DEPARTMENT OF ELECTRICAL ENGINEERING

SYLLABUS SCHEME FOR M.TECH (POWER ENGINEERING) FULL-TIME 2019 ONWARDS

SEMESTER-I									
Sr. No.	**Course Type**	**Course code**	**Course Name**	**Hours per week**		**Internal Marks**	**External Marks**	**Total**	**Credits**
				L	**P**				
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.	Mandatory	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	Dynamics of Electrical Machines						
		MEP-106	SCADA System and Applications						
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 Laboratory	0	4	50	50	100	2
7.	Lab-II	LMEP-102	Renewable Energy Laboratory	0	4	50	50	100	2
8.	Audit Course-I	MAC-XXX	Audit Course	2	0	50	-	50	S/US
TOTAL				**17**	**8**	**400**	**600**	**1000**	**19**

SEMESTER-II									
Sr. No.	**Course Type**	**Course code**	**Course Name**	**Hours per week**		**Internal Marks**	**External Marks**	**Total**	**Credits**
				L	**P**				
1.	Core-III	MEP-111	Digital Protection of Power System	3	0	50	100	150	3
2.	Core-IV	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	High Power Converters						
		MEP-116	Power Apparatus Design						
4.	Program Elective -IV	MEP-117	Advanced Micro-Controller Based Systems	3	0	50	100	150	3
		MEP-118	Wind and Solar Systems						
		MEP-119	Power Quality						
		MEP-120	Artificial Intelligence Techniques						
5.	Project	LMPEP-101	Project	0	4	50	50	100	2
6.	Lab-III	LMEP-103	Power System Protection Laboratory	0	4	50	50	100	2
7.	Lab-IV	LMEP-104	Smart Grid Laboratory	0	4	50	50	100	2
8.	Audit course-II	MAC-XXX	Audit Course	2	0	50	-	50	S/US
TOTAL				**14**	**12**	**400**	**550**	**950**	**18**

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA
M.TECH (POWER ENGINEERING) FULL-TIME 2019 ONWARDS

SEMESTER-III									
Sr. No.	**Course Type**	**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.	Open Elective	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.	**Course Type**	**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

LIST OF AUDIT COURSES		
S. No.	**Course Code**	**Course Name**
1.	MAC-101	English for Research Paper Writing
2.	MAC-102	Disaster Management
3.	MAC-103	Sanskrit for Technical Knowledge
4.	MAC-104	Value Education
5.	MAC-105	Constitution of India
6.	MAC-106	Pedagogy Studies
7.	MAC-107	Stress Management by Yoga
8.	MAC-108	Personality Development through Life Enlightenment Skills

LIST OF OPEN ELECTIVE SUBJECT OFFERED TO OTHER DEPARTMENTS		
S. No.	**Course Code**	**Course Name**
1.	MOEP-101	Renewable Energy System
2.	MOEP-102	Optimization Techniques
3.	MOEP-103	Organisation & Finance in Power Sector
4.	MOEP-104	Electric and Hybrid Vehicles

GUIDELINES FOR M.TECH THESIS

For evaluation of M.Tech. Thesis at Mid-Term and End Semester Evaluation, the board will consist of Supervisor, M.Tech Incharge/HOD and one observer minimum of rank of Associate Professor and above from other than the parent department.

The following Procedure is to be adopted for evaluation.

a) Published/Accepted for publication in International/National/SCI Journal (non paid) with consent of Supervisor - 15 Marks
b) Published/Accepted for publication in International/National Journal Non SCI Non paid (Science Citation Index) with consent of Supervisor – 10 Marks
c) Published and Presented for publication in International Conference – 7 Marks
d) Published and Presented for publication in National Conference with consent of Supervisor- 5 Marks.

For distinction, the candidate will have to earn at least A grade in Theory and O grade in Thesis. For obtaining O grade, the candidate has to publish a paper in any of the above mentioned categories (a to d).

In addition, the thesis report is to be submitted in spiral binding for external viva voce examination.

The hard bind report will be submitted (after incorporation of any modification recommended by the External Examiner) after the final viva-voce exam.

No dues will be submitted to office of Dean Academics after the end of final viva-voce exam.

After that the notification will be released from the office of Controller of Examination.

