery life cycle-Discharge/charge rate - Classification of Batteries-Constructions and working principle of Lead Acid battery – Advances in lead-acid batteries

UNIT II ADVANCED ENERGY STORAGE BATTERIES 9

Principle of operation, components & design, Electrode, cell and battery fabrications& Applications of Li-ion batteries, Nickel Cadmium batteries, Nickel Metal Hydride Battery, Ni-Hydrogen batteries, Super capacitors

UNIT III FUEL CELLS 9

Introduction-Advantages-Applications-Classification of fuel cells- Construction and working of Phosphoric Acid fuel cell-Alkaline Fuel cell-Polymer Electrolyte Membrane Fuel cell-Fuels for Fuel Cells-Efficiency of Fuel cell-VI characteristics of Fuel Cell

UNIT IV BATTERY CHARGING AND CHARGE CONTROLLERS 9

Factors affecting battery performance - Factors affecting Choice of a battery-Battery charging and discharging methods - Charge controllers for stand-alone PV system-Types of charge controllers for stand-alone PV system: Shunt type, Series type, DC-DC converter type, MPPT charge controller –Power stage and control scheme for battery charging using DC-DC converter-Flow chart for battery charging

UNIT V BATTERY MANAGEMENT SYSTEMS (BMS) 9

Fundamentals of battery management systems and controls - Battery Thermal Management - Passive cooling – PCM systems, Active cooling – Liquids & air

systems - Regulations and Safety Aspects of High Voltage Batteries, Code and Standards, Safe handling of Lithium Batteries, Safety of high voltage devices

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Describe construction and working of various types of commonly used batteries

CO2: Describe principle of operation & design of advanced energy storage batteries

CO3: Identify the basics for using fuel cells for power storage and production applications.

CO4: Infer the performance of battery charge controllers and their applications.

CO5: Summarize battery management systems, active and passive thermal management systems & safety aspects of high voltage devices.

TEXT BOOK:

1. Khan B.H.,*Non-Conventional Energy Resources*, Tata McGraw Hill Publication, 2nd Edition, 2009.

REFERENCE BOOKS:

1. Sandeep Dhameja, *Electric Vehicle Battery Systems*, Elsevier Science,2001
2. H. A. Kiehne, *Battery Technology Handbook*, Marcel Dekker, NYC, 2003

OEE172 **ELECTRIC VEHICLES**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide the fundamental concepts, principles, analysis and design of electric vehicles.
- To realize the importance of electric transportation systems.
- To describe the basics of electric vehicle components and configuration.
- To describe the various energy storage methods used in EVs.

UNIT I INTRODUCTION TO ELECTRIC VEHICLES 9

History of electric vehicles - Introduction to EVs- Types of EVs -BEV, HEV, PEV, FCEV-social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

UNIT II ELECTRIC DRIVE-TRAINS 9

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

UNIT III ELECTRIC PROPULSION UNIT 9

Introduction to electric components used in hybrid and electric vehicles, Configuration and control- DC Motor Drives, Induction Motor drives, Permanent Magnet Drives, Switched Reluctance Drives.

UNIT IV ENERGY STORAGE AND SIZING 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy Storage and Analysis- Battery, Fuel, Super Capacitor, Hybridization of different energy storage devices, Power Electronic Converter for Battery Charging Sizing- Propulsion motor, Power Convertors, Energy Storage.

UNIT V CONTROL SYSTEM FOR ELECTRIC AND HYBRID VEHICLE 9

Function of the Control System in HEVs and EVs-Different Operational Modes-Overview of Control System-Control Variables-Principle of Rule based Control

Methods for ECU Design-State Machine based ECU Design- Fuzzy Logic Based Control System- Case study of torque control and battery recharging control based on fuzzy Logic.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the modeling and operation of various types of electric vehicle.

CO2: Explicate the different drive train topologies and power flow control in electric vehicles.

CO3: Choose a suitable drive scheme for developing an electric hybrid vehicle depending on available resources

CO4: Identify suitable energy storage system and power electronic converter for battery sizing in design of EVs

CO5: Design and develop basic controlling scheme for electric vehicles and hybrid electric vehicles.

TEXT BOOK:

1. Husain, I., 2011. *Electric and hybrid vehicles: design fundamentals*. CRC press.

REFERENCE BOOKS:

1. Gay, S.E., Gao, Y., Ehsani, M. and Emadi, A., 2004. *Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design*. CRC press.
2. Larminie, J. and Lowry, J., 2012. *Electric vehicle technology explained*. John Wiley & Sons.

OEE173 **ELECTRICAL SAFETY**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on statutory requirements for electrical safety
- To outline the concept of various protection systems and the importance of earthing
- To explain the various hazardous zones and applicable fire proof electrical devices
- To achieve an understanding of principles of safety management.

UNIT I INTRODUCTION 9

Introduction – current, voltage, resistance, electrostatics, electro magnetism, stored energy, energy radiation-Ionizing and Non-ionizing radiation- Electromagnetic interference-Indian Electricity act and rules-statutory requirements from electrical inspectorate

UNIT II ELECTRICAL HAZARDS 9

Primary and secondary hazards - shocks, burns, scalds, falls - Human safety in the use of electricity - Classes of insulation-voltage classifications -current surges- over current and short circuit current-heating effects of current-electrical causes of fire and explosion- First aid-cardio pulmonary resuscitation (CPR)

UNIT III PROTECTION SYSTEMS 9

Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage –safe distance from lines - overload and short circuit protection. Earth leakage circuit breaker (ELCB)-Lightning hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance- Personal protective equipment

UNIT IV HAZARDOUS ZONES 9

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification- use of barriers and isolator-Permit to work

UNIT V SAFETY MANAGEMENT 9

Importance of safety education and training-identification of training needs-training methods – programmes, seminars, conferences, competitions - Components of

safety audit, types of audit, audit methodology, non-conformity reporting (NCR), audit checklist and report – review of inspection and maintenance of safety records-safety committee-roles and responsibilities.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Explain the statutory requirements related to electrical safety.

