VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

Master of Engineering Programmes

(M.TECH.-Power System)

(For admission in 2022-23 and onwards)

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

[M.Tech.(Power System) Model Curriculum Structure]

Semester-I

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	(AHT-301)	AdvancedMathematics	3	1	0	30	20	50	100		150	4
2	(MPST101)	PowerSystemAnalysis	3	1	0	30	20	50	100		150	4
3	(MPST102)	PowerSystem stability and Control	3	1	0	30	20	50	100		150	4
4	(MPST111) (MPST112) (MPST113) (MPST114)	1. RenewableEnergySystem 2. Smart Grid Technology 3. High Power Converters 4. Hybrid ElectricVehicles	3	0	0	30	20	50	100		150	3
5	(MPST121) (MPST122) (MPST123) (MPST124)	1. ElectricalPower Distribution System 2. MathematicalMethods forPower Engineering 3. PulseWidthModulationforPowerConverters 4. WindandSolar Energy Systems	3	0	0	30	20	50	100		150	3
6	(MPSP101)	PowerSystem AnalysisLab	0	0	3		25	25		25	50	1
7	(MPSP102)	Power System Stability and Control Lab	0	0	3		25	25		25	50	1
8	(AHT-302)	Research Methodology andIPR	2	0	0		50	50	50		100	2
9	(AHT-303)	Technical Writing and Presentation Skill	2	0	0			50	0			0
		Total	**19**	**3**	**6**			**400**	**600**		**950**	**22**
10		*Open Elective-1(Optional)	3	0	0	30	20	50	100		150	3

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week,
CT-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance,
PS-Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks,
PE- Practical External Examination Marks

[M.Tech.(Power System) Model Curriculum Structure]

Semester-II												
S. No.	**Subject Codes**	**Subject Name**	**Periods**			**Sessional Exam**			**ESE**		**Subject Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	(MPST201)	Digital Protection of Power	3	1	0	30	20	50	100		150	4
2	(MPST202)	Power System Dynamics	3	1	0	30	20	50	100		150	4
3	(MPST231) (MPST232) (MPST233) (MPST234)	1. RestructuredPowerSystems 2. AdvancedDigital 3. Dynamics of Electrical Machines 4. PowerApparatusDesign	3	1	0	30	20	50	100		150	4
4	(MPST241) (MPST242) (MPST243) (MPST244)	1. Advanced Micro-Controller Based Systems 2. SCADA System and Applications 3. Power Quality 4. Artificial Intelligence Techniques	3	0	0	30	20	50	100		150	3
5		Open Elective-1	3	0	0	30	20	50	100		150	3
6	(MPSP201)	Advance Power System Protection Lab	0	0	3		25	25	25	25	50	1
7	(MPSP202)	Power System Dynamics Lab	0	0	3		25	25	25	25	50	1
		Total	**15**	**3**	**6**			**300**	**550**		**950**	**20**
8		*Open Elective-2(Optional)	3	0	0	30	20	50	100		150	3

Abbreviations: L-No. of Lecture hours per week, **T**-No. of Tutorial hours per week, **P**-No. of Practical hours per week,
CT-Class Test Marks, **TA**-Marks of teacher's assessment including student's class performance and attendance,
PS-Practical Sessional Marks, **ESE**-End Semester Examination, **TE**- Theory Examination Marks,
PE- Practical External Examination Marks

[M.Tech.(Power System) Model Curriculum Structure]

Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0 **Credits-4**

Course objectives:

From this course, students will be able to:
1. learn distinct methods of solving simultaneous equations.
2. well-versed with partial differential equations and their solutions and applications.
3. acquire the knowledge of transformation to ease the complex problems.
4. acquaintance with basics of random variables and their distribution for dealing with events by chance.
5. study different mathematical domains to deal with real-time engineering problems.

Learning outcomes:

1. Comprehend with engineering problems in different mathematical realm.
2. Learn analytical and numerical methods to deal with mathematical problems.
3. Understand how to model the engineering problems and their solutions.
4. Implement the solutions to real-time complex engineering problems.
5. Apprehend with mathematical methodology.

Course content:

Unit I: Solution of linear simultaneous equations: **(8 hours)**

Consistency, Iterative method, Convergence, Cholesky's (Crout's) method, Gauss-Jordan method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems, Smallest, largest, and intermediate Eigen values

Computer based algorithm and programme for these methods (non-evaluative)

Unit II: Partial differential equation and its applications: **(10 hours)**

Introduction and classification of partial differential equation, Four standard forms of non-linear partial differential equations and their solutions, linear equations with constant coefficients. Applications of partial differential equationsone and two-dimensional wave equation, one and two-dimensional heat equation, Two-dimensional Laplace's equation.

Syllabus

Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0 **Credits-4**

Unit III: Transform calculus-I: **(8 hours)**

Laplace transform, Properties of Laplace transform, Inverse Laplace transform,Applications of Laplace transform, Fourier integral theorem, Fourier transforms, Application of Fourier transform

Unit IV: Transform calculus-II: **(8 hours)**

Z-transform, Properties of Z-transform, Shifting theorems, Initial and final value theorem, Convolution theorems, Inverse Z-transform, Application of Z-transform

Unit V: Basic probability theory: **(8 hours)**

Concept and laws of probability,Discrete and continuous random variable and their distributions; Some special distributions such as Binomial, Poisson, Negative Binomial, Geometric, Continuous uniform, Normal, Exponential, Weibull, Moments,Moment generating functions, Expectation and variance

Practical demo with statistical software like R, SPSS, SAS, etc. (non-evaluative)

Text Books / References:

1. B.S. Grewal, Engineering Mathematics, Khanna Publications, 44th edition.
2. F.B. Hilderbrand, Method of Applied Mathematics, PHI Publications, 2nd edition.
3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publication, 20th edition.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathmematical Statistics, S. Chand Publication, 4th edition.
5. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th edition.
6. S. Ross, A First Course in Probability, Pearson Education, 8th edition.

Syllabus

Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Course Objectives: Students will be able to:

1. To understand the fundaments of research in today's world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and inturn brings about, economic growth and social benefits.

