GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

ELECTRICAL ENGINEERING DEPARTMENT

SYLLABUS SCHEME FOR M.TECH (POWER ENGINEERING) FULL-TIME

SEMESTER-I

Sr. No.	Core/ Elective	Course code	Course Name	Hours per week L	Hours per week P	Internal Marks	External Marks	Total	Credits
1.	Core-I	MEP-101	Advanced Power System Analysis	3	0	50	100	150	3
2.	Core-II	MEP-102	Power System Dynamics-I	3	0	50	100	150	3
3.	Core-III	MRM-101	Research Methodology and IPR	3	0	50	100	150	3
4.	Program Elective -I	MEP-103	Renewable Energy System	3	0	50	100	150	3
		MEP-104	Smart grids						
		MEP-105	High Power Converters						
		MEP-106	Wind and Solar Systems						
5.	Program Elective -II	MEP-107	Electrical Power Distribution System	3	0	50	100	150	3
		MEP-108	Mathematical Methods for Power Engineering						
		MEP-109	Pulse Width Modulation for Power Electronics Converters						
		MEP-110	Electric and Hybrid Vehicles						
6.	Lab-I	LMEP-101	Power System Steady State Analysis Lab	0	4	50	50	100	2
7.	Lab-II	LMEP-102	Renewable Energy Lab	0	4	50	50	100	2
8.	Audit course I	MAC-101	English for Research Paper Writing	2	0	50	100	150	0
TOTAL				**17**	**8**	**400**	**700**	**1100**	**19**

SEMESTER-II

Sr. No.	Core/ Elective	Course code	Course Name	Hours per week L	Hours per week P	Internal Marks	External Marks	Total	Credits
1.	Core-IV	MEP-111	Digital Protection of Power System	3	0	50	100	150	3
2.	Core-V	MEP-112	Power System Dynamics-II	3	0	50	100	150	3
3.	Program Elective -III	MEP-113	Restructured Power Systems	3	0	50	100	150	3
		MEP-114	Advanced Digital Signal Processing						
		MEP-115	Dynamics of Electrical Machines						
		MEP-116	Power Apparatus Design						
4.	Program Elective -IV	MEP-117	Advanced Micro-Controller Based Systems	3	0	50	100	150	3
		MEP-118	SCADA System and Applications						
		MEP-119	Power Quality						
		MEP-120	Artificial Intelligence Techniques						
5.	Project	MPEP-101	Project	0	4	50	50	100	2
6.	Lab-III	LMEP-103	Power System Protection Lab	0	4	50	50	100	2
7.	Lab-IV	LMEP-104	Smart Grids Lab	0	4	50	50	100	2
8.	Audit courseII	MAC-104	Value Education	2	0	50	100	150	0
TOTAL				**14**	**12**	**400**	**650**	**1050**	**18**

SEMESTER-III									
Sr. No.	**Core/ Elective**	**Course code**	**Course Name**	**Hours per week**		**Internal Marks**	**External Marks**	**Total**	**Credits**
				L	**P**				
1.	Program Elective -V	MEP-121	Power System Transients	3	0	50	100	150	3
		MEP-122	Flexible AC Transmission and Custom Power Devices						
		MEP-123	Industrial Load Modeling and Control						
		MEP-124	Dynamics of Linear Systems						
2.	OE	MOZZ-XXX	Open Elective	3	0	50	100	150	3
3.	Pre-Thesis	MPTEP-101	Pre-Thesis	0	2#+18*	100	100	200	10
TOTAL				**6**	**20**	**200**	**300**	**500**	**16**

Max. Hours for Teacher * Independent Study hours

SEMESTER-IV									
Sr. No.	**Core/ Elective**	**Course code**	**Course Name**	**Hours per week**		**Internal Marks**	**External Marks**	**Total**	**Credits**
				L	**P**				
1.	Thesis	MTEP-101	Thesis	0	4#+28*	100	200	300	16
TOTAL				**0**	**32**				**16**

Max. Hours for Teacher * Independent Study hours

Subject Code: MEP-101
Subject Name: ADVANCED POWER SYSTEM ANALYSIS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Compulsory

Prerequisites: Computer Aided Power System Analysis (at UG Level)
Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Perform load flow analysis using various methods
2	Apply generalized method of fault analysis on simultaneous and open conductors faultsand rank various contingencies according to their severity
3	Apply Ward method and REI equivalents for reduction of large power system models
4	Apply Weighted Least Square method for power system state estimation
5	Estimate closeness to voltage collapse and calculate PV curves

Unit 1 Load flow: Overview of Newton-Raphson, Gauss-Siedel, Fast Decoupled methods, convergence properties, sparsity techniques, handling Q_{min} and Q_{max} violations in Jacobian matrix, inclusion of frequency effects, Automatic Voltage Regulation in load flow.

Unit 2 Faults and Security Analysis: 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 Power System Equivalents: Ward Method, and Radial, Equivalent and Independent(REI)equivalents for reduction of large power system models.

Unit 4 State Estimation: Sources of errors in measurement, Virtual and Pseudo Measurements, Observability, Tracking state estimation, Weighted Least Square method, bad data correction.

Unit 5 Voltage Stability: Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal load flow, voltage collapse proximity indices.

Suggested reading:-

1. J.J. Grainger and W.D.Stevenson, “Power system analysis”, McGraw Hill,2003
2. A. R. Bergen and Vijay Vittal, “Power System Analysis”,Pearson, 2000
3. L.P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 2006
4. G.L. Kusic, “Computer aided power system analysis” ,Prentice Hall India, 1986
5. A. J. Wood, B. F. Wollenberg and G. B. Sheblé, “Power generation, operation and control”, Wiley, 2013
6. P.M. Anderson, “Faulted power system analysis”, IEEE Press , 1995

Subject Code:MEP-102
Subject Name:POWER SYSTEM DYNAMICS-I

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Compulsory

Prerequisites: Electrical Machines (atUG level)

Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability 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
5	Understand the modeling of prime movers

Unit1 Synchronous Machine Modelling: Per unit systems, Park's Transformation and Modified Park's Transformation,Flux-linkage equations.

Unit 2Synchronous Machine Equivalent Representation: Voltage and current equations, Formulation of State-space equations, Equivalent circuit.

Unit 3 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 Synchronous Machine Excitation System: Philips-Heffron model and PSS Load modelling.

