GURU KASHI UNIVERSITY

Master of Technology in Electrical Engineering

Session : 2023-2024

Department of Electrical Engineering

GRADUATE OUTCOME OF THE PROGRAMME

Graduates of Electrical Engineering programs should have a deep understanding of electrical principles and their applications. They should be able to design, analyze, and troubleshoot electrical systems and components which help them to have strong analytical and problem-solving skills to identify and solve complex engineering problems. Therefore, graduates should be able to work effectively in teams and contribute their expertise to achieve project goals.

PROGRAMME LEARNING OUTCOMES

After completion of the course, M.Tech Electrical Engineering graduates will have ability to:

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 analysis 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.

Course Structure
Program: Master of Technology in
Electrical Engineering

Semester: I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
MEE101	Energy Management and Energy Audit	Compulsory Foundation	4	0	0	4
MEE102	Advanced Power System Analysis	Core Course	4	0	0	4
MEE103	Renewable Energy System	Core Course	4	0	0	4
MEE104	Renewable Energy System Laboratory	Skill Based	0	0	4	2
Elective-I (Any one of the following)						
MEE105	Power System Dynamics-I	Discipline Elective	3	0	0	3
MEE106	Power System Operation and Control					
MEE107	Dynamics of Electrical Machines					
Elective-II (Any one of the following)						
MEE108	Electrical Power Distribution System	Discipline Elective	3	0	0	3
MEE109	Smart Grids					
MEE110	Pulse Width Modulation for Power Electronics Converters					
Total			**18**	**0**	**4**	**20**

Semester: II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
MEE201	Digital Protection of Power System	Core Course	3	0	0	3
MEE202	Restructured Power Systems	Core Course	3	0	0	3
MEE203	Power System Planning	Core Course	3	0	0	3
MEE204	Simulation Lab.	Skill Based	0	0	4	2
MEE205	Mini Project	Skill Based	0	0	2	1
Discipline Elective-III (Any one of the following)						
MEE206	Power System Dynamics-II	Discipline Elective	3	0	0	3
MEE207	Power System Transients					
MEE208	Advanced Micro-Controller Based Systems					
Discipline Elective-IV (Any one of the following)						
MEE209	Power Electronic Devices and Converters	Discipline Elective	3	0	0	3
MEE210	Distribution System Operation & Analysis					
MEE211	Power Quality					
Value Added Course (Any one of the following)						
MEE212	English for Research Paper Writing	VAC	2	0	0	2
MEE213	Value Education					
MEE214	Constitution of India					
Total			**17**	**0**	**6**	**20**

Semester: III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
MEE301	Research Methodology	Research Based	4	0	0	4
Discipline Elective-V (Any one of the following)						
MEE303	SCADA Systems and Applications	Discipline Elective	3	0	0	3
MEE304	Wind Energy and Small Hydro Energy Station					
MEE305	Non Conventional Energy Sources					
MEE306	Major Project	Phase-I Dissertation	0	0	0	6
MEE399	XXX	MOOC	-	-	-	4
Open Elective Course						
XXX	Open Elective	OEC	3	0	0	3
	Total		**10**	**0**	**0**	**20**
Open Elective Course (Any one of the following)						
MEE307	Industrial Safety	Open Elective	3	0	0	3
MEE308	Waste to Energy					
MEE309	Operations Research					

Semester: IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
MEE401	Dissertation Phase - II	Research Based	-	-	-	20
Total						**20**
Grand Total			**45**	**0**	**10**	**80**

Semester: I

Course Title: Energy Management and Energy Audit

Course Code: MEE101

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes:

- To understand Energy Audit procedure along with relevant technologies/ tools
- To understand Energy Conservation measures undertaken across different user segments using case studies
- To develop Energy Audit Report writing skills

Course content

Unit –1 **15 Hours**

Energy Scenario: Primary and Secondary Energy, Conventional and non-conventional energy, Energy Security, Energy Conservation and its importance, Energy conservation Act., Thermal Energy basics, Energy Audit its definition & methodology, Energy Audit Instruments, Benchmarking for energy performance, Energy Action Planning, Duties and responsibilities of Energy Manager; Energy financial management, Project Management, Energy monitoring and targeting, pinch technology. Fuels and Combustions, Types of fuels, Important properties of fuels, calorific values, proximate and ultimate analysis of fuel, storage, handling & preparation of coal properties of gaseous fuels, combustion and combustion calculations, 3T's of combustion, Burners, Turndown ratio, draft.

Unit –2 **15 Hours**

Boilers: Introduction, different types and their classification, performance evaluation of boilers, Thermal efficiency and its determination by direct and indirect method, Blow-down, boiler water treatment, external water treatment, feed water preheating, combustion air preheating, excess air control, energy saving opportunities in boilers. Fluidized bed boilers: principles of fluidization, circulating fluidized bed, bubbling bed boilers, pressurized fluid bed combustion, advantages of fluidized bed combustion boilers. Industrial furnaces- Types & classifications of furnaces, shanky diagram, Performance and its evaluation of a typical furnace, Heat losses in a furnace, furnace efficiency, Determination using direct and indirect methods, fuel economy measures in furnaces, Heat distribution in a reheating furnace, furnace draught, optimum capacity utilization, waste heat recovery from flue gases.

Unit –3 **15 Hours**

Fans and Blowers: Difference between fans, blowers and compressors, Fan types, centrifugal fans, arial flow fans, fan laws, fan design and selection criteria's, flow control strategies, fan performance, assessment, energy saving opportunities in fans. Pumps & Pumping System: Types of pumps, pump curves, factors affecting pump performance, flow control strategies, Energy conservation opportunities in pumping system.

Unit –4 **15 Hours**

Cooling Towers, flow control strategies, Energy saving options in cooling towers. Refrigeration System: Introduction, types of refrigeration system, Performance assessment of a refrigeration system, COP, factor affecting performance, energy savings opportunities in refrigeration systems. Compressed Air System: Compressor Type, free air delivery, efficiency of compression, leak test, energy efficiency opportunities in compressed air systems.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- Technical Literature published by Petroleum Conservation Research Association. Dr. Clive Beggs Energy Management Supply & Conservation Budseworth Heinemann- 2002
- Albert Treemann & Paul Mehta Handbook of Energy Engineering The Fiarmout Press Inc Website of Bureau of Energy Efficiency

Semester: I

Course Title: ADVANCED POWER SYSTEM ANALYSIS	**L**	**T**	**P**	**Credits**
Course Code: MEE102	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes:

On successful completion of this course, the students will be able to:

1. Calculate voltage phasors at all buses, given the data using various methods of load flow
2. Calculate fault currents in each phase
3. Rank various contingencies according to their severity
4. Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps , CB status.