Course Outcomes:

1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student's competence to discover new inventions.

Syllabus Contents:

UNIT I: FUNDAMENTAL OF RESEARCH

Meaning of research; objectives of research; basic steps of research; criteria of good research; Research methods vs. Methodology. Types of research –criteria of good research; Meaning of research problem; selection of research problem; Approaches of investigation of solutions for research problem, Errors in selecting a research problem, Scope and objectives of research problem, Review of related literature- Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION

Research design: Types of research design- exploratory, descriptive, diagnostic and experimental;Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis; Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation, case study, survey etc.

Unit 3:REPORT WRITING AND ITS INTERPRETATION

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Unit 4:RESEARCH ETHICS AND SCHOLARY PUBLISHING

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism and its concept and importance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR)

IPR- intellectual property rights and patent law, commercialization, New developments in IPR; copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Process of Patenting and Development; Procedure for grants of patents, Patenting under PCT;Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineeringstudents'"
2. WayneGoddardandStuartMelville,"ResearchMethodology:AnIntroduction"
3. RanjitKumar,2ndEdition,"ResearchMethodology:AStepbyStepGuideforbeginners"
4. Halbert,"ResistingIntellectualProperty",Taylor&FrancisLtd,2007.
5. Mayall,"IndustrialDesign",McGrawHill,1992.
6. Niebel,"ProductDesign",McGrawHill,1974.
7. Asimov,"IntroductiontoDesign",PrenticeHall,1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age",2016.
9. T.Ramappa,"IntellectualPropertyRightsUnderWTO",S.Chand,2008

Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0 **credit:00**

Course Objectives:

- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:

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

CO1: Write clearly and fluently to produce effective technical documents.

CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.

CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I **(4 hours)**

Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II **(4 hours)**

Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III **(6 hours)**

Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV **(6 hours)**

Speaking Skills: Accuracy vs. Fluency, The Audience, Pronunciation Guidelines, Voice Control.

Unit-V **(8 hours)**

Professional Presentations: Planning, Preparing, Presentation Strategies, Overcoming, Communication Barriers, Using Technology, Effective Presentations.

References:

1. Kumar, Sanjay & Pushp Lata, “Communication Skills”, Oxford UniversityPress,2011.
2. Quirk & Randolph, “A University Grammar of English”, Pearson,2006.
3. Rutherford, Andrea J., “Basic Communication Skills for Technology”, Pearson 2007.
4. Rizvi, M Ashraf, “Effective Technical Communication”, McGraw Hill,2009.
5. Leigh, Andrew & Maynard, Michael, “The Perfect Presentation”, Random House.
6. Barker, Larry L., “Communication”, Prentice-Hall.
7. Lesikar&Flatley, “Basic Business Communication-Skills for Empowering the Internet Generation”, Tata McGraw-Hill.

Syllabus

POWER SYSTEM ANALYSIS (MPST101)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of load flow analysis involving different bus matrices .To understand how to analyse various types of faults in power system. To understand power system security concepts and study the methods to rank the contingencies. To understand the need of state estimation and study simple algorithms for state estimation.

Course Outcomes:

Students will be able to-

1. Apply methods of load flow analysis involving different bus matrices.
2. Understand how to analyse various types of faults in power system.
3. Understand power system security concepts and study the methods to rank the contingencies.
4. Understand need of state estimation and study simple algorithms for state estimation.
5. Study voltage instability phenomenon.

Syllabus:

UNIT-I **(8 hours)**

Linear Graph Theory: Study of linear graph theory, Network topology, incidence, Cut-set and Tie-set matrices andtheir interpretation. Overview of Z-bus, Y-bus, Z-branch and Y loop matrices by singular and non-singular transformations.

UNIT-II **(8 hours)**

Load Flow Studies: Formulation of load flow problem. Various types of buses. Gauss-Seidel, Newton-Raphson and Fast Decoupled Algorithms, forward and backward method, Calculation of reactive power at voltage-controlled buses in the Gauss-Seidel iterative method using Y-bus, introduction to load flow of integrated ac/dc system.

UNIT-III **(8 hours)**

Short Circuit Studies: Formulation of Z-bus and Y-bus for single phase and three phase networks, transformation of network matrices using symmetrical components.

Syllabus

POWER SYSTEM ANALYSIS (MPST101)

L:T:P:: 3:1:0 **Credits-4**

UNIT-IV **(8 hours)**

Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking.

UNIT-V **(8 hours)**

State Estimation: Sources of errors in measurement, Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WLS method, bad data correction

REFERENCES:

1. J.J. Grainger and W.D. Stevenson, Jr., Power System Analysis, McGraw Hill, 2017
2. G.W. Stagg and A.H. El-Abiad, computer Methods in Power system Analysis Mc GrawHill, 1971
3. G.L. Kusic, Computer Sided Power system Analysis Prentice Hall International, 1986
4. L.P. Singh, Advanced Power System Analysis and Dynamics, Wiley Eastern,
5. J. Arrillage and C.P. Arnold "Computer Analyzing Power Sysem" john Wiley Singapore1990.
6. P. Kundur "Power System Stability and Control" Mc Graw Hill, New York 1993.
7. A.R. Bergen and V.Vittal, "Power System Analysis" Englewood, Cliff, N.J. Prentice Hall,2000.

Syllabus

POWER SYSTEM STABILITY AND CONTROL (MPST102)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of various stability and associated controls in the power system.To Analyze the stability issues related to power system loads. To understand Stability analysis with and without power system stabilizer. To explore the modeling of HVDC systems and Active and Reactive Power and Control of HVDC system.

Course Outcomes:

Students will be able to-

1. Learn various stability and associated controls in the power system.
2. Analyze the stability issues related to power system loads.
3. Stability analysis with and without power system stabilizer.
4. Study the modeling of HVDC systems and Active and Reactive Power.
5. Control of HVDC system and Steam Turbine System and Control of Excitation Systems.

Syllabus:

UNIT-I **(8 hours)**

Power System Stability and Related Problems, Associated Power System Controls. Introduction to Rotor Angle Stability, Voltage Stability, Voltage Collapse, Mid-term and Long-term Stability.Unregulated and Regulated Power System.