Unit 5Prime Movers: Modelling of Hydraulic and steam turbine, governing systems.

Suggested reading:-

1. P. M. Anderson and A. A. Fouad, "Power System Control and Stability", John Wiley & Sons, 2008.
2. J Machowski, J Bialekand J. R W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997.
3. P.Kundur, "Power System Stability and Control", McGraw Hill Inc., 1994.
4. E.W. Kimbark, "Power system stability", John Wiley & Sons, 2002.

Subject Code:MRM-101
Subject Name:RESEARCH METHODOLOGY AND IPR

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**:
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**

Prerequisites: Minor/ Major Projects (at UG level)
Additional Material allowedin ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Understand research problem formulation and analyze research related information.
2	Attain the knowledge of research ethics
3	Attain the knowledge of writing reports and research papers
4	Understanding emphasis of Intellectual Property Right and patenting
5	Gain the knowledge about new developments in IPR

Unit 1Introduction: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2 Literature Studies Approaches: Effective literature studies approaches, analysis, plagiarism, and research ethics

Unit 3 Effective Technical Writing: Writing reports and research papers, Developing a Research Proposal, Format of research proposal, presentation and assessment

Unit 4Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grantsof patents,Patenting under Patent Cooperation Treaty(PCT).

Unit 5Patent Rights: Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications, administration of Patent System. New developments in IPR; IPR of Biological Systems, related computer software

Suggested readings:-

1. S. Melville and W. Goddard, “Research methodology: an introduction for science and engineering students”, Juta Academic, 1996
2. R. Kumar, “Research Methodology: A Step by Step Guide for beginners”, SAGE,2014
3. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
4. Mayall, “Industrial Design”, McGraw Hill, 1992.
5. Niebel , “Product Design”, McGraw Hill, 1974.
6. Asimov, “Introduction to Design”, Prentice Hall, 1962.
7. R. P. Merges, P. S. Menell, M. A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
8. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

Subject Code:MEP-103
Subject Name:RENEWABLE ENERGY SYSTEM

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-I

Prerequisites: Non Conventional Energy Sources (at UG level)
Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Understand distributed and central generating station
2	Understand aboutrenewable sources of energy
3	Apply the concepts of power electronic for gridinterfacing of distributed generators
4	Understand power quality issues of distributed generation
5	Attain the knowledge of protection and economics of distributed generation

Unit 1Introduction: Distributed vs. Central Station Generation, Turbo-generator, Nucleargenerator andMicro-turbines.

Unit 2Renewable Sources of Energy: Introduction to Solar Energy, Wind Energy, Combined Heat and Power, Hydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells.

Unit 3Interfacing Distributed Generators with Grid: Applications ofPower Electronic devices for GridInterfacing of Distributed Generators.

Unit 4Power Quality Issues: Impact of Distributed Generation on the Power System, Power Quality Disturbances.

Unit 5 Protection and Economics: Transmission System Operation, Protection of Distributed Generators, Economics of Distributed Generation.

Suggested reading:-

1. R. Ranjan,D.P.Kothari, andK.C.Singal, “Renewable Energy Sources and Emerging Technologies”, Prentice Hall of India,2011.
2. M.H.Bollen and F.Hassan, “Integration of Distributed Generation in the Power System”, Wiley – IEEE Press,2011.
3. L.L. Lai and T.F. Chan, “Distributed Generation: Induction and Permanent Magnet Generators”, Wiley-IEEE Press,2007.
4. R. A. Messenger and J. Ventre, “Photovoltaic System Engineering”, 2010.
5. J.F.Manwell, J.G. McGowan and A.L Rogers, “Wind energy explained: Theory, Design and Application”, John Wiley and Sons, 2010.

Subject Code:MEP-104
Subject Name:SMART GRIDS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-I

Prerequisites: Power System and Microcontroller (at UG level)

Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability 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
5	Come up with smart grid solutions using modern communication technologies

Unit 1Introduction 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.

Unit 2Introduction 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 3 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 4 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 5 Smart Communication: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood 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

Suggested reading:-

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

Subject Code:MEP-105
Subject Name:HIGH POWER CONVERTERS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-I

Prerequisites: Power Electronics (at UG level)

Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Learn the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems
2	Knowledge of working of multi-level VSIs, and the ability to use them properly
3	Knowledge of working of DC-DC switched mode converter and cyclo-converters.
4	Acquire knowledge of power conditioners and their applications
5	Ability to design power circuit of PSDs and converters

Unit 1Power electronic systems: An overview of Power Switching Devices, multi-pulse diode rectifier, multi-pulse SCR.

Unit 2Multilevel voltage source inverters: Two level voltage source inverter, cascaded, H bridge multilevel inverter, Diode clamped multilevel inverters, flying capacitor multilevel inverter

Unit 3DC to DC switch mode converters: Introduction to DC-DC Converters, Control of DC-DC Converters, Buck Converter, Boost Converter, Buck-Boost Converter, Cuk Converter, Full Bridge DC-DC Converter. Forward, Push-Pull and Fly back converters. Comparison of DC-DC Converters.

Unit 4AC voltage controllers: Cyclo-converters, matrix converter, Power conditioners and UPS.

Unit 5Practical Converter Design Considerations: 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.

Suggested reading:-

1. N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converter, Applications and Design”, John Wiley and Sons, 1989
2. M.H. Rashid, “Power Electronics”, Prentice Hall of India, 1994
3. B. K .Bose, “Power Electronics and A.C. Drives”, Prentice Hall, 1986
4. B. Wu, “High power converters and drives”, IEEE press, Wiley Enter science

Subject Code:MEP-106
Subject Name:WIND AND SOLAR SYSTEMS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-I

Prerequisites: Renewable Energy Sources(At UG Level)

Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Appreciate the importance of characteristics of wind power generation and network integration issues.
2	Demonstrate the knowledge of the application of Power Electronics for Power quality improvement of wind generators
3	Identify the problems and develop solutions for integration of wind generation in power system.
4	Demonstrate the knowledge of physics of solar power generation and the associated issues
5	Demonstrate the knowledge of various types of solar power generations.

Unit 1Historical development and current status:Characteristics of wind power generation, network integration issues

Unit 2Power electronics for wind turbines: Power quality standards for wind turbines, Technical regulations for interconnections of wind farm with power systems.