Course Content

UNIT 1 **15 Hours**

Overview of Newton-Raphson, Gauss-Siedel, Fast Decoupled methods, convergence properties, sparsity techniques, is handling Q_{min} and Q_{max} violations in Jacobian matrix, inclusion of frequency effects, Automatic Voltage Regulation in load flow.

UNIT 2 **15 Hours**

Simultaneous faults, open conductor faults, generalized method of fault analysis. Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking.

UNIT 3 **15 Hours**

Power System Equivalents, Ward Method, and Radial, Equivalent and Independent (REI) equivalents for reduction of large power system models. Sources of errors in measurement, Virtual and Pseudo Measurements, Observability, Tracking state estimation, Weighted Least Square method, bad data correction.

UNIT 4 **15 Hours**

Voltage Stability**,** Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal load flow, voltage collapse proximity indices.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *J.J. Grainger and W.D. Stevenson, "Power system analysis", McGrawHill,2003*
- *A. R. Bergen and Vijay Vittal, "Power System Analysis", Pearson,2000*
- *L.P. Singh, "Advanced Power System Analysis and Dynamics", New Age International,2006*
- *G. L. Kusic, "Computer aided power system analysis" ,Prentice Hall India,1986*
- *A. J. Wood, B. F. Wollenbergand G. B. Sheblé, "Power generation, operation and control", Wiley, 2013*
- *P.M. Anderson, "Faulted power system analysis", IEEE Press ,1995*

E-Book and Online learning material:

1. Debapriya Das, Indian Institute of Technology, Kaharagpur, https://swayam.gov.in/courses/4745-july-2018-power-system-analysis

Semester: I

Course Title: RENEWABLE ENERGY SYSTEM
Course Code: MEE102

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Knowledge about renewable energy
2. Understand the working of distributed generation system in autonomous/grid connected modes
3. Know the Impact of Distributed Generation on Power System
4. Understand power quality issues of distributed generation.

Course Content

UNIT 1 **20 Hours**
Distributed vs. Central Station Generation, Turbo-generator, nuclear generator and Micro-turbines, Introduction to Solar Energy, Wind Energy, Combined Heat and Power, Hydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells.

UNIT 2 **15 Hours**
Interfacing Distributed Generators with Grid: Applications of Power Electronic devices for Grid Interfacing of Distributed Generators.

UNIT 3 **10 Hours**
Power Quality Issues: Impact of Distributed Generation on the Power System, Power Quality Disturbances.

UNIT 4 **15 Hours**
Protection and Economics: Transmission System Operation, Protection of Distributed Generators, Economics of Distributed Generation.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *R. Ranjan, D. P. Kothari, and K. C. Singal, "Renewable Energy Sources and Emerging Technologies", Prentice Hall of India,2011.*
- *M. H. Bollen and F. Hassan, "Integration of Distributed Generation in the Power*

System", Wiley –IEEE Press,2011.

- *L.L. Lai and T.F. Chan, "Distributed Generation: Induction and Permanent Magnet Generators", Wiley- IEEE Press,2007.*
- *R. A. Messenger and J. Ventre, "Photovoltaic System Engineering",2010.*
- *J. F. Manwell, J.G. McGowan and A.L Rogers, "Wind energy explained: Theory, Design and Application", John Wiley and Sons,2010.*

E-Book and Online learning material:

- *Technical University of Denmark, https://www.coursera.org/learn/wind-energy*
- *P.Haridos, IIT Madras,https://swayam.gov.in/courses/4894-july-2018-non-conventionalenergy-resources*
- *A. Smets, Sustainable Energy: Design a Renewable Future, TU Delft &EDX*
- *A. Smets, Solar Energy, TU Delft &EDX*
- *A. Stegner, P.P. Drobinski, Wind resources for renewable energies, École Polytechnique & Courser*

Semester: I

Course Title: RENEWABLE ENERGY SYSTEM LABORATORY
Course Code: MEE104

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Determine calorific value of a fuel
2. Analyze characteristics of solar module
3. Attain the knowledge of different MPPT techniques
4. Use of HOMER software

Course content

Sr. No. Name of Practical

1. Calorific value using Bomb calorimeter
2. Gas Analyser for biomass plants
3. I-V curves for solar cell
4. Energy management of solar modules
5. Implementation of MPPT techniques for solar module
6. Effect of Load on Solar Panel Output
7. Test the Capabilities of Solar Panels
8. Wind power simulator
9. Microgrid AC/DC Simulation using RCP.

Semester: I

Course Title: POWER SYSTEM DYNAMICS-I

Course Code: MEE105

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Understand the modeling of synchronous machine
2. Develop synchronous machine equivalent representation
3. Carry out synchronous machine stability analysis
4. Develop model of excitation system

Course Content

UNIT 1 **10 Hours**
Synchronous Machine Modelling: Per unit systems, Park's Transformation and Modified Park's Transformation, Flux-linkage equations.

UNIT 2 **10 Hours**
Synchronous Machine Equivalent Representation: Voltage and current equations, Formulation of State-space equations, Equivalent circuit.

UNIT 3 **10 Hours**
Synchronous Machine Stability**,** Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines, Small signal model, Introduction to frequency model.

UNIT 4 **15 Hours**
Synchronous Machine Excitation System, Philips-Heffron model and PSS Load modelling, Prime Movers, Modelling of Hydraulic and steam turbine, governing systems.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *P. M. Anderson and A. A. Fouad, "Power System Control and Stability", John Wiley & Sons, 2008.*
- *J Machowski, J Bialekand J. R W. Bumby, "Power System Dynamics and*

Stability", John Wiley & Sons, 1997.

- *P. Kundur, "Power System Stability and Control", McGraw Hill Inc.,1994.*
- *E.W. Kimbark, "Power system stability", John Wiley & Sons,2002.*

E-Book and Online learning material:

1.https://courses.engr.illinois.edu/ece576/sp2018/Sauer%20and%20Pai%20book%20-%20Jan%202007.pdf

Semester: I

Course Title: POWER SYSTEM OPERATIONS AND CONTROL
Course Code: MEE106

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Understand the optimal operation of generators in thermal power stations and their characteristics with and without transmission loss coefficient.
2. Design the mathematical models of the speed governing systems, turbine and excitation system.
3. Discuss single area load frequency control and two area load frequency control.
4. Discuss the need of power factor correction and voltage drop compensation and identify the best methods for power factor improvement and voltage control.

Course Content

Unit 1 **5 Hours**

Characteristics of Power Generation Units

Characteristics of steam units, variation of steam unit characteristics, cogeneration Composite generation production cost functions.

Unit 2 **10 Hours**

Economic dispatch of Thermal Units

The economic dispatch problem; Thermal dispatching with network losses considered, penalty factors, lambda-iteration method, Gradient Method, Newtons Method, Economic Dispatch with piecewise linear cost functions, Economic dispatch using dynamic programming. Base Point and participation factors. George and Kron transmission loss formula (No derivation required), limitations of loss formula exact method of calculating penalty factors from power flow, Introduction to optimal power flow. Solution of optimal power flow by gradient method.