UNIT-II **(8 hours)**

Representation of Synchronous Machine in Stability Studies, Power System Loads: Static and Dynamic Load Models, Load Modelling of Induction and Synchronous Model, Types and Dynamics of Excitation Systems, Prime Movers

UNIT-III

(8 hours)

Small Signal Stability, Transient Stability, Sub-synchronous Oscillations, Methods of Enhancing Power

Syllabus

POWER SYSTEM STABILITY AND CONTROL (MPST102)

L:T:P:: 3:1:0 **Credits-4**

System Stability. Power System Stabilizer.

UNIT-IV **(8 hours)**

Multi-Machine Stability, Modeling of HVDC Systems, Control of Active and Reactive Power.

UNIT-V **(8 hours)**

Control of HVDC Systems, Control of Excitation Systems, Steam Turbine Control.
Simulation Studies on Power System Stability and Control.

REFERENCES:

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, CRCPress, 2007
4. V. Ajjarapu, "Computational Techniques for voltage stability assessment & control";Springer, 2006

Syllabus

Renewable Energy System (MPST111)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of distributed generation and renewable energy sources .To Analyze the concept of the integrated operation of renewable energy sources . To describe the Power Electronics Interface with the Grid . To analyse the issues of power quality disturbances.

Course Outcomes:

Students will be able to-

1. Appreciate the need for distributed generation and renewable energy sources.
2. Explain the concept of the integrated operation of renewable energy sources.
3. Describe the Power Electronics Interface with the Grid.
4. Analyze the issues of power quality disturbances.
5. Impact of Distributed Generation on Power System.

Syllabus:

UNIT-I **(8 hours)**

Introduction, Distributed vs Central Station, Generation, Sources of Energy such as Micro-turbines, Internal Combustion Engines.

UNIT-II **(8 hours)**

Introduction to Solar Energy, Wind Energy, Combined Heat and PowerHydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells.

UNIT-III **(8 hours)**

Power Electronic Interface with the Grid

UNIT-IV **(8 hours)**

Impact of Distributed Generation on the Power System,
Power Quality Disturbances

Syllabus

Renewable Energy System (MPST111)

L:T:P:: 3:0:0 **Credits-3**

UNIT-V **(8 hours)**

Transmission System Operation, Economics of Distributed Generation, Case Studies

REFERENCES:

1. Ranjan Rakesh, Kothari D. P, Singal K.C, "Renewable Energy Sources and Emerging Technologies", 2nd Ed. Prentice Hall of India, 2011.
2. Math H. Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power System," July 2011,Wiley –IEEE Press.
3. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators." October 2007, Wiley-IEEE Press.
4. Roger A. Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010.
5. James F. Manwell, Jon G. McGowan, Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed, 2010

Syllabus

SMART GRID TECHNOLOGY (MPST112)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of the smart grid and its advantages over the conventional grid .To familiarize with the smart metering, its commercial uses and smart grid solutions using modern communication technologies.

CourseOutcomes:

Studentswill beable to-

1. Understand the concepts of a smartgridanditsadvantagesover the conventionalgrid
2. Knowsmart meteringtechniques
3. Applysmart meteringconceptsto industrialand commercial installations
4. Formulatesolutionsintheareasofsmartsubstations, distributedgeneration,andwide-areameasurements
5. Comeupwithsmartgrid solutionsusingmoderncommunicationtechnologies

Syllabus:

UNIT-I **(8 hours)**

Introduction to Smart Grid, Evolution of Electric Grid.Concept of Smart Grid, Definitions. Need for Smart Grid, Concept of Robust & Self-Healing Grid Present development & International policies in Smart Grid

UNIT-II **(8 hours)**

Introduction to Smart Meters, Real-Time Pricing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug-in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation.

UNIT-III **(8 hours)**

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

UNIT-IV **(8 hours)**

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues interconnection, protection & control of micro-grid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind

Syllabus

SMART GRID TECHNOLOGY (MPST112)

L:T:P:: 3:0:0 **Credits-3**

generators, fuel cells, micro-turbines, Captive power plants, Integration of renewable energy sources

UNIT-V **(8 hours)**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid-connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web-based Power Quality monitoring, Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Broadband over Power line (BPL) IP based protocols

REFERENCES:

1. Ali Keyhani,“Designofsmartpower gridrenewableenergysystems”,WileyIEEE,2011
2. ClarkW.Gellings,“TheSmartGrid:EnablingEnergyEfficiencyandDemandResponse”,CRCPress, 2009
3. JanakaEkanayake,NickJenkins,KithsiriLiyanage,“SmartGrid:TechnologyandApplications”,Wiley2012
4. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions “CRC Press
5. 5.A. G. Phadke,“SynchronizedPhasorMeasurementandtheirApplications”,Springer.

Syllabus

SMART GRID TECHNOLOGY (MPST112)

L:T:P:: 3:0:0 **Credits-3**

Syllabus

HIGH POWER CONVERTERS (MPST113)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of the high-power-rated converters .To familiarize with the different topologies involved for these converters . to understand the concept of MLI, their control and protection circuit.

Course Outcomes:

Students will be able to-

1. Select high-power-rated converters
2. Employ the different topologies involved for these converters
3. Explain the multilevel converters
4. Apply suitable control techniques
5. Draw protection circuits for these converters

Syllabus

UNIT-I **(8 hours)**

Power electronic systems , An overview of PSDs, multipulse diode rectifiers, and multipulse SCR rectifiers.

UNIT-II **(8 hours)**

Phase shifting transformers, multilevel voltage source inverters: two-level voltage source inverter,
Cascaded ,H bridge multilevel inverter

UNIT-III **(8 hours)**

Diode clamped multilevel inverters, flying capacitor multilevel inverter

UNIT-IV **(8 hours)**

PWM current source inverters, DC to DC switch mode converters

Syllabus

HIGH POWER CONVERTERS (MPST113)

L:T:P:: 3:0:0 **Credits-3**

UNIT-V **(8 hours)**

AC voltage controllers: Cyclo-converters, matrix converters, Power conditioners and UPS.
Design aspects of converters, protection of devices and circuits

REFERENCES:

1. N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converter, Applicationsand 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

Syllabus

HYBRID ELECTRIC VEHICLES (MPST114)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic need and history behind electric vehicles, configurations of hybrid electric vehicles. To comprehend the electric Traction drive train mechanism and power flow.To understand the energy management strategies in a hybrid electric vehicle.To understand the electric motor required for HEV.