Unit 3Integration of Wind Generators in Power System: Isolated wind systems, reactive power and voltage control, economic aspects, impacts on power system dynamics, power system interconnection

Unit 4Introduction of solar systems: Merits and demerits, concentrators, various applications.

Unit 5Solar power generation:Solar thermal power generation, PV power generation, Energy Storage device, designing the solarsystem for small installations.

Suggested reading:-

1. T. Ackermann, Editor, “Wind power in Power Systems”, John Willy and sons ltd.2005
2. S.Heier, “Grid integration of wind energy conversion systems”, John Willy and sons ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, “Solar Energy”. Tata McGraw Hill, Second Edition, 1996

Subject Code:MEP-107
Subject Name:ELECTRIC POWER DISTRIBUTION SYSTEM

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-II

Prerequisites: Power System Transmission and Distribution (at UG level)
Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability 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
5	Understand the problems and challenges of Distribution automation

Unit1Introduction: Distribution of Power, Management, Power Loads, Load Forecasting Short-term and Long-term, Power System Loading, Technological Forecasting.

Unit 2Distribution Management System: Advantages, Distribution Automation: Definition,Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction

Unit3Supervisory Control and Data Acquisition (SCADA) System: Introduction, Block Diagram, SCADA Applied To Distribution Automation, Common Functions of SCADA, Advantages of Distribution Automation through SCADA,Control and Communication Systems, Remote Metering, Automatic Meter Reading and its implementation

Unit 4Distribution 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 5 Maintenance of Automated Distribution Systems: Difficulties in Implementing Distribution, Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation

Suggested reading:-

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd. 2008.
2. M.K. Khedkar and G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, 2011
3. A.J.Panseni, "Electrical Distribution Engineering", CRC Press,2012
4. J.Momoh, "Electric Power Distribution, automation, protection and control", CRC Press,2012

Subject Code:MEP-108
Subject Name:MATHEMATICAL METHODS FOR POWER ENGINEERING

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-II

Prerequisites: Numerical Statistical Techniques (at UG level)
Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Attain the knowledge of vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators
2	To learn about linear programming problems and understanding the simplex method for solving linear programming problems
3	Acquire knowledge about solving unconstrained nonlinear programming
4	Understanding the concept of random variables, functions of random variable and their probability distribution
5	Understand stochastic processes and their classification

Unit 1 Introduction: Vector spaces, linear transformations, Matrix representation of linear transformation,Eigen values and Eigen vectors of linear operator

Unit 2 Linear Programming: Formulation, Simplex Method, Duality.

Unit 3Non Linear Programming: Formulation, Unconstrained Problems, Search methods.

Unit 4Constrained Problems: Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions.

Unit 5Stochastic Processes: Introduction, Independent Random Variables, Marginal and Conditional distributions.

Suggested reading:-

1. K. Hoffman and R.Kunze, "Linear Algebra", 2nd Edition, PHI, 1992
2. E.Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004
3. I. Miller , M. Miller and J. E. Freund's "Mathematical Statistics", PHI, 2002
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", McGraw Hill, 2002
6. J. B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley, 2000
7. F.S.Hillier and G.J.Liebermann, "Introduction to Operations Research", McGraw Hill, 2001
8. D.M.Simmons, "Non Linear Programming for Operations Research", PHI, 1975

Subject Code:MEP-109
Subject Name:PULSE WIDTH MODULATION FOR PE CONVERTERS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-II

Prerequisites: Power Electronics (At UG Level)

Additional Material allowedin ESE: Scientific Calculator (Non-programmable)

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
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
5	Demonstrate the necessity of providing minimum pulse width and its effect

Unit 1Introduction: Introduction to Power Electronic converters, Modulation of one inverter phase leg, Modulation of single phaseVSI and 3 phase VSI.

Unit 2 Modulation: Zero space vector placement modulation strategies, Losses-Discontinuous modulation, Modulation of CSI, over modulation of converters, programme modulation strategies

Unit 3Pulse width modulation: Pulse width modulation for multilevel inverters, Implementation of modulation controller

Unit 4Recent developments: Continuing developments in modulation as random PWM, PWM for voltage unbalance

Unit 5Minimum pulse width: Effect of minimum pulse width and necessity of providing dead time

Suggested reading:-

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. B.Vew, “High Power Converter”, Wiley Publication
3. M. K. Kazimicrczuk, “Pulse width modulated dc-dc power converter”, Wiley Publication

Subject Code:MEP-110
Subject Name:ELECTRIC AND HYBRID VECHILES

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective-II

Prerequisites: Electrical Machines and Electric Drives (at UG level)
Additional Material allowedin ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
2	Understand hybrid drive-train topologies.
3	Attain the knowledge about DC motor drives configuration and control
4	Understand the selection and sizing of energy storage systems
5	Compare different energy management strategies

Unit 1History of Hybrid and Electric Vehicles: Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterizationTransmission characteristics.

Unit 2 Hybrid Drive-Train Topologies: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

Unit 3 DC Motor Drives Configuration and Control: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance, Drive system efficiency.

Unit 4Matching the Electric Machine and Internal Combustion Engine: Sizing the propulsion motor, Selectingthe energy storage technology, sizing the power electronics devices for energy storage.

Unit 5Introduction to Energy Management and Their Strategies: Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies.

Suggested reading:-

1. S. Ramirez, R. S.Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer,2011
2. S.C. Tan, Y.M. Lai and C. K.Tse, “Sliding mode control of switching Power Converters” CRC press, 2012

Subject Code:LMEP-101
Subject Name:LAB 1- POWER SYSTEM STEADY STATE ANALYSIS

Programme: M.Tech (Power Engg.)	**L: 0 T: 0 P: 4**
Semester:1	**Teaching Hours**:
Theory/Practical: Practical	**Credits:**2
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**
External Marks:	**Duration of End Semester exam (ESE):**
Total marks:	**Elective Status:**Core

Prerequisites: CAPSA Lab (At UG Level)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to apply software tools for:
1	Load flow techniques, short circuit, transient stability
2	Load forecasting and unit commitment
3	Thyristor converters and IGBT inverters
4	PID controller using software and hardware tools

Experiments:-

Sr. No.	**Name of Practical**
	Use of MATLAB /SIMULNK/PSIM/PSAT/MiPOWER/PSCAD/ETAP/other software tools for following experiments
1.	Load Flow Studies
2.	Short Circuit Studies.
3.	Transient Stability Studies
4.	Load Forecasting
5.	Unit Commitment
6.	Simulation of Thyristor Converters.
7.	Simulation of IGBT Inverters.
8.	Simulation of PID controller
9.	Hardware design of PID using ARDUINO UNO
10.	Weighted Least Square Method for state estimation