Unit 3 **8 Hours**

Commitment

Economic dispatch vs unit commitment, constraints in unit commitment, Unit Commitment solution by priority list method and forward dynamic approach.

Hydro-Thermal Co-ordination

Introduction to long range and short range hydro-scheduling, Types of short range

scheduling problems. Scheduling energy. The short term hydro-thermal scheduling problems and its solution by Lambde-Gamma iteration method and by Dynamic programming. Hydro units in series, Pumped storage hydro-plant.

Unit 4 **7 Hours**

Generation Control

Generator, Prime mover, Governor, Tie line and load models. Load frequency and generation control, automatic generation control (AGC) implementation.

Inter Connected System Operation

Need of inter connected systems. Pooling of interconnect systems. Analysis of losses in interconnect systems.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Allen J. Wood and Brace F Wollenberg, Power Generation operation and control, John Willey &Sons 2nd edition 1996.*
- *O.I. Elgerd, Electric Energy system Theory : - An Introduction TMH, 2nd Edition.*
- *L.K. Krichmayer, Economic operation of Power Systems, John Willey & Sons, N.Y.*
- *E.L. Grant, Principles of Engineering Economy, Ronald Press, N.Y. 1970.*
- *Related IEEE/IEE publications.*

Semester: I

Course Title: DYNAMICS OF ELECTRICAL MACHINES
Course Code: MEE107

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Formulation of electro dynamic equations of all electric machines
2. Analyze the performance characteristics using Park's transformation
3. Knowledge of transformations for the dynamic analysis of machines
4. Knowledge of determination of stability of the machines under small signal and transient conditions

Course Content

UNIT 1 **11 Hours**

Introduction: Stability, Primitive 4 Winding Commutator Machine, Commutator Primitive Machine, Complete Voltage Equation of Primitive 4 Winding Commutator Machine

UNIT 2 **12 Hours**

Torque Equations: Torque Equation Analysis of Simple DC Machines using the Primitive Machine Equations, The Three Phase Induction Motor, Transformed Equations, and Different Reference Frames for Induction Motor Analysis Transfer Function Formulation.

UNIT 3 **11 Hours**

Three Phase Synchronous Machine: Three Phase Salient Pole Synchronous Machine, Parks Transformation, Steady State Analysis Dynamic analysis: Large Signal Transient, Small Oscillation Equations in State Variable form, Dynamical Analysis of Interconnected Machines.

UNIT 4 **11 Hours**

Transient Analysis: Large Signal Transient Analysis using Transformed Equations, DC Generator /DC Motor System Alternator /Synchronous Motor System.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *D.P. Sengupta and J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd.1980*
- *R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education.,2001*
- *P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill BookCompany,1987*
- *I. Boldia and S.A. Nasar, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1992 5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London.1967*

E-Book and Online learning material:

1.http://www.darshan.ac.in/Upload/DIET/Documents/EE/CED_Ch_2_Dynamics_of_Electrical_Drives_v1_0 3042018_095922AM.pdf

Semester: I

Course Title: ELECTRIC POWER DISTRIBUTION SYSTEM
Course Code: MEE108

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Attain the knowledge of power distribution and its management
2. Attain the knowledge of Distribution automation and its application in practice
3. Understand Control and Communication through SCADA system
4. Apply optimization concept for Distribution Systems Switching

Course Content

UNIT 1 **11 Hours**
Distribution of Power, Management, Power Loads, Load Forecasting Short-term and Long-term, Power System Loading, Technological Forecasting, Distribution Management System: Advantages, Distribution Automation: Definition, Restoration/ Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction.

UNIT 2 **11Hours**
Supervisory Control and Data Acquisition (SCADA) System: Introduction, Block Diagram, SCADA Applied To Distribution Automation, Common Functions of SCADA, Advantages of Distribution Automation through SCADA and Communication Systems, Remote Metering, Automatic Meter Reading and implementation.

UNIT 3 **12Hours**
Distribution Systems Switching: Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution and Monitoring.

UNIT 4 **11 Hours**
Maintenance of Automated Distribution Systems: Difficulties in Implementing Distribution, Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion,

Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd.2008.*
- *M.K. Khedkar and G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press,2011*
- *A. J. Panseni, "Electrical Distribution Engineering", CRCPress,2012*
- *J. Momoh, "Electric Power Distribution, automation, protection and control", CRCPress,201*
- *TuranGonen, "Electric Power Distribution Engineering" CRC Press,2007.*
- *William H. Kersting, "Distribution System Modeling and Analysis (Electric Power Engineering Series)" 1st Edition, CRC Press,2001.*

E-Book and Online learning material:

1. Energy Management and SCADA, coordinated by IIT Madras, NPTEL, http://www.nptel.ac.in/courses/108106022/8,

Semester: I

Course Title: SMART GRIDS
Course Code: MEE109

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Appreciate the difference between smart grid and conventional grid
2. Apply smart metering concepts to industrial and commercial installations
3. Formulate solutions in the areas of smart substations, distributed generation and wide area measurements
4. Understand integration of renewable energy sources with micro-grid

Course Content

UNIT 1 **15 Hours**

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust and Self-Healing Grid, Present development and International policies in Smart Grid, Introduction to Smart Meters: Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home and Building Automation, Smart Substations, Substation Automation, Feeder Automation.

UNIT 2 **10 Hours**

Smart Measurement System: Geographic Information System (GIS), Intelligent Electronic Devices (IED) and their application for monitoring and protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU)

UNIT 3 **10 Hours**

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

UNIT 4 **10 Hours**

Smart Communication: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).Bluetooth, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Cyber Security for Smart Grid Broadband over Power line (BPL), IP based

protocols

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *A. Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011*
- *C.W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press , 2009*
- *J. Ekanayake, N. Jenkins, K. Liyanage, "Smart Grid: Technology and Applications", Wiley2012*
- *S.Borlase, "Smart Grid: Infrastructure, Technology and solutions " CRCPress,2012*
- *A.G.Phadke, "Synchronized Phasor Measurement and their Applications", Springer,2012*

E-Book and Online learning material:

- N.P. Pandey, "Introduction to smart grid", IIT Roorkeehttps://swayam.gov.in/courses/4778-july-2018-introduction-to-smart-grid
- Narayana Prasad Padhy, Premalata Jena, "Introduction to Smart Grid," NPTELhttps://onlinecourses.nptel.ac.in/noc18_ee42/preview
- M. Vadari, M. Balasubramanyan, Distributed Energy – Smart Grid Resources for the Future, IEEE, Coursera.
- Dr. M. Vadari and M. Balasubramanyan, Smart Grids: Electricity for the
- Future, IEEE &EDX
- Laura Ramirez, Pavol Bauer &SeyedmahdiIzadkhast, "Solar Energy: Integration of Photovoltaic Systems in Microgrids", Delf University of Technology,https://www.edx.org/course/solar-energy-integration-photovoltaic-delftx-pv4x-0