Course Outcomes:

Upon successful completion of this course the student will be able to:

1. Appreciate the need and history behind electric vehicles.
2. Present the configurations of hybrid electric vehicles (HEV).
3. Explain the electric Traction drive train mechanism and power flow.
4. Select and employ the electric motor required for HEV.
5. Describe the energy management strategies in a hybrid electric vehicle.

Syllabus:

UNIT-I **(8 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 vehicle performance, vehicle, power source characterization Transmission characteristics, Mathematical models to describe vehicle performance

UNIT-II **(8 hours)**

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

UNIT-III **(8 hours)**

Introduction to electric components used in hybrid and electric Vehicles, Configuration ,and control of DC Motor drives configuration and control of Introduction Motor drives, control of Permanent Magnet Motor drives configuration, and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT-IV **(8 hours)**

Matching the electric machine and the internal combustion engine(ICE),Sizingthepropulsionmotor,sizingthepowerelectronics,Selecting the energy storage technology, Communications, supporting subsystems, Introductiontoenergymanagementandthestrategiesusedinhybridandelectricvehicle

UNIT-V **(8 hours)**

Syllabus

HYBRID ELECTRIC VEHICLES (MPST114)

L:T:P:: 3:0:0 **Credits-3**

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
4. CRC Press Freebook, “Hybrid and Electric Vehicles,” CRC Press (Taylor and Francis group).
5. Wei Liu, “Introduction to Hybrid Vehicle System Modeling and Control,” Wiley Publications.
6. A. K. babu, “Electric and Hybrid Vehicles,” Khanna Publishing.
7. K. T. Chau, “Electric Vehicles, Machines and Drives: Design, Analysis and Application,” IEEE Press

Syllabus

ELECTRIC POWERDISTRIBUTIONSYSTEM (MPST121)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the distribution and management power distribution. To understand the controlling principles of Distribution Automation. To understand the SCADA system in distribution automation.To understand the various switches required in power distribution.

Course Outcomes:

Students will be able to-

1. Describe distribution and management power distribution.
2. Apply controlling principles of Distribution Automation.
3. Employ remote metering.
4. Adopt SCADA system in distribution automation.
5. Select switches according to need in power distribution.

Syllabus:

UNIT-I **(8 hours)**

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

UNIT-II **(8 hours)**

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

UNIT-III **(8 hours)**

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation

UNIT-IV **(8 hours)**

SCADA: Introduction, Block Diagram, SCADA Applied to Distribution Automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA

Syllabus

ELECTRIC POWERDISTRIBUTIONSYSTEM (MPST121)

L:T:P:: 3:0:0 **Credits-3**

UNIT-V **(8 hours)**

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring

REFERENCES:

1. A. S.Pabla,"ElectricPowerDistribution",TataMcGrawHillPublishingCo.Ltd.,FourthEdition.
2. M.K.Khedkar,G.M.Dhole,"ATextBookofElectricalpowerDistributionAutomation",UniversitySciencePress, NewDelhi
3. AnthonyJ Panseni,"ElectricalDistributionEngineering",CRCPress
4. JamesMomoh,"ElectricPowerDistribution,automation,protection&control",CRCPress

Syllabus

MATHEMATICAL METHODS FOR POWER ENGINEERING (MPST122)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of vector spaces, linear transformation, eigenvalues and eigen vectors of linear operators .To understand the LPP and simplex method. To understand the concept of random variables, functions of the random variable and their probability distribution. To understand the stochastic processes and their classification.

Course Outcomes:

Students will be able to:

1. Knowledge about vector spaces, linear transformation, eigenvalues and eigen vectors of linear operators.
2. Tolearnaboutlinearprogrammingproblemsandunderstandthesimplexmethodforsolvinglinear programming problems in various fields of science and technology.
3. Acquireknowledgeaboutnonlinearprogrammingandvarioustechniquesforsolvingconstrainedandunconstrained non linear programming problems.
4. Understanding the concept of random variables, functions of the random variable and their probability distribution.
5. Understand stochastic processes and their classification.

Syllabus:

UNIT-I **(8 hours)**

Vector spaces, Linear transformations

UNIT-II **(8 hours)**

Matrix representation of linear transformation Eigen values and Eigen vectors of the linear operator

UNIT-III **(8 hours)**

Linear Programming Problems Simplex Method ,Duality , Non-Linear Programming problems

Syllabus

MATHEMATICAL METHODS FOR POWER ENGINEERING (MPST122)

L:T:P:: 3:0:0 **Credits-3**

UNIT-IV **(8 hours)**

Unconstrained Problems, Search methods Constrained Problems

UNIT-V **(8 hours)**

Lagrange method Kuhn-Tucker conditions ,Random Variables , Distributions Independent Random Variables Marginal and Conditional distributions , Elements of stochastic processes

REFERENCES:

1. KennethHoffmanandRayKunze,“LinearAlgebra”,2ndEdition,PHI,1992
2. ErwinKreyszig,“IntroductoryFunctionalAnalysiswithApplications”,JohnWiley&Sons,2004
3. IrwinMillerandMaryleesMiller,JohnE.Freund’s“MathematicalStatistics”,6thEdn,PHI.

2002

4. J.Medhi,“StochasticProcesses”,NewAgeInternational,NewDelhi.,1994
5. APapoulis,“Probability,RandomVariablesandStochasticProcesses”,3rdEdition,McGraw Hill, 2002
6. JohnB Thomas,“AnIntroductiontoAppliedProbability andRandomProcesses”,JohnWiley,2000
7. HillierFSandLiebermannGJ,“IntroductiontoOperationsResearch”,7thEdition,McGraw Hill, 2001
8. SimmonsDM,“Non-LinearProgrammingforOperationsResearch”,PHI, 1975

Syllabus

PULSE WIDTH MODULATED POWER CONVERTERS (MPST123)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of basic control requirements in power converters . To understand the CSI and its control, Advance PWM scheme, MLI in power system and their application in power system.