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hour
Total marks: 150	**Elective Status:** Compulsory

Prerequisites: Computer Aided Power System Analysis (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	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 **11 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 **11 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 **11 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 **11 Hours**

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

Text/Reference:

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

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

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Compulsory

Prerequisites: Electrical Machines (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	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

UNIT 1 **11 Hours**
Synchronous Machine Modelling: Per unit systems, Park's Transformation and Modified Park's Transformation, Flux-linkage equations.

UNIT 2 **11 Hours**
Synchronous Machine Equivalent Representation: Voltage and current equations, Formulation of State-space equations, Equivalent circuit.

UNIT 3 **11 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 **11 Hours**
Synchronous Machine Excitation System, Philips-Heffron model and PSS Load modelling, Prime Movers, Modelling of Hydraulic and steam turbine, governing systems.

Text/Reference:

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.

E-Book and Online learning material:

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

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Mandatory

Prerequisites: Minor/ Major Projects (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	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 1 Introduction: 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 by a review committee.

Unit 4 Nature 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 grants of patents, Patenting under Patent Cooperation Treaty (PCT).

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

Text/Reference:

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

E-Book and Online learning material:

1. https://www.coursera.org/learn/research-methods
2. https://www.lawctopus.com/certificate-course-on-research-methodology-online/
3. "How to Build a Start-up", Available at Udacity, Self-Paced (One Month). https://in.udacity.com/course/how-to-build-a-startup--ep245
4. "Intellectual Property Rights: A Management Perspective, Available at edx (Offered by IIM Bangalore), Starts on 1 August 2018 (6 weeks). https://www.edx.org/intellectual-property-rights-a-management-perspective

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-I

Prerequisites: Non-Conventional 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	Understand distributed and central generating station
2	Understand aboutrenewable 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 and economics of distributed generation

UNIT 1 **11 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 **11 Hours**

Interfacing Distributed Generators with Grid: Applications of Power Electronic devices for Grid Interfacing of Distributed Generators.

UNIT 3 **11 Hours**

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

UNIT 4 **11 Hours**

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

Text/Reference:

1. R. Ranjan, D. P. Kothari, and K. 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.

E-Book and Online learning material:

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

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-I

Prerequisites: Power System and Microcontroller (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 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 1 **12 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 **11 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 **11 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), 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

Text/Reference:

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

E-Book and Online learning material:

1. N.P. Pandey, “Introduction to smart grid”, IIT Roorkee
   https://swayam.gov.in/courses/4778-july-2018-introduction-to-smart-grid
2. Narayana Prasad Padhy, Premalata Jena, “Introduction to Smart Grid,” NPTEL
   https://onlinecourses.nptel.ac.in/noc18_ee42/preview

3. M. Vadari, M. Balasubramanyan, Distributed Energy – Smart Grid Resources for the Future, IEEE, Coursera
4. Dr. M. Vadari and M. Balasubramanyan, Smart Grids: Electricity for the Future, IEEE & EDX
5. Laura Ramirez, Pavol Bauer & Seyedmahdi Izadkhast, "Solar Energy: Integration of Photovoltaic Systems in Microgrids", Delf University of Technology, https://www.edx.org/course/solar-energy-integration-photovoltaic-delftx-pv4x-0

Subject Code: MEP-105
Subject Name: DYNAMICS OF ELECTRICAL MACHINES

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester: 1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:**3
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-I

Prerequisites: Electrical machines (At UG Level)
Additional Material allowed in ESE: Scientific Calculator
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
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
5	Study about synchronous machine

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 **11 Hours**

Torque Equations: Torque Equation Analysis 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 **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

Text/Reference:

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. 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_03042018_095922AM.pdf

Subject Code: MEP-106
Subject Name: SCADA SYSTEM AND APPLICATIONS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester: 1	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:** 3
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-I

Prerequisites: Microcontroller (At UG Level)
Additional Material allowed in ESE: Scientific Calculator
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	Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3	Knowledge about single unified standard architecture IEC 61850
4	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

UNIT 1 **11 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 **11 Hours**

Industry SCADA System: 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 **11 Hours**

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

UNIT 4 **11 Hours**

Communication Technologies: 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

Text/Reference:

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, “Cyber security for SCADA systems”, Penn Well 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