Semester: I

Course Title: PULSE WIDTH MODULATION FOR POWER ELECTRONICS CONVERTERS **Course Code: MEE110**	**L**	**T**	**P**	**Credits**
	3	**0**	**0**	**3**

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Appreciate importance of power electronics converters and its modulation techniques
2. Apply advanced modulation strategies such as zero space vector placement, loss discontinuous and modulation applied to current source inverter.
3. Implement PWM using different strategies
4. Demonstrate the knowledge of continuing developments in modulation

Course Content

UNIT 1 **11 Hours**

Introduction to Power Electronic converters, Modulation of one inverter phase leg, Modulation of single phase VSI and 3 phase VSI.

UNIT 2 **11 Hours**

Modulation: Zero space vector placement modulation strategies, Losses Discontinuous modulation, Modulation of CSI, over modulation of converters, programme modulation strategies

UNIT 3 **11 Hours**

Pulse width modulation: Pulse width modulation for multilevel inverters, Implementation of modulation controller

UNIT 4 **12 Hours**

Recent developments: Continuing developments in modulation as random PWM, PWM for voltage unbalance, Effect of minimum pulse width and necessity of providing dead time.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *D. Grahame Holmes, Thomas A. Lipo, "Pulse width modulation of Power Converter:*

Principles and Practice", John Wiley & Sons,03-Oct-2003

- *B.Vew, "High Power Converter", Wiley Publication*
- *M. K. Kazimicrczuk, "Pulse width modulated dc-dc power converter",*
- *Wiley Publication*

E-Book and Online learning material:

1. Dr. K. Afridi, Dr. R. Erickson, Dr. D. Maksimovic, Power Electronics Specialization, University of Colorado, Coursera

Semester: II

Course Title: DIGITAL PROTECTION OF POWER SYSTEM **Course Code: MEE201**	**L**	**T**	**P**	**Credits**
	4	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes:

On successful completion of this course, the students will be able to:

1. Understand the concept and importance of digital Relays
2. Apply mathematical techniques for digital protection
3. Understand the control system techniques for digital protection
4. Understand to develop various protection algorithms

Course Content

UNIT 1 **15 Hours**

Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection, Mathematical background of protection algorithms.

UNIT 2 **15 Hours**

Finite difference techniques, Interpolation formulae, forward, backward and central difference interpolation, Numerical differentiation, Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers

UNIT 3 **15 Hours**

Conversion subsystem: the sampling theorem, signal aliasing, Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a unit consisting of hardware and Software Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrisn) algorithm.

UNIT 4 **15 Hours**

Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm, Walsh function based algorithm. Differential equation based algorithms. Travelling Wave based Techniques, Digital Differential Protection of Transformers, Digital Line Differential Protection, and Recent Advances in Digital Protection of Power Systems.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *A.G.PhadkeandJ.S.Thorp,"ComputerRelayingforPowerSystems",Wiley/Researchst*

udiesPress,2009

- *A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEEPress,1999*
- *Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing,2006*
- *S.R. Bhide "Digital Power System Protection" PHI LearningPvt.Ltd.2014*
- *Ravindra P Singh "Digital Power System Protection" PHI learning*

E-Book and Online learning material:

1. https://books.google.co.in/books?id=0reaEkBzX8C&printsec=frontcover&source=gbs_ge_summary_r &cad=0#v=onepage&q&f=false
2. https://epdf.pub › download › computer-relaying-for power-systems-2nd edition/
3. https://nptel.ac.in/courses/108/101/108101039/

SEMESTER-II

Course Title: RESTRUCTURED POWER SYSTEMS
Course Code: MEE202

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Understand the need for restructuring of Power Systems, discuss different market models, different stakeholders and market power
2. Understand and generalize the functioning and planning activities of ISO.
3. Understand transmission open access pricing issues and congestion management.
4. Define transfer capability and estimate the transfer capability of a small power systems.
5. Define ancillary services and understand reactive power as ancillary service and management through synchronous generator.

Course content

UNIT-1 **10 Hours**

Deregulation of the Electricity Supply Industry

Introduction – What is Deregulation?; Deregulation Vs Restructuring; Restructuring Models; Key Stakeholders in Restructured Power System – Independent System Operator, Power Exchange, Load Serving Entities; Market Operations – Day ahead and Hour ahead markets, elastic and non-elastic markets; Market Power; Benefits from Competitive Electricity Markets.

UNIT-2 **10 Hours**

Power System Operation in Competitive Environment

Introduction; Role of the Independent System Operator; Operational planning activities of ISO – in pool and bilateral markets; Operational planning activities of ISO - in pool and bilateral markets; Market participation issues; Unit Commitment in Deregulated Environment; Competitive Bidding.

UNIT-3 **10 Hours**

Transmission Open Access, Pricing Issues and Congestion Management:
Introduction; Power Wheeling; Transmission Open Access – Types of Transmission services, cost components; Pricing of Power Transactions – Embedded Cost Based Transmission Pricing, Incremental Cost Based Pricing; Congestion Pricing – Congestion Pricing Methods, Transmission Rights; Management of Inter-zonal/Intra-zonal congestion.

UNIT-4 **15 Hours**

Transfer Capability Definitions, Transfer Capability issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation; Methodologies to calculate ATC.

Ancillary Services Management General description of some ancillary services; Ancillary Services Management in various countries; Reactive Power as an Ancillary Service

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- Kankar Bhattacharya, Math H.J. Boller, JaapE. Daalder, 'Operation of Restructured Power System' Klumer Academic Publisher – 2001.
- Mohammad Shahidehpour, and Muwaffaqalomoush, - "Restructured electrical Power systems" Marcel Dekker, Inc. 2001.

SEMESTER-II

Course Title: POWER SYSTEM PLANNING
Course Code: MEE203

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. The scope of employability in power utilities will increase.
2. The management skills required in the field of power system engineering is enhanced.
3. Use the tools required to analyze and evaluate an electric power system for generation planning and load forecasting
4. Execute production costing analysis and long term generation expansion plans in a deregulated environment

Course content

UNIT 1 **10 Hours**

Introduction: power system planning, objective, stages in planning and design, the electric utility industry, growth characteristics generation, transmission and distribution systems.

Demand/energy forecasting: electricity consumption pattern, peak demand and energy forecasting by trend and economic projection methods. Review of load forecasting.