Subject Code:LMEP-102
Subject Name: LAB2- RENEWABLE ENERGY LAB

Programme: M.Tech (Power Engg.)	**L: 0 T: 0 P: 4**
Semester:1	**Teaching Hours**:
Theory/Practical: Practical	**Credits:**2
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**
External Marks:	**Duration of End Semester exam (ESE):**
Total marks:	**Elective Status:**Core

Prerequisites:

CO#	Course Outcomes (CO)
	On Completion of the course, the student will have the ability 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

Experiments:-

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.	Analysis of renewable energy resources in HOMER software
8.	Test the Capabilities of Solar Panels

Subject Code:MAC-101
Subject Name:ENGLISH FOR RESEARCH PAPER WRITING

Programme: M.Tech (Power Engg.)	**L: 2 T: 0 P: 0**
Semester:1	**Teaching Hours**:
Theory/Practical: Theory	**Credits:**2
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status: Audit-I**

Prerequisites: Communication Skills (at UG level)

Additional Material allowedin ESE: Nil

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Plan and prepare research papers/ reports
2	Prepare layout and sections of a report/ research paper
3	Develop skills for readability and writing review of the Literature
4	Develop skills for writing various sections of a research paper/ report
5	Develop skills for ensuring quality of research paper/ report

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

Unit 2Layout of a report/ research paper: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Unit 3 Review of the Literature: Introduction, Methods, Results, Discussion, Conclusions, The Final Check. 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,

Unit 4 Writing Skills: 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

Unit 5Miscellaneous Topics: Usefulphrases, ensuring quality of research paper, first- time submission

Suggested readings:-

1. R. Goldbort, “Writing for Science”, Yale University Press, 2006
2.R.Day,“How to Write and Publish a Scientific Paper”, Cambridge University Press, 2006

3.N. Highman, “Handbook of Writing for the Mathematical Sciences”, SIAM,1998.

4.A.Wallwork, “English for Writing Research Papers”, Springer New York, 2011

Subject Code:MEP-111
Subject Name:DIGITAL PROTECTION OF POWER SYSTEM

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Core

Prerequisites:
Additional Material allowed in ESE:
On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Learn the importance of Digital Relays
2	Apply Mathematical approach towards protection
3	Learn to develop various Protection algorithms

Unit1 Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection

Unit 2 Mathematical background to protection algorithms, Finite difference techniques

Unit 3 Interpolation formulae, Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis ,Fourier series and Fourier transform, Walsh function analysis

Unit 4 Basic elements of digital protection, Signal conditioning: transducers, surge protection, analogfiltering, analog multiplexers, 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

Unit 5 Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm, Fourier and Walsh based algorithms

Unit 6 Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm, Walsh function based algorithm. Least Squares based algorithms. 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.

Suggested reading:-

1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999
3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4. S.R.Bhide “Digital Power System Protection” PHI Learning Pvt.Ltd.2014

Subject Code:MEP-112
Subject Name:POWER SYSTEM DYNAMICS-II

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Core

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Gain valuable insights into the phenomena of power system including obscure ones.
2	Understand the power system stability problem
3	Analyze the stability problems and implement modern control strategies
4	Simulate small signal and large signal stability problems

Unit 1 Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System

Unit 2 Effect of Damper, Flux Linkage Variation and AVR

Unit 3 Large Signal Rotor Angle Stability, Dynamic Equivalents And Coherency, Direct Method of Stability Assessment, Stability Enhancing Techniques, Mitigation Using Power System Stabilizer

Unit 4 Asynchronous Operation and Resynchronization, Multi-Machine Stability

Unit 5 Dynamic Analysis of Voltage Stability, Voltage Collapse

Unit 6 Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures

Suggested reading:-

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994
2. J. Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. L. Leonard Grigsby (Ed.); “Power System Stability and Control”, Second edition, CRC Press, 2007
4. V. Ajjarapu, “Computational Techniques for voltage stability assessment and control”; Springer, 2006

Subject Code:MEP-113
Subject Name:RESTRUCTURED POWER SYSTEMS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective III

Prerequisites:
Additional Material allowed in ESE:
On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Describe various types of regulations in power systems.
2	Identify the need of regulation and deregulation.
3	Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4	Identify and give examples of existing electricity markets.
	Classify different market mechanisms and summarize the role of various entities in the market.

Unit 1 Fundamentals of restructured system, Market architecture, Load elasticity, Social welfare maximization

Unit 2OPF: Role in vertically integrated systems and in restructured markets, congestion management

Unit 3 Optimal bidding, Risk assessment, Hedging, Transmission pricing, Tracing of power

Unit 4 Ancillary services, Standard market design, Distributed generation in restructured markets

Unit 5 Developments in India, IT applications in restructured markets

Unit 6 Working of restructured power systems, PJM, Recent trends in Restructuring

Suggested reading:-

1. LorrinPhilipson, H. Lee Willis, “Understanding electric utilities and de-regulation”, Marcel Dekker Pub.,1998.
2. Steven Stoft, “Power system economics: designing markets for electricity”, John Wiley and Sons, 2002.
3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, “Operation of restructured power systems”, Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, MuwaffaqAlomoush, “Restructured electrical power systems: operation, trading and volatility”, Marcel Dekker.