Course Outcomes:

Students will be able to-

1. Employ and describe basic control requirements in power converters.
2. Appreciate current source inverters and their control.
3. Describe advance pulse width modulation schemes.
4. Apply multilevel converters in power systems.
5. Use these methods for high power applications in power systems.

Syllabus:

UNIT-I **(8 hours)**

Introduction to PE converters, Hysteresis and pulse width modulation Control, Modulation of one inverter phase, Unipolar and Bipolar Modulation, VSI and 3 phase VSI

UNIT-II **(8 hours)**

Zero space vector placement modulation strategiesContinuous and Discontinuous Current modulation, Single-Phase and 3-phase CSI, Modulation of CSI

UNIT-III **(8 hours)**

Over modulation of converters, SVM, DTC control , Program modulation strategies

UNIT-IV **(8 hours)**

Types of multilevel inverters, Pulse width modulation for multilevel inverters, Modulated DC-DC converters, Implementation of modulation controller

UNIT-V **(8 hours)**

Syllabus

PULSE WIDTH MODULATED POWER CONVERTERS (MPST123)

L:T:P:: 3:0:0 **Credits-3**

High power-controlled AC to DC and DC to AC Conversion, Continuing developments in modulation as random PWM , PWM for voltage unbalance , Effect of minimum pulse width and dead time

REFERENCES:

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. Bin Wu, “High Power Converter”, Wiley Publication

Marian K. Kazimicrczuk, “Pulse width modulated dc-dc power converter”, Wiley Publication

3. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
4. 2. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.

Syllabus

WIND AND SOLAR SYSTEMS (MPST124)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of wind and solar systems, their installation and commissioning .To learn the dynamics involved when interconnected with power system grid. To learn the dynamics related to power system integrated wind and solar systems. Design of the PV system

Course Outcomes:

Students will be able to-

1. To get exposure to wind and solar systems.
2. To understand the factors involved in installation and commissioning of a Solar or Windplant.
3. Learning the dynamics involved when interconnected with power system grid.
4. Learn the dynamics related to power system integrated wind and solar systems.
5. Design the PV system.

Syllabus:

UNIT-I **(8 hours)**

Historical development and current status characteristics of wind power generation , network integration issues

UNIT-II **(8 hours)**

Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm with powersystems.

UNIT-III **(8 hours)**

Isolated wind systems, reactive power and voltage control, economic aspects.

UNIT-IV **(8 hours)**

Impacts on power system dynamics, power system interconnection

Syllabus

WIND AND SOLAR SYSTEMS (MPST124)

L:T:P:: 3:0:0 **Credits-3**

UNIT-V **(8 hours)**

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

REFERENCES:

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 sonsltd., 2006
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata MacGraw Hill, Second Edition, 1996

Syllabus

DIGITALPROTECTIONOFPOWERSYSTEM(MPST201)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of digital protection with the usefulness of mathematics in digital protection. To analyze and implement the Interpolation, Numerical differentiation, Curve fitting, Least-squares, Fourier, and Walsh function-based techniques in digital protection. To understand the Signal conditioning and Conversion subsystems of the digital relay to work as a Units consisting of hardware and software. To analyze and implement the Sinusoidal, Fourier, and Walsh-based algorithms in digital protection.

Course Outcomes:

Students will be able to-

1. Analyze the major advantages of digital protection with the usefulness of mathematics in digital protection.
2. Analyze and implement the Interpolation, Numerical differentiation, Curve fitting, Least-squares, Fourier, and Walsh function-based techniques in digital protection.
3. Analyze the Signal conditioning and Conversion subsystems of the digital relay to work as a Units consisting of hardware and software.
4. Analyze and implement the Sinusoidal, Fourier, and Walsh-based algorithms in digital protection.

Analyze and implement the Differential equation-based algorithms

Syllabus

UNIT-I **(8 hours)**

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

UNIT-II **(8 hours)**

Mathematical background to protection algorithms, Finite difference techniques**.**

UNIT-III **(8 hours)**

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

Syllabus

DIGITALPROTECTIONOFPOWERSYSTEM(MPST201)

L:T:P:: 3:1:0 **Credits-4**

UNIT-IV **(8 hours)**

Basic elements of digital protection , Signal conditioning :transducers, surge protection, analog filtering, analog multiplexers, Conversion sub system : the sampling theorem, signal aliasing, Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a Units consisting of hardware and software

UNIT-V **(8 hours)**

Sinusoidal wave based algorithms, Sample and first derivative (Mannand Morrison) algorithm. Fourier and Walsh based algorithms, Least Squares based algorithms. Differential equation based algorithms. Traveling Wave based Techniques. DigitalDifferentialProtectionofTransformers.DigitalLineDifferential Protection. Recent Advances in Digital Protection of Power Systems.

REFERENCES:

1. A.G.Phadkeand J.S.Thorp,“ComputerRelayingforPowerSystems”,Wiley/ResearchstudiesPress, 2009.
2. A.T.Johns and S.K.Salman,“Digital Protection of Power Systems”, IEEEPress,1999
.
3. Gerhard Zeigler,“NumericalDistanceProtection”,SiemensPublicisCorporatePublishing,2006
4. S.R. Bhide“DigitalPowerSystemProtection”PHILearningPvt.Ltd.2014.

Syllabus

POWER SYSTEM DYNAMICS (MPST202)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of dynamics and transformations needed in analysis. To formulate the state space equations involved in dynamic power system conditions. To describe the mathematical models for synchronous machine, frequency model. To understand the Excitation systems and Power system stabilized load.

Course outcomes:

Students will be able to-

1. Describe the reasons for dynamics and transformations needed in analysis
2. Formulate the state space equations involved in dynamic power system conditions
3. Develop of mathematical models for synchronous machine
4. Discuss the frequency model
5. Explain Excitation systems and Power system stabilized load

Syllabus

UNIT-I **(8 hours)**

Synchronous Machines: Per Units systems , Park's Transformation (modified) , Flux-linkage equations.