UNIT 2 **15 Hours**

Power System Planning: Investment planning: traditional generation expansion planning models, integrated resource planning models, production cost simulation models.

Generating system capability planning: probabilistic models of generating units, growth rate, rate of generation capacity, outage performance and system evaluation of loss of load and loss of energy indices, power supply availability assessment, Expansion planning, unit maintenance schedule, unit effective load carrying capability.

Transmission system planning: automatic transmission system expansion planning, automatic transmission planning using interactive graphics.

UNIT 3 **15 Hours**

Distribution system planning and automation: load characteristics, design of sub transmission lines and distribution, substations, design considerations of' primary and secondary distribution systems, voltage drop and power loss calculations.

Interconnected systems: multi-area reliability analysis, power pool operation and power exchange energy contracts, quantification of economic and reliability benefits of pool operation.

UNIT 4 **5 Hours**

Power system Expansion planning: formulation of least cost optimization problem involving capital, operation and maintenance costs of candidate units of different types.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Y. Wallach, 'Power System Planning', McGraw Hill International.*
- *P. Sullivan, 'Power System Planning', McGraw Hill International.*
- *S. Dasari, 'Electric Power System Planning', IBT Publishers, New Delhi.*
- *R. Billinton, 'Power System Reliability Calculation', MIT Press, USA.*
- *Endreyni, 'Reliability Modelling in Electric Power System', John Wiley, New York.*
- *J.R. McDonald, 'Modern Power System Planning', McGraw Hill International. 7. A.S. Pabla, 'Electrical Power System Planning', Macmillan, 1998.*

Semester: II

Total Hours: 15

Course Title: SIMULATION LAB	**L**	**T**	**P**	**Credits**
Course Code: MEE204	**0**	**0**	**2**	**1**

Course content **Total Hours:15 Hours**

List of Experiments:-

1. Introduction to MATLAB and its basic commands.
2. MATLAB program to simulate Ferranti effect.
3. MATLAB program to model transmission lines.
4. MATLAB program to solve load flow equations by Gauss-Seidel method.
5. MATLAB program to find optimum loading of generators neglecting transmission losses.
6. MATLAB program to find optimum loading of generators with penalty factors.
7. MATLAB program to solve swing equation using point-by-point method.
8. Simulink model of single area load frequency control with and without pi controller and without pi controller in Simulink.
9. Simulink model for two area load frequency control.
10. Simulink model for evaluating transient stability of single machine connected to infinite bus.
11. Gauss Seidel load flow analysis using MATLAB Software.
12. Newton Raphson method of load flow analysis using MATLAB Software.
13. Fast decoupled load flow analysis using MATLAB Software.
14. Fault analysis using MATLAB Software.
15. Economic dispatch using MATLAB Software.

Semester: II

Course Title: MINI PROJECT
Course Code: MEE205

L	T	P	Credits
-	-	4	2

Course Outcomes:

1. Synthesis of knowledge.
2. To demonstrate the aptitude of applying the own knowledge to solve a specific problem.
3. To mature the knowledge.
4. Able to organize, compile and record all work details in an efficient manner

Each student will be required to complete a Project and submit a Project Report on a topic on any of the areas of modern technology related to Electrical Engineering including interdisciplinary fields.

Semester: II

Course Title: POWER SYSTEM DYNAMICS-II
Course Code: MEE206

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Gain valuable insights into the dynamic phenomena of power system
2. Understand and Analyze the power system rotor angle stability problem
3. Understand and Analyze the power system voltage stability problem
4. Analyze and implement modern control strategies for automatic generation control

Course Content

UNIT 1 **15 Hours**

Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low-Frequency Oscillations)of Unregulated and Regulated System, Effect of Damper, Flux Linkage Variation and AVR

UNIT 2 **15 Hours**

Large Signal Rotor Angle Stability, Dynamic Equivalents And Coherency, Direct Method of Stability Assessment, Stability Enhancing Techniques, Mitigation Using Power System Stabilizer

UNIT 3 **15 Hours**

Asynchronous Operation and Resynchronization, Multi-Machine Stability, Dynamic Analysis of Voltage Stability, Voltage Collapse

UNIT 4 **15 Hours**

Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures, use of simulation tool for automatic generation control.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *P. Kundur, "Power System Stability and Control", McGraw Hill Inc,1994*
- *J.Machowski,Bialek,Bumby,"PowerSystemDynamicsandStability",JohnWiley&So*

ns,1997

- *L.LeonardGrigsby(Ed.);"PowerSystemStabilityandControl",Secondedition,CRCPress,2007*
- *V. Ajjarapu, "Computational Techniques for voltage stability assessment & control"; Springer,2006*

E-Book and Online learning material:

1. http://www.elcomhu.com/Electrical/Power%20System%20Stability/%5Bprabha%20kundur%5D%20power%20system%20stability%20and%20control.pdf
2. https://nptel.ac.in/courses/108/102/108102080/

Semester: II

Course Title: POWER SYSTEMS TRANSIENTS
Course Code: MEE207

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Generation of switching transients and their control using circuit – theoretical concept.
2. Mechanism of lighting strokes and the production of lighting surges.
3. Propagation, reflection and refraction of travelling waves.
4. Voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

Course Content

Unit 1 **10 Hours**

INTRODUCTION AND SURVEY

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

Unit 2 **15 Hours**

SWITCHING TRANSIENTS

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

Unit 3 **10 Hours**

LIGHTNING TRANSIENTS

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke – factors contributing to good line

design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

Unit 4 **25 Hours**

TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response – Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.

TRANSIENTS IN INTEGRATED POWER SYSTEM

The short line and kilometric fault - distribution of voltages in a power system –Line dropping and load rejection - voltage transients on closing and reclosing lines- over voltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', McGraw Hill, Fifth Edition, 2013.*
- *R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986*
- *. Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.*

J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012.

Semester: II

Course Title: ADVANCED MICRO-CONTROLLER BASED SYSTEMS	L	T	P	Credits
Course Code: MEE208	**3**	**0**	**0**	**3**

Total Hours: 45

Learning Outcomes:

On successful completion of this course, the students will be able to:

1. To learn how to program a processor in assembly language
2. To learn how to develop an advanced processor based system
3. To learn configuring and using different peripherals in a digital system
4. To compile and debug a Program

Course Content

UNIT 1 **10 Hours**

Basic Computer Organization, Accumulator based Processes-Architecture, Memory Organization - I/O Organization.

UNIT 2 **12 Hours**

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication Timers, Interrupts, Programming, Intel 8051 – Assembly language programming, Addressing-Operations, Stack & Subroutines, Interrupts-DMA.

UNIT 3 **11Hours**

PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication.