E-Book and Online learning material:

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

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-II

Prerequisites: Power System Transmission and Distribution (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	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

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 **11 Hours**

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 its implementation

UNIT 3 **11 Hours**

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

Text/Reference:

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,201
5. Turan Gonen, "Electric Power Distribution Engineering" CRC Press, 2007.
6. 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,

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 60%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-II

Prerequisites: Numerical Statistical Techniques (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	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 **11 Hours**
Vector spaces, linear transformations, Matrix representation of linear transformation, Eigen values and Eigen vectors of linear operator

UNIT 2 **11 Hours**
Linear Programming: Formulation, Simplex Method, Duality, Non Linear Programming: Formulation, Unconstrained Problems, Search methods.

UNIT 3 **11 Hours**
Constrained Problems: Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions.

UNIT 4 **11 Hours**
Stochastic Processes: Introduction, Independent Random Variables, Marginal and Conditional distributions, Monte Carlo Simulation.

Text/Reference:
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

E-Book and Online learning material:
1. https://pdfs.semanticscholar.org/905c/728be51197ea7af9e19e4848f037fb097341.pdf

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-II

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	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 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 **11 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

Text/Reference:

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

E-Book and Online learning material:

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

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: 50	**Percentage of Numerical/Design/ Programming Problems:**40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-II

Prerequisites: Electrical Machines and Electric Drives (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	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 1 **11 Hours**

History 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 characterization Transmission characteristics.

UNIT 2 **11 Hours**

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 **11 Hours**

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 **11 Hours**

Matching the Electric Machine and Internal Combustion Engine: Sizing the propulsion motor, selecting the energy storage technology, sizing the power electronics devices for energy storage, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies.

Text/Reference:

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

E-Book and Online learning material:

1. https://nptel.ac.in/courses/108103009/
2. https://books.google.co.in/books?id=bQFuTCGNYWgC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

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

Programme: M.Tech (Power Engg.)	**L:** 0 **T:** 0 **P:** 4
Semester: 1	**Teaching Hours**: 48
Theory/Practical: Practical	**Credits:** 2
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 100%
External Marks: 50	**Duration of End Semester exam (ESE):** NIL
Total marks: 100	**Elective Status:** Core

Prerequisites: CAPSA Lab (At UG Level)
On Completion of the course, the student will have the ability to apply software tools for:

CO#	Course Outcomes (CO)
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

Sr. No. **Name of Practical**
Use of MATLAB/SIMULNK/PSIM/PSAT/MiPOWER/PSCAD/ETAP/Fuzzy Logic/other software tools for following experiments

1. Load Flow Studies
2. Short Circuit Studies.
3. Transient Stability Studies/Load frequency control of single and multi-area systems
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: RENEWABLE ENERGY LABORATORY

Programme: M.Tech (Power Engg.)	**L:** 0 **T:** 0 **P:** 4
Semester: 1	**Teaching Hours**: 48
Theory/Practical: Practical	**Credits:** 2
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 100%
External Marks: 50	**Duration of End Semester exam (ESE):** NIL
Total marks: 100	**Elective Status:** Core

Prerequisites: Renewable Energy Resources (At UG Level)

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

CO#	Course Outcomes (CO)
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

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
9.	Wind power simulator
10.	Microgrid AC/DC Simulation using RCP.

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

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

Prerequisites: Communication Skills (at UG level)
Additional Material allowed in ESE: Nil
On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
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 2 Layout 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, and skills are needed when writing the Conclusions

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

Text/Reference:

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

E-Book and Online learning material:

1. “Take Your English Communication Skills to the Next Level”. Available at Coursera (Offered by Georgia Institute of Technology), 4 weeks, Starts on September 10, 2018.
   https://www.coursera.org/learn/english-communication-capstone
2. “Effective Communication in Globalised Workplace- The Capstone”. Available at Coursera (Offered by National University of Singapore), 3 weeks, Starts on August 06, 2018.
   https://www.coursera.org/specializations/effective-communication

Subject Code: MAC-102
Subject Name: Disaster Management

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

Prerequisites: Communication Skills (at UG level)
Additional Material allowed in ESE: Nil
On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2	critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4	critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Unit 1 Introduction: Disaster - Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Unit 2 Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem; Natural Disasters - Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches; Man-made disasters - Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Unit 3 Disaster Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards With Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Unit 4 Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Unit 5 Risk Assessment: Disaster Risk - Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