Subject Code: MEP-114
Subject Name:ADVANCED DIGITAL SIGNAL PROCESSING

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective III

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
2	Study the design techniques for IIR and FIR filters and their realization structures.
3	Acquire knowledge about the finite word length effects in implementation of digital filters
4	. Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
5	Design of optimum FIR and IIR filters

Unit1 Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signals, Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform, Z transform-Properties of different transforms

Unit 2 Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method

Unit 3FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantisation effects in IIR and FIR filters

Unit 4 A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zeroInput limit cycles in IIR filters Linear Signal Models

Unit 5 All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals. Estimation of power spectrum of stationary random signals

Unit 6 Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters

Suggested reading:-

1. Sanjit K Mitra, “Digital Signal Processing: A computer-based approach “,TataMc Grow-Hill Edition1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, “Statistical and Adaptive Signal Processing”, Mc Grow Hill international editions. -2000

Subject Code: MEP-115
Subject Name:DYNAMICS OF ELECTRICAL MACHINES

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective III

Prerequisites:
Additional Material allowed in ESE:
On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics
2	Knowledge of transformations for the dynamic analysis of machines
3	Knowledge of determination of stability of the machines under small signal and transient conditions
4	Study about synchronous machine

Unit 1 Stability,Primitive 4 Winding Commutator Machine, Commutator Primitive Machine, Complete Voltage Equation of Primitive 4 Winding Commutator Machine

Unit 2 Torque EquationAnalysis of Simple DC Machines using the Primitive Machine Equations, The Three Phase Induction Motor, Transformed Equations, Different Reference Frames for Induction Motor Analysis Transfer Function Formulation

Unit 3 Three Phase Salient Pole Synchronous Machine, Parks Transformation, Steady State Analysis

Unit 4 Large Signal Transient, Small Oscillation Equations in State Variable form, Dynamical Analysis of Interconnected Machines

Unit 5 Large Signal Transient Analysis using Transformed Equations, DC Generator /DC Motor System

Unit 6 Alternator /Synchronous Motor System

Suggested reading-

1. D.P. Sengupta and J.B. Lynn,” Electrical Machine Dynamics”, The Macmillan Press Ltd. 1980
2. R Krishnan “Electric Motor Drives, Modeling, Analysis, and Control”, Pearson Education., 2001
3. P.C. Kraus, “Analysis of Electrical Machines”, McGraw Hill Book Company,1987
4. I. Boldiaand S.A. Nasar,,”Electrical Machine Dynamics”, The Macmillan Press Ltd. 1992 5. C.V. Jones, “The Unified Theory of Electrical Machines”, Butterworth, London. 1967

Subject Code: MEP-116
Subject Name:POWER APPARTUS DESIGN

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective III

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used
2	Ability to model and design all types of rotation machines including special machines

Unit 1 Principles of Design of Machines **-**Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling

Unit 2 Specific loadings, choice of magnetic and electric loadings Real and apparent flux **-**densities, temperature rise calculation Separation of main dimension for DC machines, Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating

Unit 3 General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, Calculation of losses, efficiency and regulation, Forces winding during short circuit

Unit 4 General considerations, output equation, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor, Elimination of harmonic torques

Unit 5 Design of stator and rotor winding, slot leakage flux, Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data

Unit 6 Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions, Introduction to Computer Aided Electrical Machine Design Energy efficient machines

Suggested reading:-

1. Clayton A.E, “The Performance and Design of D.C. Machines”, Sir I. Pitman & sons, Ltd.
2. M.G. Say, “The Performance and Design of A.C. Machines “, Pitman
3. Sawhney A.K, “A course in Electrical Machine Design”, Dhanpat Rai& Sons, 5th Edition

Subject Code:MEP-117
Subject Name:ADVANCED MICRO-CONTROLLER BASED SYSTEMS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective IV

Prerequisites:
Additional Material allowed in ESE:
On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	To learn how to program a processor in assembly language and develop an advanced processorbased system
2	To learn configuring and using different peripherals in a digital system
3	To compile and debug a Program
4	To generate an executable file and use it

Unit 1 Basic Computer Organization, Accumulator based Processes-Architecture, Memory Organization-I/O Organization

Unit 2 Micro-Controllers-Intel 8051,Intel 8056- Registers, Memories, I/O Ports, Serial Communication Timers, Interrupts, Programming

Unit 3 Intel 8051 – Assembly language programming, Addressing-Operations, Stack and Subroutines, Interrupts-DMA 8

Unit 4PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication

Unit 5 Digital Signal Processor (DSP), Architecture – Programming, Introduction to FPGA

Unit 6 Microcontroller development for motor control applications, Stepper motor control using micro controller

Suggested reading:-

1. John.F.Wakerly: “Microcomputer Architecture and Programming”, John Wiley and Sons 1981
2. Ramesh S.Gaonker: “Microprocessor Architecture, Programming and Applications with the 8085”, Penram International Publishing (India), 1994
3. Raj Kamal: “The Concepts and Features of Microcontrollers”, Wheeler Publishing, 2005
4. Kenneth J. Ayala, “The 8051 microcontroller”, Cengage Learning, 2004
5. John Morton,” The PIC microcontroller: your personal introductory course”, Elsevier, 2005
6. Dogan Ibrahim,” Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series”, Elsevier, 2008
7. Microchip datasheets for PIC16F877

Subject Code: MEP-118
Subject Name:SCADA SYSTEM AND APPLICATIONS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective IV

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications
2	2Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3	Knowledge about single unified standard architecture IEC 61850
4	To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server
5	Learn and understand about SCADA applications in transmission and distribution sector, industries etc

Unit1 Introduction to SCADA, Data acquisition systems, Evolution of SCADA, Communication technologies

Unit 2 Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA

Unit 3 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 4 SCADA Architecture, Various SCADA architectures, advantages and disadvantages of each system, single unified standard architecture -IEC 61850.

Unit 5 SCADA Communication, various industrial communication technologies, wired and wireless methods and fiber optics, Open standard communication protocols

Unit 6 SCADA Applications: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement, Industries - oil, gas and water

Suggested reading:-

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

Subject Code: MEP-119
Subject Name:POWER QUALITY

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective IV

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
2	To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components
3	To introduce the student to active power factor correction based on static VAR compensators and its control techniques
4	To introduce the student to series and shunt active power filtering techniques for harmonic

Unit 1 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 problems power acceptability curves-IEEE guides, standards and recommended practices.