CO2: Explain the basic concepts in usage of electricity and hazards involved in it.

CO3: Describe the operation of various protection systems and types of personal protective equipment

CO4: Recognize different hazardous zones in Industries and work permit system

CO5: Describe the importance of safety education and carry out safety audit.

TEXT BOOK:

1. Rao .S,*Electrical Safety Fire Safety Engineering and Safety Management*, Khanna Publications, 2nd Edition, 2012.

REFERENCE BOOKS:

1. Fordham Cooper, W., *Electrical Safety Engineering* Butterworth and Company, London, 2006.
2. Indian Electricity Act and Rules, Government of India.
3. *Power Engineers – Handbook of TNEB*, Chennai, 2009.

OEE174 ENERGY CONSERVATION AND MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To interpret and analyse the energy data of industries.
- To carryout energy accounting and balancing.
- To conduct energy audit and suggest methodologies for energy saving.
- To identify the optimal utilization of available resources.

UNIT I INTRODUCTION 9

Energy - Power – Past & Present scenario of World; National Energy consumption Data –Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers- Instruments for energy auditing.

UNIT II ELECTRICAL SYSTEMS 9

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III THERMAL SYSTEMS 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam utilization, Insulators & Refractories.

UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – Distributed Generation.

UNIT V ECONOMICS 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Discuss on energy and power Scenario in the world and the process of energy auditing.

CO2: Discuss the operations of various components and apparatus of Electrical System in the context of energy saving.

CO3: Summarize the electrical utilization of thermal systems used for various applications.

CO4: Outline the energy conservation techniques in electrical utilities.

CO5: Discuss the concepts of Economics of Electrical Energy.

TEXT BOOK:

1. Witte, L.C., Schmidt, P.S. and Brown, D.R., 1988. *Industrial energy management and utilization*.

REFERENCE BOOKS:

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. O'Callaghan, P.W., 1981. *Design and Management for Energy Conservation*: *A Handbook for Energy Managers, Plant Engineers, and Designers*. Pergamon Press.
3. Dryden, I.G.C. ed., 2013. *The efficient use of energy*. Butterworth-Heinemann.
4. Doty, S. and Turner, W.C., 2004. *Energy management handbook*. Crc Press.
5. Murphy. W.R. and G. Mc KAY, *Energy Management*, Butterworths, London 1987.

OEE175 WIRING ESTIMATION AND COSTING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on Wires and types and installation
- To disseminate the selection of Fuse, MCB, ELCB, RCBO, Electrical Control Panels
- To familiarize the estimation and costing procedure for internal and external wiring systems.

UNIT I INTRODUCTION 9

Wires, Wire Splicing and Termination, Types and Installation of Wiring Systems, Lighting Accessories. Electrical Symbols.

UNIT II PROTECTIVE DEVICES 9

Introduction, Protective devices used in Residential, Commercial and Industrial buildings for protection of wiring system, Fuse, MCB, MCCB, ELCB/RCCB, RCBO, SPD.

UNIT III INTERNAL WIRING SYSTEM AND LAMP CIRCUITS 9

Design and drawing of Internal wiring system for various types of Residential, Commercial and Industrial buildings, Electrical layout, Different types of circuits, Light circuit, Power circuit, Sub-main wiring, Main wiring, Single Line diagram. Load Calculations for internal wiring system.

UNIT IV EXTERNAL WIRING SYSTEM 9

Introduction, Different types of Under Ground (UG) Cables, Cable Laying, Electrical Control Panels, Feeder Pillar, External Electrical Distribution System, Single Line Diagram, Load Calculations for external wiring system, General Specifications of Generator and Transformer.

UNIT V ESTIMATING AND COSTING 9

Introduction, Estimating and Costing of Internal and External Wiring System (a) based upon actual measurement and prevailing market rate and rate analysis (b) based upon Government Schedule of rates

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Describe the types and installation of Electrical wiring system.

CO2: Discuss on various protective devices used in Residential, Commercial and Industrial buildings

CO3: Design internal wiring system for various types of Residential, Commercial and Industrial buildings.

CO4: Design and analyze the various equipment used in external wiring system.

CO5: Prepare an estimate of internal / external wiring system for a given case study.

TEXT BOOK:

1. Alagappan N. & Ekambaram S., 2019. *Electrical Estimating and Costing*. Tata McGraw Hill.

REFERENCE BOOKS:

1. Uppal S. L. & Garg G C., 2010. *Electrical Wiring, Estimating and costing*. Khanna publishers.
2. Gupta, J.B., 2012. *A course in Electrical Installation Estimating and Costing*, S.K. Kataria and Sons.
3. Raina, K.B. and Battacharya, K., 2012. *Electrical Design Estimating and Costing,* New age Internationals Pvt. Ltd.
4. Surjit Singh., 2016. *Electrical Estimating and costing.* DhanpatRai Company.
5. Arora B. D., 2019. *Electrical Wiring, Estimating and Costing.* R.B. Publication.
6. Sergent, J.S., Coach, C.D. and Roux, R.J., 2011. *National electrical code handbook*. NFPA.