UNIT 4 **12 Hours**

Digital Signal Processor (DSP), Architecture – Programming, Introduction to FPGA, Microcontroller development for motor control applications, Stepper motor control using microcontroller.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons1981*
- *Ramesh S. Gaonker: "Microprocessor Architecture, Programming and Applications*

with the 8085", Penram International Publishing (India),1994

- *Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing,2005*
- *Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning,2004*
- *John Morton," The PIC microcontroller: your personal introductory course", Elsevier,2005*
- *Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier,2008*
- *Microchip datasheets forPIC16F877*

E-Book and Online learning material:

1. http://s1.nonlinear.ir/epublish/book/The_PIC_Microcontroller_Your_Personal_Introductory_Course_0750666641.pdf
2. http://www.kelm.ftn.uns.ac.rs/literatura/mms/pdf/The%208051%20Microcontroller%20Architecture,%20Programming%20And%20Applications.pdf

Semester: II

Course Title: POWER ELECTRONIC DEVICES AND CONVERTERS Course Code: MEE209	L	T	P	Credits
	3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Knowledge of power semiconductor devices
2. Develops the understanding of Gate and base drive circuits
3. Develop skills to utilize the different PWM schemes
4. Know about the different types of power converters and their applications

Course content

UNIT 1 **10 Hours**

REVIEW OF SEMICONDUCTOR DEVICES: Conduction Process in semiconductors, pn Junction, Charge control description, Avalanche breakdown, Power diodes, Thyristors, Gate Turn Off Thyristor (GTO), VI characteristics, Dynamic characteristics, ratings, protection.

UNIT 2 **15 Hours**

POWER MOSFET AND IGBT: Basic structure, I-V Characteristic, Physics of device operation, switching characteristics, operating limitation and safe operating area. EMERGING DEVICES AND CIRCUITS: Power junction Field effect transistor (FET), Integrated Gate-Commutated Thyristor (IGCT), Field Control Thyristor, Metal oxide semiconductor (MOS) Control Thyristor etc. Power ICs, New semiconductor materials.

UNIT 3 **10 Hours**

SNUBBER CIRCUITS: Types of Snubber circuits, needs of Snubber circuit with diode, thyristor and transistors, Turn-off Snubber, over voltage snubber, turn on snubber, Snubber for bridge circuit configurations, GTO Snubber circuit.

UNIT 4 **10 Hours**

GATE AND BASIC DRIVE CIRCUITS: Design Consideration, De-coupled drive circuits, electrically isolated drive circuits, cascade connected drive circuits, Power device protection in drive circuits, circuit layout considerations.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion,

Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Mohan, Undeland and Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and Sons.*
- *M.H. Rashid, 'Power Electronics Handbook', Elsevier Press (Academic Press Series).*
- *D. Finney, 'The Power Thyristor and its Applications', McGraw Hill, New York.*
- *C.W. Lander, 'Power Electronics', McGraw Hill Book Co., U.K.*
- *M.H. Rashid, 'Power Electronics - Circuits, Devices and Applications', PHI, India*

Semester: II

Course Title: DISTRIBUTION SYSTEM OPERATION & ANALYSIS	L	T	P	Credits
Course Code: MEE210	**3**	**0**	**0**	**3**

Total Hours: 45

Learning Outcomes:

On successful completion of this course, the students will be able to:

1.Memorize modelling of loads and their characteristics
2. Understand design of substations
3. Compare voltage drops for uniformly distributed loads and concentrated loads
4. Illustrate compensation methods for voltage drops and pf improvements
5. Analyze the Coordination of Protective Devices.

Course content

UNIT-1 **10 Hours**

System Planning: Introduction, Distribution system planning, Factors affecting system planning, present planning techniques, planning models, Introduction to optimum line network. future trends in planning, systems approach, distribution automation. Load Characteristic: Basic definitions, relation between load and loss factors, maximum diversified demand, load forecasting, Load management.

UNIT-2 **10 Hours**

System Design and Operation: Criteria, system developers, dispersed generation, distribution systems, economics and finance, mapping, Design of substation and feeder, Operation criteria, voltage measurements, harmonics, load variations, system losses, Introduction to energy management.

UNIT-3 **10 Hours**

Voltage Regulation and Automation: Quality of Service and Voltage Standards, Voltage Control, Line Drop Compensation, Distribution capacitor automation, Voltage fluctuations, SCADA and Communication with Load Dispatch Centres.

UNIT-4 **10 Hours**

Distribution System Protection: Objective of distribution system protection, high impedance faults coordination of protective devices: fuse to fuse co-ordination, re-closer to re-closer coordination, re-closer to fuse coordination, re-closer to substation transformer high side fuse coordination, fuse to circuit breaker coordination, re-closer to circuit breaker coordination, lightning protection.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- Gonen, Turan, 'Electric Power Distribution System Engineering', CRC PRESS, Third Indian Reprint, 2012.
- A.S. Pabla, 'Electric Power Distribution', 6 th Edn., TMH, 2011.
- 'Electric Power Distribution Handbook' Thomas Allen Short

Semester: II

Course Title: POWER QUALITY
Course Code: MEE211

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Acquire knowledge about the harmonics, harmonic introducing devices.
2. Acquire knowledge about effect of harmonics on system equipment and Loads.
3. To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components
4. To have knowledge of active power factor correction based on static VAR compensators and its control techniques

Course Content

UNIT 1 **10 Hours**

Introduction-power quality-voltage quality-overview of power quality phenomena classification of power quality issues-power quality measures and standards-THD TIF-DIN-C message weights-flicker factor transient phenomena-occurrence of power quality, voltage sags and swells, Current and voltage limits of harmonic distortions: IEEE, IEC, EN, NORSO.

UNIT 2 **13 Hours**

Harmonics-individual and total harmonic distortion, Causes of harmonics, RMS value of a harmonic waveform- Triplex harmonics-important harmonic introducing devices-SMPS, Elimination/suppression of harmonics, Three phase power converters- arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads. Modeling of networks and components under non-sinusoidal conditions transmission and distribution systems, Shunt capacitors-transformers-electric machines-ground, systems loads that cause power quality problems, power quality problems created by drives and its impact on drive.

UNIT 3 **11 Hours**

Power factor improvement- Passive Compensation, Passive Filtering, Harmonic, Resonance, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC, Based on Bilateral Single Phase and Three Phase Converter, Static VAR compensators-SVC and STATCOM Active Harmonic Filtering Shunt Injection, Filter for single phase, three-phase three-wire and three-phase four wire systems, d-q domain control of three phase shunt active filters uninterruptible power supplies

constant voltage , transformers, series active power filtering techniques for harmonic cancellation and isolation.