Unit 2 Harmonics-individual and total harmonic distortion, RMS value of a harmonic waveform- Triplex harmonics-important harmonic introducing devices-SMPS, Three phase power converters- arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Unit 3 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 4 Power factor improvement- Passive Compensation , Passive Filtering , Harmonic ,Resonance, Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC, Based on Bilateral Single Phase and Three Phase Converter

Unit 5 Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection, Filter for single phase, three-phase three-wire and three-phase fourwire 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 6 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

Suggested reading :-

1. G.T. Heydt, “Electric power quality”, McGraw-Hill Professional, 2007
2. Math H. Bollen, “Understanding Power Quality Problems”, IEEE Press, 2000
3. J. Arrillaga, “Power System Quality Assessment”, John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson and A. R.Wood ,”Power system Harmonic Analysis”, Wiley, 199

Subject Code:MEP-120
Subject Name:ARTIFICIAL INTELLIGENCE TECHNIQUES

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:**Elective IV

Prerequisites:
Additional Material allowed in ESE:
On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Learn the concepts of biological foundations of artificial neural networks
2	Learn Feedback networks and radial basis function networks and fuzzy logics
3	Identifications of fuzzy and neural network
4	Acquire the knowledge of GA

Unit 1 Biological foundations to intelligent Systems Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks
Unit 2 Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods
Unit 3 Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA
Unit 4 System Identification using Fuzzy and Neural Network
Unit 5 Genetic algorithm, Reproduction cross over, mutation, Introduction to evolutionary program
Unit 6 Applications of above mentioned techniques to practical problems

Suggested reading:-

1. J M Zurada , “An Introduction to ANN”,Jaico Publishing House
2. Simon Haykins, “Neural Networks”, Prentice Hall
3. Timothy Ross, “Fuzzy Logic with Engg.Applications”, McGraw. Hill
4. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication 5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

Subject Code:LMEP-103
Subject Name:LAB 3-POWER SYSTEM PROTECTION

Programme: M.Tech (Power Engg.)	**L: 0 T: 0 P: 4**
Semester:2	**Teaching Hours**:
Theory/Practical: Practical	**Credits:**2
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**
External Marks:	**Duration of End Semester exam (ESE):**
Total marks:	**Elective Status:**Core

Prerequisites:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	
2	
3	
4	

Experiments:-

Sr. No.	**Name of Practical**
1.	Introduction to Power System Protection
2.	Impact of Induction Motor Starting on Power System
3.	Modelling of Differential Relay using MATLAB
4.	Radial Feeder Protection
5.	Parallel Feeder Protection
6.	Principle of Reverse Power Protection
7.	Differential Protection of Transformer
8.	To the study time vs.voltagecharacteristics of over voltage induction relay

Subject Code:LMEP 104
Subject Name:LAB 4- SMART GRID

Programme: M.Tech (Power Engg.)	**L: 0 T: 0 P: 4**
Semester:2	**Teaching Hours**:
Theory/Practical: Practical	**Credits:**2
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:**
External Marks:	**Duration of End Semester exam (ESE):**
Total marks:	**Elective Status:**Core

Prerequisites:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	
2	
3	
4	

Experiments:-

Sr. No.	**Name of Practical**
1.	Write A Program For Best First Search
2.	Write A Program to Generate the output for A* Algorithm.
3.	Write a Program To Show the Tic Tac Toe Game for 0 and X
4.	Write A Program For Expert System By Using Forward Chaining
5.	Comparing the Search Methods
6.	Implement the Greedy Search Algorithm
7.	Implement the min-max Algorithm
8.	Adding a Heuristic

Subject Code: MEP-121
Subject Name: POWER SYSTEM TRANSIENTS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:3	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective V

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Knowledge of various transients that could occur in power system and their mathematical formulation
2	Analyze electromagnetic transients using computational tools and understand the influence of lightning on power system
3	Understand the source and characteristics of lightning, switching and temporary over voltages
4	Understand wave equations and travelling wave propagation on transmission line
5	Coordinating the insulation of various equipments in power system
6	Ability to design various protective devices in power system for protecting equipment and personnel

Detailed Contents

Part A

Unit 1 Fundamental circuit analysis of electrical transients Laplace Transform method of solving simple Switching transients, Damping circuits -Abnormal switching transients, Three-phase circuits and transients Computation of power system transients

Unit 2 Principle of digital computation – Matrix method of solution Modal analysis- Z transform- Computation using Electromagnetic Transients Program (EMTP), Lightning, switching and temporary over voltages, Lightning, Physical phenomena of lightning.

Unit 3 Interaction between lightning and power system, Influence of tower footing resistance and Earth Resistance, Switching: Short line or kilo metric fault, Energizing transients - closing and, re-closing of lines, line dropping, load rejection – over voltages induced by faults

Part B

Unit 4 Switching HVDC line Travelling waves on transmission line, Circuits with distributed Parameters Wave Equation, Reflection, Refraction, Behavior of Travelling waves at the line terminations, Lattice Diagrams – Attenuation and Distortion, Multi-conductor system and Velocity wave

Unit 5 Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Co-ordination between insulation and protection level, Statistical approach

Unit 6 Protective devices, Protection of system against over voltages, lightning arresters, substation earthling.

Suggested reading: -

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991
2. C. L. Wadhwa, “Electrical Power Systems”, New Age International 2006.
3. Bewley, L.V., Travelling Waves on Transmission System, Power Publications Inc. (1993).
4. Rudenterg, R., Electric Stroke Waves in Power Systems, Harvard University Press (1998).
5. Gonen, T., Electric Power Transmission System Engineering: Analysis and Design, John Wiley and Sons (1997).
6. EPRI, Transmission Line, Reference Book 345KV and above, 1984.
7. Surge Protection in Power Systems, IEEE Publication, 79EHD 144-46PWR.
8. Regaller K., Surges in High Voltage Networks, Plenum Press, 1980.
9. Related IEEE/IEE Publications.

Subject Code: MEP-122
Subject Name: Flexible AC transmission and custom power devices

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:3	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 30%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective V

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
2	Learn various Static shunt VAR Compensation Schemes
3	Understand operation, control and applications of static series compensation
4	Comprehend significance of unified power flow controller
5	To develop analytical skill to model & analyze FACTS Controllers and harmonic mitigation
6	Summarize various power quality parameters

Detailed Contents:

Part A

Unit 1 Reactive power flow control in Power Systems, Control of dynamic power unbalances in Power System - Power flow control, Constraints of maximum transmission line loading , Benefits of FACTS Transmission line compensation, Uncompensated line -Shunt compensation, Series compensation Phase angle control, Reactive power compensation Shunt and Series compensation principles, Reactive compensation at transmission and distribution level

Unit 2 Static shunt compensators: SVC and STATCOM, Operation and control of TSC, TCR and STATCOM -Compensator control, Comparison between SVC and STATCOM

Unit 3 Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators, TCVR and TCPAR Operation and Control, Applications of Static series compensation and their Control.

Part B

Unit 4 Unified Power Flow Controller, Circuit Arrangement, Operation and control of UPFC, Basic Principle of P and Q control, Independent real and reactive power flow control-Applications.