Unit 6 Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India

Text/References:
1. R. Nishith, Singh A.K., "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company.
2. Sahni, Pardeep et al. (Eds.), "Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3. Goel S.L., Disaster Administration and Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Subject Code: MAC-103
Subject Name: Sanskrit for Technical Knowledge

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

Prerequisites: Communication Skills (at UG level)
Additional Material allowed in ESE: Nil
On Completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understanding basic Sanskrit language
2	Ancient Sanskrit literature about science & technology can be understood
3	Being a logical language will help to develop logic in students

Unit 1: Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Unit 2: Order, Introduction of roots, Technical information about Sanskrit Literature

Unit 3: Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Text/References:
1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi

Subject Code: MAC-104
Subject Name: Value Education

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

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

CO#	Course Outcomes (CO)
1	Knowledge of self-development
2	Learn the importance of Human values
3	Developing the overall personality

Unit 1: 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: 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: 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: 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

Text/References:
1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Subject Code: MAC-105
Subject Name: Constitution of India

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

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

CO#	Course Outcomes (CO)
1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. 3.
2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4	Discuss the passage of the Hindu Code Bill of 1956.

Unit 1: History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)

Unit 2: Philosophy of the Indian Constitution: Preamble Salient Features

Uint 3: Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit 4: Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Unit 5: Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit 6: Election Commission: Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

Text/References:
1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Subject Code: MAC-106
Subject Name: Pedagogy Studies

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

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

CO#	Course Outcomes (CO)
1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Unit 1 Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

Unit 2 Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Unit 3 Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? , Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

Unit 4 Professional development: alignment with classroom practices and follow up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Unit 5 Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Text/References:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379

Subject Code: MAC-107
Subject Name: Stress Management by Yoga

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

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

CO#	Course Outcomes (CO)
1	Develop healthy mind in a healthy body thus improving social health also
2	Improve efficiency

Unit 1: Definitions of Eight parts of yog. (Ashtanga)

Unit 2: Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit 3: Asan and Pranayam i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam

Text/References:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Subject Code: MAC-108
Subject Name: Personality Development through Life Enlightenment Skills

Programme: M.Tech (Power Engg.)	**L:** 2 **T:** 0 **P:** 0
Semester: 1/2	**Teaching Hours**: 28
Theory/Practical: Theory	**Credits:** S/US
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 0%
External Marks: 00	**Duration of End Semester exam (ESE):** NA
Total marks: 50	**Elective Status:** Audit Course

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

CO#	Course Outcomes (CO)
1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3	Study of Neetishatakam will help in developing versatile personality of students.

Unit 1 Neetisatakam-Holistic development of personality:

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

Unit 2 Approach to day to day work and duties:
Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.

Unit 3 Statements of basic knowledge:

- Shrimad Bhagwad Geeta: Chapter 2-Verses 56, 62, 68, Chapter 12 -Verses 13, 14, 15, 16,17,
- Personality of Role model.
- Shrimad Bhagwad Geeta: Chapter 2-Verses 17, Chapter 3-Verses 36,37, 42, Chapter 4-Verses 18, 38,39, Chapter18 – Verses 37,38,63

Text/References:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Core

Prerequisites: Power System (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	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
5	Apply digital protection techniques in power system

UNIT 1 **11 Hours**
Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection, Mathematical background of protection algorithms.

UNIT 2 **11 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 **11 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 Morrison) algorithm,

UNIT 4 **11 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.

Text/Reference:

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
5. 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/

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Core

Prerequisites: Power System Dynamics-I
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	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
5	Simulate small signal and large signal stability problems

UNIT 1 **11 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 **11 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 **11 Hours**
Asynchronous Operation and Resynchronization, Multi-Machine Stability, Dynamic Analysis of Voltage Stability, Voltage Collapse

UNIT 4 **11 Hours**
Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures, use of simulation tool for automatic generation control.

Text/Reference:
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 & 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/

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective III

Prerequisites: Power System analysis
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	Identify the need of regulation and deregulation.
2	Understand market architectures in deregulated power system environment.
3	Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4	Identify and give examples of existing electricity markets.
5	Classify different market mechanisms and summarize the role of various entities in the market.