UNIT 4 **11 Hours**

Dynamic Voltage Restorers for sag, swell and flicker problems. Grounding and wiring introduction, NEC grounding requirements-reasons for grounding, typical grounding and wiring problems solutions to grounding and wiring problems

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *G.T. Heydt, "Electric power quality", McGraw-Hill Professional,2007*
- *Math H. Bollen, "Understanding Power Quality Problems", IEEE Press,2000*
- *J. Arrillaga, "Power System Quality Assessment", John Wiley,2000*
- *J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley,2008*
- *Dugan R. C., McGranaghan M. F. and Beaty H. W., Electrical Power System Quality", McGraw-Hill International BookCompany*
- *Surajit Chattopadhyay , "Electric Power Quality (Power Systems)" springer, 2011Edition*

E-Book and Online learning material:

1. http://uni-site.ir/khuelec/wp-content/uploads/Electrical-Power-Systems-Quality-2nd-Ed-Malestrom.pdf
2. http://www.gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/electrical_power_systems_quality.pdf
3. https://nptel.ac.in/courses/108/106/108106025/

Semester: II

Course Title: ENGLISH FOR RESEARCH PAPER WRITING
Course Code: MEE212

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title.
4. Ensure the good quality of paper at very first-time submission.

Course Content

Unit 1 **5 Hours**
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit 2 **5 Hours**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit 3 **5 Hours**
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4 **15 Hours**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books*
- *2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press*

- *3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.*
- *4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011*

Semester: II

Course Title: VALUE EDUCATION
Course Code: MEE213

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Understand value of education and self- development
2. Learn the importance of Human values
3. Developing the overall personality
4. Knowledge of self-development

Course Content

Unit 1 **5 Hours**
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non- moral valuation. Standards and principles, Value judgments.

Unit 2 **5 Hours**
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism, Love for nature, Discipline.

Unit 3 **15 Hours**
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth. Aware of self destructive habits, Association and Cooperation, Doing best for saving nature.

Unit 4 **5 Hours**
Character and Competence – Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi*

Semester: II

Course Title: CONSTITUTION OF INDIAN
Course Code: MEE214

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. To realize the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution.
2. To identify the importance of fundamental rights as well as fundamental duties.
3. To understand the functioning of Union, State and Local Governments in Indian federal system.
4. To learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.

Course Content

UNIT1 **5 Hours**

Introduction to Constitution: Meaning and importance of the Constitution, salient features of Indian Constitution. Preamble of the Constitution. Fundamental rights- meaning and limitations. Directive principles of state policy and Fundamental duties -their enforcement and their relevance.

UNIT 2 **5 Hours**

Union Government: Union Executive- President, Vice-president, Prime Minister, Council of Ministers. Union Legislature- Parliament and Parliamentary proceedings. Union Judiciary-Supreme Court of India – composition and powers and functions.

UNIT 3 **10 Hours**

State and Local Governments: State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-Panchay at raj system with special reference to 73rd and Urban Local Self Govt. with special reference to74th Amendment.

UNIT 4 **10 Hours**

Election provisions, Emergency provisions, Amendment of the constitution Election Commission of India-composition, powers and functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *M.V.Pylee, "Introduction to the Constitution of India",4th Edition, Vikas publication,2005.*
- *Durga Das Basu(DD Basu) , "Introduction to the constitution of India",(Student Edition),19th edition,Prentice-Hall EEE, 2008.*
- *Reference Book*
- *Merunandan, "Multiple Choice Questions on Constitution of India", 2 nd Edition,Meraga publication,2007.*

Semester: III

Course Title: RESEARCH METHODOLOGY
Course Code: MEE301

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes:

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

Course Content

Unit 1 **5 Hours**

Research: its concept, nature, scope, need and Objectives of Research, Research types, Research methodology, Research process – Flow chart, description of various steps, Selection of research problem.

Unit 2 **10 Hours**

Research Design: Meaning, Objectives and Strategies of research, different research designs, important experimental designs.

Methods of Data Collection and Presentation: Types of data collection and classification, Observation method, Interview Method, Collection of data through Questionnaires, Schedules, data analysis and interpretation, editing, coding, content analysis and tabulation

Unit 3 **8 Hours**

Sampling Methods:

Different methods of Sampling: Probability Sampling methods, Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling and Multistage Sampling. Non probability Sampling methods, Sample size.

Unit 4 **7 Hours**

Report writing and Presentation: Types of reports, Report Format – Cover page, Introductory page, Text, Bibliography, Appendices, Typing instructions, Oral Presentation

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- Kothari C.R., "Research Methodology", New Age Publisher
- Nargundkar R, Marketing Research, Tata McGraw Hill, New Delhi,2002.
- Sekran, Uma, "Business Research Method", Miley Education, Singapore

Website/Links/Online Portal/ICT

1. https://www.academia.edu/
2. https://www.studeersnel.nl
3. https://www.scribd.com

Semester-III

Course Title: SCADA SYSTEM AND APPLICATIONS
Course Code: MEE302

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications
2. Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3. To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server
4. Learn and understand about SCADA applications in transmission and distribution sector, industries, etc.

Course content

Unit 1 **10 Hours**
Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility, Automation, Industries SCADA

Unit 2 **15 Hours**
Industries SCADA System Components: Schemes- Remote Terminal, Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

Unit 3 **05 Hours**
SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture-IEC 61850.

Unit 4 **15 Hours**
SCADA Communication: various industrial communication technologies-wired and wireless methods and fiber optics. open standard communication protocols, SCADA Applications: Utility applications- Transmission and Distribution sector-operations, monitoring, analysis and improvement. Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested reading:

- *Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA,2004.*
- *Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK,2004.*
- *William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.*
- *David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003. 5. Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999.*

Semester: III

Course Title: WIND ENERGY AND SMALL HYDRO ENERGY STATION	L	T	P	Credits
Course Code: MEE303	3	0	0	3

Total Hours: 45

Learning Outcomes:

On successful completion of this course, the students will be able to:

1. Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems
2. Demonstrate the knowledge of the physics of wind and all associated issues
3. Demonstrate the knowledge of the physics of solar power generation and all associated issues so as to solve practical problems
4. Demonstrate the knowledge of physics of solar power generation and the associated issues

Course content

UNIT-1 **11 Hours**

Wind Energy

Introduction, general theory of wind machines, basic laws and concepts of aerodynamics, Micrositing, Description and performance of the horizontal–axis wind machines, Introduction to blade design, Description and performance of the vertical–axis wind machines, generation of electricity by wind machines and case studies.

UNIT-2 **11 Hours**

Hydro Power Plant

Overview of micro mini and small hydro, site selection and civil works, Penstocks and turbines, speed and voltage regulation, investment issues.

UNIT 3 **11 Hours**

Isolated wind systems, reactive power and voltage control, economic aspects, Impacts on power system dynamics, power system interconnection.