UNIT-II **(8 hours)**

Voltage and current equations , Formulation of State-space equations , Modeling of Induction Motors

UNIT-III **(8 hours)**

Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines

UNIT-IV **(8 hours)**

Small signal model: Introduction to frequency model.

Syllabus

POWER SYSTEM DYNAMICS (MPST202)

L:T:P:: 3:1:0 **Credits-4**

UNIT-V **(8 hours)**

Excitation systems, PSS Load modeling.

REFERENCES:

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotia , New Delhi,1981
2. J Machowski, J Bialek& 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", Vol. I & III, John Wiley & Sons, New York 2002

Syllabus

RESTRUCTURED POWER SYSTEMS (MPST231)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of various types of regulations in power systems . To Identify the need of regulation and deregulation. To describe the Technical and Non-technical issues in Deregulated Power Industry.. To understand different market mechanisms and summarize the role of various entities in themarket.

Course Outcomes:

Students will be able to-

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.
5. Classify different market mechanisms and summarize the role of various entities in themarket.

Syllabus:

UNIT-I **(8 hours)**

Fundamentals of restructured system, Market architectureLoad elasticity, Social welfare maximization

UNIT-II **(8 hours)**

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

UNIT-III **(8 hours)**

Optimal bidding , Risk assessmentHedging , Transmission pricing , Tracing of power

UNIT-IV **(8 hours)**

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

UNIT-V **(8 hours)**

Developments in India, IT applications in restructured markets , Working of restructured power systems

Syllabus

RESTRUCTURED POWER SYSTEMS (MPST231)

L:T:P:: 3:1:0 **Credits-4**

PJM, Recent trends in Restructuring Transmission System Operation, Economics of Distributed Generation, Case Studies .

REFERENCES:

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", JohnWiley and Sons, 2002.

3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructuredpower systems", Kluwer Academic Pub., 2001.

4. Mohammad Shahidehpour, MuwaffaqAlomoush, "Restructured electrical powersystems: operation, trading and volatility", Marcel Dekker.

Syllabus

ENERGY MANAGEMENT AND AUDITING (MPST232)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of present state of energy security and its importance. To describe the basic principles and methodologies adopted in energy audit of utility . To describe the Audit energy in domestic and industrial units. To understand the energy performance evaluation of installations having motors.

COURSE OUTCOMES:

Upon successful completion of this course the student will be able to:

1) Identify and describe present state of energy security and its importance.
2) Identify and describe the basic principles and methodologies adopted in energy audit of utility.
3) Carryout the energy performance evaluation of installations having motors.
4) Analyse the data collected during performance evaluation and recommend energy saving measures
5) Audit energy in domestic and industrial units.

Syllabus:

UNIT-I **(8 hours)**

BASIC PRINCIPLES OF ENERGY AUDIT Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit Need for energy management, energy basics, designing and starting an energy management program, energy audit process. Need for energy management, energy basics, designing and starting an energy management program, energy accounting, energy monitoring, targeting and reporting.

UNIT-II **(8 hours)**

ENERGY COST AND LOAD MANAGEMENT Important concepts in an economic analysis, economic models, time value of money, utility rate structures, cost of electricity, loss evaluation. Load management: demand control techniques, utility monitoring and control system-HVAC and energy management, economic justification.

UNIT-III **(8 hours)**

ENERGY EFFICIENT MOTORS Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics, variable speed, variable duty cycle systems, RMS hp voltage variation,

Syllabus

ENERGY MANAGEMENT AND AUDITING (MPST232)

L:T:P:: 3:1:0 **Credits-4**

voltage unbalance, over motoring, motor energy audit applications to Systems and equipment such as: electric motors, transformers and reactors, capacitors and synchronous machines.

UNIT-IV **(8 hours)**

METERING FOR ENERGY MANAGEMENT Relationships between parameters, Units of measure, typical cost factors, utility meters, timing of meter disc for kilowatt measurement, demand meters, paralleling of current transformers, instrument transformer burdens, multitasking solid-state meters, metering location vs. requirements, metering techniques and practical examples.

UNIT-V **(8 hours)**

LIGHTING SYSTEMS AND COGENERATION Concept of lighting systems, the task and the working space, light sources, ballasts –luminaries, lighting controls, optimizing lighting energy, power factor and effect of harmonics on power quality, cost analysis techniques, lighting and energy standards. Cogeneration: forms of cogeneration, feasibility of cogeneration, electrical interconnection. Economics Analysis-Depreciation Methods

REFERENCES:

1) Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.

2) Reay D.A., "Industrial Energy Conservation", first edition, Pergamon Press, 1977.

3) IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.

4) Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.

5) Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", Fifth Edition, The Fairmont Press, Inc., 2006

Syllabus

DYNAMICS OF ELECTRICAL MACHINES (MPST233)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of electrodynamic equations of all electric machines and analyze the performance characteristics. To describe the basic principles of transformations for the dynamic analysis of machines. To describe the stability of the machines under small signal andtransient conditions.

Course Outcomes:

Students will be able to-

1. Formulation of electrodynamic equations of all electric machines and analyze theperformance characteristics.
2. Knowledge of transformations for the dynamic analysis of machines.
3. Knowledge of determination of stability of the machines under small signal andtransient conditions.
4. Study about synchronous machine.
5. Determine the stability of machine.

Syllabus:

UNIT-I **(8 hours)**

Stability, Primitive four-Winding Commutator MachineCommutator Primitive Machine, Complete Voltage Equation of Primitive four-Winding Commutator Machine

UNIT-II **(8 hours)**

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

UNIT-III **(8 hours)**

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

UNIT-IV **(8 hours)**

Large Signal Transient, Small Oscillation Equations in State Variable formDynamical Analysis of Interconnected Machines

Syllabus

DYNAMICS OF ELECTRICAL MACHINES (MPST233)

L:T:P:: 3:1:0 **Credits-4**

UNIT-V **(8 hours)**

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

REFERENCES:

1. D. P. Sengupta & 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 & S.A. Nasar,,"Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

Syllabus

POWER APPARATUS DESIGN (MPST 234)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

To explore the basic understanding of rotating machine employed in Power Systems . To describe the basic principles of electromagnetic energy conversion, sizing and rating of machines. To describe the Model rotating machines under transient conditions.