UNIT 1 **11 Hours**
Fundamentals of restructured system, Market architecture, Load elasticity, supply and demand bidding, Social welfare maximization

UNIT 2 **11 Hours**
Optimal power flow (OPF): Role of OPF in vertically integrated systems and in restructured markets, congestion management techniques

UNIT 3 **11 Hours**
Optimal bidding, Risk assessment, Hedging, Transmission pricing, Tracing of power, Ancillary services, Standard market design, distributed generation in restructured markets

UNIT 4 **11 Hours**
Developments in India, Information Technology applications in restructured market, working of restructured power systems, Pennsylvania-New Jersey-Maryland (PJM) Interconnection, recent trends in Restructuring

Text/Reference:
1. Lorrin Philipson, 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, Muwaffaq Alomoush, “Restructured electrical power systems: operation, trading and volatility”, Marcel Dekker.
5. P. Venkatesh, B.V. Manikandan. S. Charles Raja. A. Srinivasan. Electrical. Power Systems. Analysis, Security and Deregulation, PHI Learning, 2012
6. Loi Lei Lai.Power System Restructuring and Deregulation: Trading, Performance and Information Technology., Wiley, 2001
7. A. R. Abhyankar, S. A. Khaparde, Restructured Power Systems, Narosa, 2011

E-Book and Online learning material:
1. https://nptel.ac.in/courses/108/101/108101005/

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective III

Prerequisites: Linear algebra, Calculus and multivariable calculus, Signal and system (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	Analyze the time domain and frequency domain representations as well analysis of discrete time signals and systems
2	Understand the design techniques for IIR and FIR filters and their realization structures.
3	Understand the implementation of digital filters
4	Understand about the various linear signal models and estimation of power spectrum of stationary random signals
5	Design of optimum FIR and IIR filters

UNIT 1 **11 Hours**

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 (DFT),

UNIT 2 **11 Hours**

Z transform-Properties of different transforms, linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, bilinear transformation method

UNIT 3 **11 Hours**

Finite Impulse Response (FIR) filter design using window functions, Comparison of Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) digital filters, Basic IIR and FIR filter realization structures, Coefficient quantisation effects in IIR and FIR filters, A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling.

UNIT 4 **11 Hours**

All pole, zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals, Optimum linear filters, Optimum signal estimation, Mean square error estimation.

Text/Reference:

1. Sanjit K Mitra, “Digital Signal Processing: A computer-based approach “,Tata Mc 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
3. Andreas Antoniou “Digital Filters: Analysis, Design, and Signal Processing Applications” Tata Mc Grow-Hill Edition 2018

E-Book and Online learning material:

1. https://nptel.ac.in/courses/108/106/108106151/
2. https://nptel.ac.in/courses/108/105/108105055/
3. http://dl.icdst.org/pdfs/files/025bf242e23c7ed259ea93f3cdfbb2f2.pdf

Subject Code: MEP-115
Subject Name: HIGH POWER CONVERTERS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester: 2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:** 3
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-III

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	Understand the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems
2	Knowledge of working of multi-level VSIs, DC-DC switched mode converters
3	Knowledge of working of CSI and DC-DC switched mode converters
4	Knowledge of working of cyclo-converters, power conditioners and their applications
5	Ability to design power circuit and protection circuit of PSDs and converters

UNITS 1 **11 Hours**
Power electronic systems, An overview of power semiconductor devices (PSD), multipulse diode rectifier, multipulse SCR rectifier.

UNIT 2 **11 Hours**
Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, cascaded, H bridge multilevel inverter.