Unit 5 Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers, Simulation of FACTS controllers Power quality problems in distribution systems, harmonics, loads that create harmonics, series and parallel resonances mitigation of harmonics, passive filters, active filtering – shunt, series and hybrid and their control

Unit 6 Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners, IEEE standards on power quality.

Suggested Reading: -

1. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International Publishers, 2007
2. X P Zhang, C Rehtanz, B Pal, “Flexible AC Transmission Systems- Modelling and Control”, Springer Verlag, Berlin, 2006
3. N.G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.

4. K.S. Suresh Kumar, S. Ashok, “FACTS Controllers and Applications”, E-book edition, Nalanda Digital Library, NIT Calicut,2003
5. G T Heydt, “Power Quality”, McGraw-Hill Professional, 2007
6. T J E Miller, “Static Reactive Power Compensation”, John Wiley and Sons, New York, 1982.
7. Understanding Power Quality Problems by Math. H. J. Bollen, Standard Publishers and Distributors, Delhi
8. Song, Y.H. and Allan T. Johns, “Flexible ac transmission systems (FACTS)‟, Institution of Electrical Engineers Press, London, 1999
9. Elinar V. Larsen, Juan J Sanchez – Gasca Joe H. Chow, “Concepts for design of FACTS controllers to damp power swings”, IEEE Transactions on Power Systems, Vol. 10, No. 2, May.1995.
10. Miller. T.J.E., Reactive Power Control in Electric System, John Wiley & Sons, 1997.
11. Dubey G.K., Thyristorized Power Controller, New Age international (P) Ltd. New Delhi 2001.
12. R. Mohan Mathur, Rajiv K Varma, “Thyristor based FACTS Controller for Electrical Power Systems”, John Wiley Sons, 2011.

Subject Code: MEP-123

Subject Name: INDUSTRIAL LOAD MODELING AND CONTROL

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:3	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 30%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective V

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	**Course Outcomes (CO)**
1	Understand the energy demand scenario and industrial load classification
2	Interpret different electricity pricing models and knowledge about load control techniques
3	Understand reactive power management in industries
4	Learn optimization of different types of industrial load profiling using various optimization tools
5	Apply operating and control strategies to reduce demand of electricity during peak time
6	Understand proper selection of appropriate optimization technique for energy saving considering different constraints

Part A

Unit 1 Electric Energy Scenario-Demand Side Management, Industrial Load Management, Load Curves, Load Shaping Objectives, Methodologies, Barriers, Classification of Industrial Loads, Continuous and Batch processes Load Modeling.

Unit 2 Electricity pricing, Dynamic and spot pricing, Models, Direct load control, Interruptible load control, Bottom up approach, scheduling, Formulation of load, Models, Optimization and control algorithms, Case studies

Unit 3 Reactive power management in industries, controls, power quality impacts, application of filters Energy saving in industries

Part B

Unit 4 Cooling and heating load profiling, Modeling, Cool storage, Types, Control strategies, optimal operation, Problem formulation, Case studies

Unit 5 Captive power units, Operating and control strategies, Power Pooling, Operation models, Energy banking, Industrial Cogeneration

Unit 6 Selection of Schemes, Optimal Operating Strategies, Peak load saving, Constraints Problem formulation, Case study, Integrated Load management for Industries.

Suggested reading:-

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
4. H. G. Stoll, "Least cost Electricity Utility Planning”, Wiley Interscience Publication, USA, 1989.

5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995
6. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA
7. Cogeneration as a means of pollution control and energy efficiency in Asia 2000. Guide book byUNESC for ASIA and the Pacific , Book No: ST/ESCAP/2026, UNESCAP, Bangkok
8. Engineers Inc., Atlanta, GA.Richard E. Putman, industrial energy systems: analysis, optimization, and control, ASME Press, 2004
9. ASHRAE Handbooks-1997-2000, American Society of Heating, Refrigerating and Air- conditioning

Subject Code:MEP-124
Subject Name: DYNAMICS OF LINEAR SYSTEMS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:3	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective V

Prerequisites:

Additional Material allowed in ESE:

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	To create state models and learn state space analysis of different systems
2	Knowledge on carrying out detailed stability analysis of linear time varying systems
3	Learn about the stability of linear and nonlinear systems by Lyapunov method.
4	Analyze the effect of sampling on stability, controllability and observability Analyze the stability of a given control system.
5	Acquire knowledge of discrete time linear systems modeling, analysis and design
6	Develop and utilize modern software tools for analysis and design of linear continuous and discrete time systems

Part A

Unit 1 State variable representations of systems, transfer function and transfer function matrix, solutions of state equations

Unit 2 Observability and controllability, minimal realization of MIMO systems, analysis of linear time varying systems, the concepts of stability

Unit 3 Lyapunov stability analysis, Lyapunov function and its properties, controllability by state variable feedback

Part B

Unit 4 Ackerman's Formula, stabilisation by output feedback, asymptotic observers for state measurement, observer design

Unit 5 State space representation of discrete systems, solution of state equations, controllability and observability stability analysis using Lyapunov method

Unit 6 State feedback of linear discrete time systems, design of observers - MATLAB Exercises

Suggested reading:-

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3. K. Ogata, "Modern Control Engineering, (second edition)", Prentice Hall Inc., Englewood Cliffs, N.J., 1990
4. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston ,1984
6. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999
7. Nagrath I.J, Gopal M, Control System Engineering, New age International.

8. Horacio J. Marquez, Nonlinear Control Systems Analysis and Design, Wiley Publications.
9. Hassan K. Khalil, Non Linear Systems, 3rd Edition, Prentice Hall.
10. Eronini Umez – Eronini, "System Dynamics and Conrol", Thomson Asia PTE Ltd. Singapore, ISBN:981-243-113-6, 2002.

Subject Code: MOEE-101
Subject Name: RENEWABLE ENERGY SYSTEM

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective-I

Prerequisites: Non Conventional Energy Sources (at UG level)

Additional Material allowed in ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Understand distributed and central generating station
2	Understand about renewable sources of energy
3	Apply the concepts of power electronic for grid interfacing of distributed generators
4	Understand power quality issues of distributed generation
5	Attain the knowledge of protection of distributed generation
6	Learn the economics of distributed generation

PART-A

Unit 1 Distributed vs. Central Station Generation, Turbo-generator, Nuclear generator and Micro-turbines.

Unit 2 Introduction to Solar Energy, Wind Energy, Combined Heat and Power, Hydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells.