Course Outcomes:

Students will be able to-

1. Analyze of rotating machine employed in Power Systems.
2. Explain electromagnetic energy conversion.
3. Select sizing and rating of machines.
4. Model rotating machines under transient conditions.
5. Design rotating electrical machines.

Syllabus:

UNIT-I **(8 hours)**

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, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling.

UNIT-II **(8 hours)**

Specific loadings, choice of magnetic and electric loadings Real 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-III **(8 hours)**

General considerations, output equation, 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.

Syllabus

POWER APPARATUS DESIGN (MPST 234)

L:T:P:: 3:1:0 **Credits-4**

UNIT-IV **(8 hours)**

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-V **(8 hours)**

Design of stator and rotor winding, slot leakage flux ,Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data, Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions, Introduction to Computer Aided Electrical Machine Design Energyefficient machines.

REFERENCES:

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, 5^{th} Edition.

Syllabus

ADVANCED MICRO-CONTROLLER BASED SYSTEMS (MPST241)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To Describe the architecture of advanced microcontrollers. To employ processor for these controllers
To understand the program a processor in assembly language for application system. To understand the DSP and FPGA for control applications.

Course Outcomes:
Students will be able to-
1. Describe the architecture of advanced microcontrollers
2. Employ processor for these controllers
3. Program a processor in assembly language for application system
4. Configure different peripherals in a digital system

Explain DSP and FPGA for control applications

Syllabus

UNIT-I **(8 hours)**

Basic Computer Organization with examples of 8086, 80X86, 8051 etc. Accumulator based Processes-Architecture, Memory Organization-I/O Organization

UNIT-II **(8 hours)**

Micro-Controllers-Intel 8051, Intel 8056- Registers, MemoriesI/O Ports, Serial Communication Timers, Interrupts, Programming

UNIT-III **(8 hours)**

Intel 8051 – Assembly language programmingAddressing-Operations, Stack & SubroutinesInterrupts-DMA

UNIT-IV **(8 hours)**

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

Syllabus

ADVANCED MICRO-CONTROLLER BASED SYSTEMS (MPST241)

L:T:P:: 3:0:0 **Credits-3**

UNIT-V **(8 hours)**

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

REFERENCES:

1. John. F. Wakerly: “Microcomputer Architecture and Programming”, John Wiley and Sons1981
2. Ramesh S. Gaonker: “Microprocessor Architecture, Programming and Applications with the8085”,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 PIC18FSeries”, Elsevier, 2008
7. Microchip datasheets for PIC16F877

Syllabus

SCADA SYSTEM AND APPLICATIONS (MPST242)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of Supervisory Control Systems (SCADA) as well as their typical applications. To understand about the SCADA architecture and the various advantages and disadvantages.To learn about SCADA system components: remote terminal Units, PLCs, intelligent electronic devices, HMI systems, and SCADA servers. Learn and understand SCADA applications in the transmission and distributionsector, industries etc.

Course Outcomes:

Students will be able to-

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as theirtypical applications.
2. Acquire knowledge about SCADA architecture and the various advantages and disadvantagesof 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, and SCADA servers.
5. Learn and understand SCADA applications in the transmission and distributionsector, industries etc.

Syllabus

UNIT-I **(8 hours)**

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

UNIT-II **(8 hours)**

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industrial SCADA

UNIT-III **(8 hours)**

SCADA System Components, Schemes- Remote Terminal Units (RTU) Intelligent Electronic Devices (IED) Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

Syllabus

SCADA SYSTEM AND APPLICATIONS (MPST242)

L:T:P:: 3:0:0 **Credits-3**

UNIT-IV **(8 hours)**

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

UNIT-V **(8 hours)**

SCADA Communication, various industrial communication technologies wired and wireless methods and fiber optics Open standard communication protocols, SCADA Applications: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and Improvement, Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises

REFERENCES:

1. Stuart A. Boyer: “SCADA-Supervisory Control and Data Acquisition”, Instrument Society ofAmerica Publications, USA, 2004
2. Gordon Clarke, Deon Reynders: “Practical Modern SCADA Protocols: DNP3, 60870.5 and RelatedSystems”, 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 electricpower”, PennWell 1999

Syllabus

POWER QUALITY (MPST243)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of power quality issues to be addressed and recommended practices . To understand about the Model network components . To learn about series and shunt active power filtering techniques .To study the reactive power control and eliminate undesired harmonics.

Course Outcomes:

Students will be able to-

1. Explain the different power quality issues to be addressed and recommended practices
2. Analyze the effect of harmonics
3. Model network components
4. Compensate for reactive power control and eliminate undesired harmonics
5. Apply series and shunt active power filtering techniques

Syllabus

UNIT-I **(8 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 problems, power acceptability curves-IEEE guides, standards and recommended practices

UNIT-II **(8 hours)**

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

Syllabus

POWER QUALITY (MPST243)

L:T:P:: 3:0:0 **Credits-3**

UNIT-III **(8 hours)**

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-IV **(8 hours)**

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-V **(8 hours)**

Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection, Filter for single phase, d-q domain control of three phase shunt active filters, uninterrupted power supplies, constant voltage Transformers, series active power filtering techniques for harmonic cancellation and isolation. Dynamic Voltage Restorers for sag, swell and flicker problems. Grounding and wiring introduction. NEC grounding requirements

REFERENCES:

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, 1997
5. H. W. Beaty, Mark F. McGranaghan, Roger C Dugan, “Electrical Power Systems Quality” McGraw-Hill

Syllabus

ARTIFICIAL INTELLIGENCE TECHNIQUES (MPST244)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

To explore the basic understanding of ANN Artificial Neural Networks , its use, control and design application. To Identify the fuzzy and neural network. To learn about series and shunt active power filtering techniques .To study the Genetic algorithm and evolutionary algorithms .