UNIT 3 **11 Hours**
Diode clamped multilevel inverters, flying capacitor multilevel inverter, PWM current source inverters, DC to DC switch mode converters

UNIT 4 **11 Hours**
AC voltage controllers: Cyclo-converters, matrix converter, Power conditioners and UPS, Design aspects of converters, protection of devices and circuits

Text/Reference:
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. Bin Wu, “High power converters and drives”, IEEE press, Wiley Enter science

E-Book and Online learning material:
1. https://jntuforum.com/files/JNTUK/ElectricMachinesbyB.K.Bose.pdf
2. https://www.academia.edu/36264608/HIGH-POWER_CONVERTERS_AND_AC_DRIVES
3. https://download.e-bookshelf.de/download/0008/4373/77/L-G-0008437377-0017429215.pdf

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective III

Prerequisites: Machine design 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	Understand the general concepts of electrical machine design.
2	Acquire knowledge about various insulating materials used in electrical machine design.
3	Understand the different ways of cooling and ventilation of electric machine.
4	Analyze, design, model and synthesize of Transformers and Induction motors.
5	Learning of mathematical models of power system components

UNIT 1 **11 Hours**

Principles of Design of Machines Basic: General considerations & Limitations in design, specific magnetic and electric loadings, output, real and apparent flux densities, separation of main dimensions for D.C., induction and synchronous machines. Review of different types of insulating materials used in electrical machines.

UNIT 2 **11 Hours**

Heating, Cooling and Ventilation: Introduction, Modes of heat transfer, Heating and cooling of machines, Temperature rise calculation, continuous, short time and intermittent ratings, methods of ventilation and cooling.

UNIT 3 **11 Hours**

Design of Transformers: General considerations, output equation, choice of flux density and current density, main dimensions, leakage reactance & conductor size, design of tank and cooling tubes, calculation of magnetizing current, losses, efficiency and regulation, Recent advances in design of transformer.

UNIT 4 **11 Hours**

Design of Three-Phase Induction Motors & Alternators: General considerations, output equation, choice of specific electric and magnetic loadings, No. of slots in stator and rotor, elimination of harmonic torques, design of stator and rotor windings, leakage reactance, equivalent resistance of squirrel cage rotor, Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions.

Text/Reference:

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
4. Aggarwal R. K., Principles of Electrical Machine Design, S. K. Kataria & Sons.
5. Fitzgerald A.E., Charles Kingsley, Jr, and Stephan D, Umanx, Electric Machinery, Tata McGraw Hill.

E-Book and Online learning material:

1. http://prof.usb.ve/jaller/Fitzgerald.pdf

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective IV

Prerequisites: Microprocessor & Microcontroller (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	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
5	To generate an executable file and use it

UNIT 1 **11 Hours**

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

UNIT 2 **11 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 8

UNIT 3 **11 Hours**

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

UNIT 4 **11 Hours**

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

Text/Reference:

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

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

Subject Code: MEP-118
Subject Name: WIND AND SOLAR SYSTEMS

Programme: M.Tech (Power Engg.)	**L: 3 T: 0 P: 0**
Semester: 2	**Teaching Hours**: 44
Theory/Practical: Theory	**Credits:** 3
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective-IV

Prerequisites: Non Conventional energy resources (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 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
5	Identify, formulate and solve the problems of energy crises using wind and solar energy

UNIT 1 **11 Hours**
Historical development and current status, characteristics of wind power generation, network integration issues

UNIT 2 **11 Hours**
Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm with power systems.

UNIT 3 **11 Hours**
Isolated wind systems, reactive power and voltage control, economic aspects, Impacts on power system dynamics, power system interconnection

UNIT 4 **11 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.

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

E-Book and Online learning material:
1. https://www.rpc.com.au/information/faq/wind-power/wind-energy-systems.html

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks: 100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective IV

Prerequisites: Power Systems & 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	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
5	To impart knowledge about series and shunt active power filtering techniques for harmonic

UNIT 1 **11 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 **11 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

Text/Reference:

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 & A. R.Wood ,”Power system Harmonic Analysis”, Wiley, 2008
5. Dugan R. C., McGranaghan M. F. and Beaty H. W., Electrical Power System Quality”, McGraw-Hill International Book Company
6. Surajit Chattopadhyay , “Electric Power Quality (Power Systems)” springer, 2011 Edition

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/

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: 50	**Percentage of Numerical/Design/ Programming Problems:** 40%
External Marks:100	**Duration of End Semester exam (ESE):** 3 hr
Total marks: 150	**Elective Status:** Elective IV

Prerequisites: Probability and statistics
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	Understand the concepts of biological foundations of artificial neural networks
2	Understand Feedback networks and radial basis function networks and fuzzy logics
3	Explain the concept of fuzzy logic and fuzzy logic system
4	Identifications of neural network
5	Apply concept of genetic algorithms and genetic operator.