UNIT 4 **12 Hours**

Introduction of solar systems, merits and demerits, concentrators, various applications, Solar thermal power generation, PV power generation, Energy Storage device, designing the solar system for small installations.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion,

Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- J.F. Manwell, J.G. McGowan and A.L. Rogers, 'Wind Energy Explained – Theory, Design and Application', John Wiley & Sons, Ltd., 2002.
- Martin O.L. Hansen, 'Aerodynamics of Wind Turbines', Earthscan, 2008.
- 'Wind Turbine Control Systems- Principles, Modelling and Gain Scheduling Design', Fernando D. Bianchi, Hernan De Battista and Ricardo J. Mantz, Springer, 2007.
- Adam Harvey, Andy Brown and Priyantha Hettiarachi, 'Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes', ITDG, 1993.
- Maria Laguna, 'Guide on How to Develop a Small Hydropower Plant', ESHA, 2004.
- 'Good & Bad of Mini Hydro Power', edited by Roman Ritter, GTZ, 2009.

Semester: III

Course Title: NON-CONVENTONAL ENERGY SOURCES
Course Code: MEE304

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems
2. Demonstrate the knowledge of the physics of wind and all associated issues
3. Demonstrate the knowledge of the physics of solar power generation and all associated issues so as to solve practical problems
4. Demonstrate the knowledge of physics of solar power generation and the associated issues

Course content

UNIT-1 **10 Hours**

Introduction to Energy Sources: World Energy Futures, Conventional Energy Sources, Non Conventional Energy Sources, Prospects of Renewable Energy Sources.

UNIT-2 **10Hours**

Solar Energy: a) Introduction to Solar Radiation and its measurement, Introduction to Solar Energy Collectors and Storage. b) Applications of Solar Energy: Solar Thermal Electric Conversion, Thermal Electric Conversion Systems, Solar Electric power Generation, Solar Photo-Voltaics, Solar Cell Principle, Semiconductor Junctions, Conversion efficiency and power output, Basic Photo Voltaic System for Power Generation.

UNIT-3 **10 Hours**

Wind Energy: a) Introduction to wind energy Conversion, the nature of the wind, Power in the wind. b) Wind Energy Conversion: Wind data and energy estimation, Site Selection Considerations, Basic Components of a Wind Energy Conversion System, Classification of WEC Systems, Schemes for Electric Generation using Synchronous Generator and Induction Generator, Wind energy Storage.

UNIT-4 **15 Hours**

Direct Energy Conversion Processes: a) Magneto Hydro Dynamic Power Generation: Principles of MHD power generation, Open Cycle Systems, Closed Cycle Systems, Voltage and power output, Materials for MHD generators. b) Thermo-Electric Generation: Basic principles of thermo-electric power-generation, Seebeck,

Peltier, Thomson effects, Thermo-Electric power generator, Analysis, materials. c) Thermionic Generation: Thermionic emission and work function, Basic thermionic generation. d) Fuel Cells H2, O2 Cell, Classification of fuel Cells, Types, Advantages, Electrodes, Polarization. e) Thermo Nuclear Fusion Energy: The basic Nuclear Function and Reactions Plasma Confinement, Thermo Nuclear function Reactions.

Energy From Biomass: a) Introduction: Biomass conversion technologies, photosynthesis, Bio-gas generation, types of bio-gas plants. b) Biomass as a Source of Energy: Method for obtaining energy from Bio-mass, Biological Conversion of Solar Energy.

Transaction Mode:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested reading:

- Non-Conventional Sources of Energy by :G.D. Rai, Khanna Publishers.
- Bio Energy by David Boyles, Elis Horwood Ltd.,
- Renewable energy sources and conversion technology by N.K. Bansal, M. Kleemann, M. Heliss, Tata McGraw Hill 1990.
- Direct Energy Conversion by R. A. Coombie, Pitman.
- Bio Energy Spectrum, Bio Energy and Wasteland Development Organization by O.P Vimal and P.D. Tyagi.
- Related IEEE/IEE Publications

Semester: III

Course Title: MAJOR PROJET (DISSERTATION-I)
Course Code: MEE305

L	T	P	Credits
0	0	20	10

Total Hours: -

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Synthesis of knowledge.
2. To demonstrate the aptitude of applying the own knowledge to solve a specific problem.
3. To mature the knowledge.
4. Able to organize, compile and record all work details in an efficient manner

Each student will be required to complete a Project and submit a Project Report on a topic on any of the areas of modern technology related to Electrical Engineering including interdisciplinary fields.

Semester: III

Course Title: INDUSTRIAL SAFETY
Course Code: MEE306

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Identify hazard and potential hazard areas.
2. Develop safety programs to prevent or mitigate damage or losses.
3. Assess safety practices and programs.
4. Conduct safety audits and Improve safety practices

Course content

Unit 1 **10 Hours**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit 2 **10 Hours**
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit 3 **10 Hours**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit 4 **15 Hours**
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Transaction Mode:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested reading:

- *Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.*
- *Maintenance Engineering, H. P. Garg, S. Chand and Company.*
- *Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.*
- *Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.*

Semester: III

Course Title: WASTE TO ENERGY
Course Code: MEE307

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Apply the knowledge about the operations of Waste to Energy Plants.
2. Analyse the various aspects of Waste to Energy Management Systems.
3. Carry out Techno-economic feasibility for Waste to Energy Plants.
4. Apply the knowledge in planning and operations of Waste to Energy plants.

Course content

Unit 1 **10 Hours**
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit 2 **10 Hours**
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit 3 **10 Hours**
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit 4 **15 Hours**
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Transaction Mode:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested reading:

- Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
- Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I &
- II, Tata McGraw Hill Publishing Co. Ltd., 1983.
- Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
- Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &
- Sons, 1996.

Semester: III

Course Title: OPERATION RESEARCH
Course Code: MEE308

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:

On successful completion of this course, the students will be able to:

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Course content

Unit 1 **10 Hours**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Unit 2 **10 Hours**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Unit 3 **10 Hours**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit 4 **20 Hours**

Scheduling and sequencing - single server and multiple server models – deterministic inventory models - Probabilistic inventory control models – Geometric Programming. Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

Transaction Mode:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested reading:

- *H.A. Taha, Operations Research, An Introduction, PHI, 2008*
- *H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.*
- *J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008*

- *Hitler Libermann Operations Research: McGraw Hill Pub. 2009*
- *Pannerselvam, Operations Research: Prentice Hall of India 2010*
- *Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010*

Semester: IV

Course Title: DISSERTATION-II
Course Code: MEE401

L	T	P	Credits
-	-	-	20

Total Hours: 45

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Synthesis of knowledge.
2. To demonstrate the aptitude of applying the own knowledge to solve a specific problem.
3. To mature the knowledge.
4. Able to organize, compile and record all work details in an efficient manner.

Each student will be required to complete a Project and submit a Project Report on a topic on any of the areas of modern technology related to Electrical Engineering including interdisciplinary fields.