PART - B

Unit 3 Applications of Power Electronic devices for Grid Interfacing of Distributed Generators.

Unit 4 Impact of Distributed Generation on the Power System, Power Quality Disturbances.

Unit 5 Transmission System Operation, Protection of Distributed Generators, Economics of Distributed Generation.

Suggested reading:-

6. R. Ranjan, D.P.Kothari, and K.C.Singal, “Renewable Energy Sources and Emerging Technologies”, Prentice Hall of India,2011.
7. M.H.Bollen and F.Hassan, “Integration of Distributed Generation in the Power System”, Wiley – IEEE Press,2011.
8. L.L. Lai and T.F. Chan, “Distributed Generation: Induction and Permanent Magnet Generators”, Wiley-IEEE Press,2007.
9. R. A. Messenger and J. Ventre, “Photovoltaic System Engineering”, 2010.
10. J. F.Manwell, J.G. McGowan and A.L Rogers, “Wind energy explained: Theory, Design and Application”, John Wiley and Sons, 2010.

Subject Code: MOEE-102
Subject Name: OPTIMIZATION TECHNIQUES

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective-II

Prerequisites:

Additional Material allowedin ESE:

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Classify the optimization problems and their solution methods into various categories.
2	Understand and apply analytical methods for the solution of unconstrained problems
3	Find the optimal solution of constrained problems with continuous variables.
4	Understand and apply analytical methods for the solution of variable unconstrained and constrained optimization problems with non-continuous variables
5	Understand and apply analytical methods for the solution of variable unconstrained and constrained optimization problems with non-continuous variables
6	Apply techniques for optimal solution of multi-variable problems.

PART-A

Unit 1 Statement of an Optimization Problem, Classification of Optimization Problems, Optimization Techniques, Engineering Applications of Optimization.

Unit 2 Single Variable Optimization, Multivariable Optimization with no Constraints, Multivariable Optimization with Equality Constraints, Multi variable Optimization with in Equality Constraints.

PART-B

Unit 3 Standard Form of Linear Programming, Graphical Solution, Simplex Method, Two phase simplex Method, Computer Implementation of The Simplex Method, Duality theory, North-West Corner Rule, Least Cost Method, Vogel Approximation Method, Testing for Optimality.

Unit 4 Unimodal Function, Dichotomous Search, Fibonacci Search, Quadratic Interpolation method, Cubic Interpolation Method.

Unit 5 Random Search Method, Steepest Descent Method, Conjugate Gradient Method, Variable Metric Method, Interior Penalty Function Method, Exterior Penalty Function Method.

Suggested reading:-

1. Rao, S.S., Optimization : Theory and Application Wiley Eastern Press, 2nd edition 1984.
2. Deb Kalyanmoy,.Optimisation for Engineering Design-Algorithms and Examples., Prentice Hall India-1998
3. Taha H.A., Operations Research -An Introduction,Prentice Hall of India,2003.
4. Fox, R.L., Optimization methods for Engineering Design, Addition Welsey, 1971.
5. Ravindran A., Ragsdell K.M. and Reklaitis G.V. , Engineering Optimization: Methods And applications , Wiley, 2008
6. Godfrey C. Onwubolu , B. V. Babu , New optimization techniques in engineering , Springer, 2004

Subject Code: MOEE-103
Subject Name: ORGANISATION AND FINANCE IN POWER SECTOR

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective-III

Prerequisites:

Additional Material allowedin ESE:

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Understand the need of Management Process for Power Utility.
2	Apply Financial Accounting during construction in power sector.
3	Understand the Economics Evaluation of Investment Proposal in Power sector
4	Learn different tariff schemes for system costs.
5	Understand cost levelization and real time pricing.
6	Understand the different structure of a Utility Organization.

PART-A

Unit 1 Organization and Management, the management process, Managerial skills and Managerial performance, Policy and Objectives of a Power Utility, the Goal of a Firm.

Unit 2 Balance Sheet, Income Statements and Cash Report, Depreciation, Interest charges during construction, Financial Statement Analysis.

Unit 3 Interest and compounding, Measure of price- public versus private perspective, Economic evaluation of investment proposal, Internal Rate of return, Pay-Back Period.

PART-B

Unit 4 Traditional approach, Long-run Marginal costs, General Principles of Tariff Construction, Objectives of tariff, Generating system costs, Basic concept of cost levelization, Levelized busbar cost, spot and real time pricing

Unit 5 Functional structure, Divisional Structure, Matrix structure, Hybrid structure, main concerns of electric utilities, Performance of electric utilities.

Suggested reading:-

3. Bartol K. M. and David C., Management, Martin McGraw-Hill, INC
4. Weston J.F., Brigham Essential of Managerial Finance, Dryden Press
5. Stoll, Least-Cost Electric Utility Planning, John Wiley.
6. Stickney C.P. and Weil R.L., Financial Accounting, Dryden Press
7. Berrie T. W., Electricity Economics and Planning, IEE Power Series.
8. Levy H. and Sarnat M., Capital Investment and Financial Decisions, Prentice Hall

Subject Code: MOEE-104
Subject Name: ELECTRIC AND HYBRID VECHILES

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester:1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks:	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:	**Duration of End Semester exam (ESE):** 3 hr
Total marks:	**Elective Status:** Elective-IV

Prerequisites: Electrical Machines and Electric Drives (at UG level)

Additional Material allowedin ESE: Scientific Calculator (Non-programmable)

CO#	**Course Outcomes (CO)**
	On Completion of the course, the student will have the ability to:
1	Acquire knowledge about fundamental concepts and principles of hybrid and electric vehicles.
2	Learn about the analysis and design of hybrid and electric vehicles
3	Understand hybrid drive-train topologies.
4	Attain the knowledge about DC motor drives configuration and control
5	Understand the selection and sizing of energy storage systems
6	Compare different energy management strategies

PART-A

Unit 1 Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics.

Unit 2 Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

PART-B

Unit 3 Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance, Drive system efficiency.

Unit 4 Sizing the propulsion motor, Selecting the energy storage technology, sizing the power electronics devices for energy storage.

Unit 5 Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies.

Suggested reading:-

1. S. Ramirez, R. S. Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer,2011
2. S.C. Tan, Y.M. Lai and C. K. Tse, “Sliding mode control of switching Power Converters” CRC press, 2012