UNIT 1 **11 Hours**
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 **11 Hours**
Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods

UNIT 3 **11 Hours**
Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA, System Identification using Fuzzy and Neural Network

UNIT 4 **11 Hours**
Genetic algorithms, Reproduction cross over, mutation, Introduction to evolutionary program, Applications of techniques to practical problems

Text/Reference:

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

E-Book and Online learning material:

1. https://books.google.co.in/books?id=03DfRqUrTwsC&pg

Subject Code: LMEP-103
Subject Name: POWER SYSTEM PROTECTION LABORATORY

Programme: M.Tech (Power Engg.)	**L: 0 T: 0 P: 4**
Semester: 2	**Teaching Hours**: 48
Theory/Practical: Practical	**Credits:** 2
Internal marks: 50	**Percentage of Numerical/Design/Programming Problems:** 100%
External Marks: 50	**Duration of End Semester exam (ESE):** NIL
Total marks: 100	**Elective Status:** Core

Prerequisites: Digital Protection of Power System

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

CO#	Course Outcomes (CO)
1	Understand the operation and characteristics of electro-mechanical/ static/numerical relays.
2	Understand the operation of reverse power protection.
3	Understand the use of microcontroller/ arduino for power system protection.
4	Understand the use of software tool for short circuit analysis.
5	Understand the use of energy analyzer for power system monitoring.

Experiments:-

Sr. No. **Name of Practical**

1. To perform and plot inverse time characteristics of Electro-mechanical Non-directional Over-current relay for power system protection.
2. To perform and plot inverse time characteristics of Electro-mechanical directional Over-current relay for power system protection.
3. To perform and plot the characteristics of Static overcurrent relay.
4. To perform and plot the characteristics of Static earth-fault relay.
5. To perform and plot the characteristics of Numerical Over- and Under- Voltage relays.
6. To perform reverse power protection.
7. Monitoring and analysis of power system using three-phase energy analyser.
8. Determination of ground resistance and soil resistivity.
9. Testing the dielectric strength of insulating oil.
10. Use of Microcontroller/Arduino for power system protection.
11. Short Circuit Analysis using software tool.
12. Modelling of Differential Relay using software tool.

Subject Code: LMEP-104
Subject Name: SMART GRID LABORATORY

Programme: M.Tech (Power Engg.)	**L:** 0 **T:** 0 **P:** 4
Semester: 2	**Teaching Hours**: 48
Theory/Practical: Practical	**Credits:** 2
Internal marks: 50	**Percentage of Numerical/Design/ Programming Problems:** 100%
External Marks: 50	**Duration of End Semester exam (ESE):** NIL
Total marks: 100	**Elective Status:** Core

Prerequisites: Advanced Power System Analysis

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

CO#	Course Outcomes (CO)
1	Understand the fundamental elements of the smart grid system.
2	Understand the use of WAVECT controller for smart grid system.
3	Use simulation tools such as MATLAB/Labview/ WAVECT for power flow analysis, optimization and state estimation
4	Understand communication, networking, and sensing technologies involved with the smart grid.
5	Understand key technologies in generation, transmission and distribution systems that enables smart grid.

Experiments:-

Sr. No. Name of Practical

1. Familiarization with the components of Smart Grid using laboratory scale Real Time Control Prototyping (RCP) system.
2. Introduction to FPGA based WAVECT controller for control and communication.
3. To generate a simple PWM signal and implement it using WAVECT controller.
4. To develop three phase representation of grid connected solar PV based smart grid system.
5. Use of WAVECT software for Power System Analyzer plots.
6. To develop strategy for synchronized connection of various power sources.
7. To study a basic Demand Side Management (DSM) technique for load management in a micro grid using a laboratory scale Real Time Control Prototyping (RCP) system.
8. Write a program using software tool for optimal power flow of smart grid system.
9. Write a program using software tool for state estimation.
10. Use of simulation tool LAB-VIEW for Smart Grid Architecture Model.
11. Intelligent automatic generation control with high penetration of renewable.
12. Testing inverter design for solar emulator to a step change in load.
13. To develop reactive power strategy and its testing using software tool.