Course Outcomes:

Students will be able to-

1. Explain and apply ANN Artificial Neural Networks
2. Explain and apply fuzzy logic
3. Use Fuzzy logic in control and design application
4. Identify of fuzzy and neural network
5. Explain and apply Genetic algorithm and evolutionary algorithms

Syllabus

UNIT-I **(8 hours)**

Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward Neural Networks, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks

UNIT-II **(8 hours)**

Fuzzy Logic , Knowledge Representation and Inference Mechanism Defuzzification Methods, Fuzzy logic in control and design application

UNIT-III **(8 hours)**

Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA

Syllabus

ARTIFICIAL INTELLIGENCE TECHNIQUES (MPST244)

L:T:P:: 3:0:0 **Credits-3**

UNIT-IV **(8 hours)**

System Identification using Fuzzy and Neural Network

UNIT-V **(8 hours)**

Genetic algorithm, Reproduction cross over, mutation,
Introduction to evolutionary program, Applications

REFERENCES:

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 Company

Syllabus

ARTIFICIAL INTELLIGENCE TECHNIQUES (MPST244)

L:T:P:: 3:0:0 **Credits-3**

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus

POWERSYSTEMANALYSISLAB(MPSP101)

L:T:P:: 0:0:3 **Credits-01**

Course Objectives:

To introduce the hands-on descriptions of various Load flow methods techniques, short circuit studies, load forecasting etc. with the help of simulation.

CourseOutcomes:

Studentswill beable to-

1. Apply methods of load flow analysis involving different bus matrices.
2. Understand how to simulate a basic IEEE bus system in power system.
3. Understand power system security concepts and study the methods to rank the contingencies.
4. Understand need of state estimation and study simple algorithms for state estimation.
5. Understand the phenomenon of Load Forecasting and Units Commitment Analysis

Syllabus:

1 Power Systems & Power Converter modelling

2 Simulation of a basic IEEE bus system

3 Simulation of IGBT based Inverter circuits

4 Simulation of Thyristor Converters AC-DC converter.

5 Transient Stability Studies of Power system

6 Short Circuit Studies in Power system

7 Load Flow Analysis of a standard system

8 Load Forecasting and Units Commitment Analysis

Syllabus

POWER SYSTEM STABILITY AND CONTROL LAB (MPSP102)

L:T:P:: 0:0:3 **Credits-01**

Course Objectives:

To describe the variousconcept of power system i.e. stability of power system, swing equation, Modeling of Turbine and Governor System etc. using MATLAB.

CourseOutcomes:

Studentswill beable to-

1. Learn various stability and associated controls in the power system.
2. Analyze the stability issues related to power system loads.
3. Stability analysis with and without power system stabilizer.
4. Study the modeling of HVDC systems and Active and Reactive Power.
5. Control of HVDC system and Steam Turbine System and Control of Excitation Systems.

Syllabus:

1. MATLAB simulation of Load Frequency Control of a Single Area Power System.
2. To obtain step response of rotor angle and generator frequency of a synchronous machine in MATLAB.
3. To solve the swing equation of the given problem by using the point-by-point method and write a MATLAB program to verify the result.
4. To write a MATLAB program for analyzing the small-signal stability of a single-machine infinite bus system, assuming a classical model of the generator (constant voltage behindtransient reactance).
5. Modeling IEEE excitation systems in MATLAB.
6. Modeling of Turbine and Governor System in MATLAB.
7. Control of Active and Reactive Power implementing FACTS in MATLAB.
8. To obtain the Nose curves and Duck curves in MATLAB.

Syllabus

ADVANCED POWER SYSTEM PROTECTION LAB (MPS201)

L:T:P:: 0:0:3 **Credits-01**

Course Objectives:

To introduce the hands-on descriptions of various digital protection device , different protection relays etc. with the help of related instruments and devices.

Course Outcomes:

1. Analyze the major advantages of digital protection with the usefulness of mathematics in digital protection.
2. Analyze and implement the Interpolation, Numerical differentiation, Curve fitting, Least-squares, Fourier, and Walsh function-based techniques in digital protection.
3. Analyze the Signal conditioning and Conversion subsystems of the digital relay to work as a Units consisting of hardware and software.
4. Analyze and implement the Sinusoidal, Fourier, and Walsh-based algorithms in digital protection.
5. Analyze and implement the Differential equation-based algorithms

Syllabus:

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. voltage characteristics of over-voltage induction relay

Syllabus

POWER SYSTEM DYNAMICS LAB (MPSP202)

L:T:P:: 0:0:3 **Credits-01**

Course Objectives:

To introduce the hands-on descriptions of small signal stability, Large small signal rotor angle stability and voltage instability, synchronous machine dynamics etc. with the help MATLAB.

Course outcomes:

Studentswill beable to-

1. Describe the reasons for dynamics and transformations needed in analysis
2. Formulate the state space equations involved in dynamic power system conditions
3. Developofmathematicalmodelsforsynchronousmachine
4. Discuss the frequency model
5. Explain Excitation systems and Power system stabilized load

Syllabus:

1. To develop a MATLAB program to study small signal stability analysis of single machine

Infinitebus system using classical machine model and type B1 model.

2. To develop a Simulink model of IEEE type 1(1968) excitation system using MATLAB.

3. To develop a MATLAB program to study small signal stability analysis if single machine

Infinitebus system using Type B1 - effect of excitation system and PSS also.

4. Simulation of Synchronous machine dynamics.

5. Simulation of Induction machine dynamics.

6. Simulation of various faults of power systems

7. Simulation of transient over voltages

8. Simulation of SSR

9. Simulation of travelling waves

10. Stability studies – Large small signal rotor angle stability and voltage instability

Syllabus

POWER SYSTEM DYNAMICS LAB (MPSP202)

L:T:P:: 0:0:3 **Credits-01**

11. Familiarization with PSCAD, EMTDC, Mi-Power, ETAP, Lab view, Power worldsimulation

software

12. Modeling of various FACTS Devices

13. Study of AGC of multi area systems

14. Determine the optimal power flow solutions for IEEE systems based on cost optimization,

transmission loss optimization and total voltage deviation optimization using variousoptimization techniques such as PSO, GA.