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

Approved in 13th Meeting of Executive Council held on 27th March 2023 subsequent to the 14th Meeting of Academic Council held on 20th March 2023

(For admission in 2022-23 and onwards)

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

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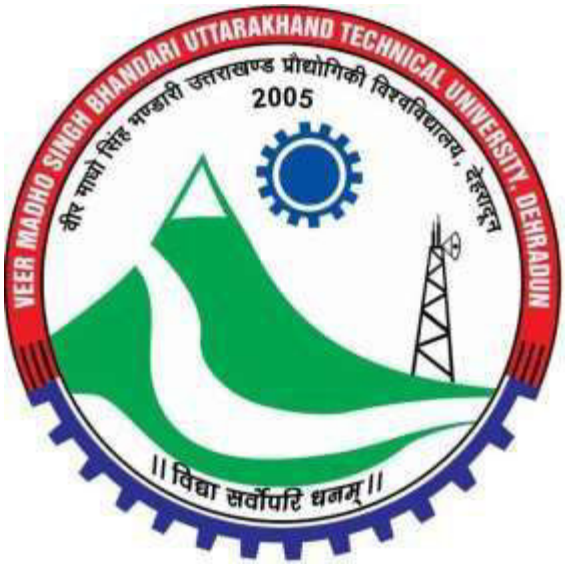

SYLLABUS

For

Master of Engineering Programmes

(M.TECH.-Power System 1st Year)

(For admission in 2022-23 and onwards)

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

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

Semester I (with effect from 2022-23)

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	(AHT-301)	Advanced Mathematics	3	1	0	30	20	50	100		150	4
2	(MPST101)	Power System Analysis	3	1	0	30	20	50	100		150	4
3	(MPST102)	Power System stability and Control	3	1	0	30	20	50	100		150	4
4	(MPST111) (MPST112) (MPST113) (MPST114)	1.Renewable Energy System 2. Smart GridTechnology 3. High PowerConverters 4. Hybrid Electric Vehicles	3	0	0	30	20	50	100		150	3
5	(MPST121) (MPST122) (MPST123) (MPST124)	1. Electrical Power Distribution System 2. Mathematical Methodsfor Power Engineering 3. Pulse Width Modulation f or Power Converters 4. Wind and Solar Energy Systems	3	0	0	30	20	50	100		150	3
6	(MPSP101)	Power System Analysis Lab	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 and IPR	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

*Open Elective-1(Optional)
MOET-391: Industrial Internet of Things
MOET392: Neural Computing Systems and Applications
MOET393: Distributed Generation & Micro-Grids
MOET394: Fundamentals of Electric and Hybrid Vehicles

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

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

Semester-II (with effect from 2022-23)

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 System	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. Restructured Power Systems 2. Advanced Digital Signal Processing 3. Dynamics of Electrical Machines 4. Power Apparatus Design	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	MOET 39X	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

Open Elective-1

MOET-391: Industrial Internet of Things
MOET392: Neural Computing Systems and Applications
MOET393: Distributed Generation & Micro-Grids
MOET394: Fundamentals of Electric and Hybrid Vehicles

*Open Elective-2(Optional)

MOET-391: Industrial Internet of Things
MOET392: Neural Computing Systems and Applications
MOET393: Distributed Generation & Micro-Grids
MOET394: Fundamentals of Electric and Hybrid Vehicles

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 Mathematical 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 inturnbrings 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 researchproblem, Errors in selecting a research problem, Scope and objectives of research problem, Review ofrelated 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 & engineering students'"
2. Wayne Goddard and Stuart Melville,"Research Methodology: An Introduction"
3. RanjitKumar,2nd Edition,"Research Methodology: A Step by Step Guide for beginners"
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 analyze 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 and their 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. Introduction of Gauss-Seidel, Newton-Raphson and Fast Decoupled Algorithms, forward and backward method, Solution of Load flow problem by using Newton Raphson method , 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 Graw Hill, 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, Factors affecting voltage stability- Classification of 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, State space representation, Physical Interpretation of small–signal stability, Eigen properties of the state matrix, eigenvalue and stability, mode shape and participation factor. Small– signal stability analysis of a Single-Machine Infinite Bus (SMIB), Methods of Enhancing Power System Stability.

UNIT-IV **(8 hours)**

Power System Stabilizer – Principle behind transient stability enhancement methods: high-speed fault clearing, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, 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, Excitation System Modelling, Excitation Systems- Standard Block Diagram, 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 Interfacewith 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)**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT-II **(8 hours)**

Introduction to Distributed vs Central Station, Sources of Energy such as Micro-turbines, Internal Combustion Engines. Introduction to Solar Energy, Wind Energy, Combined Heat and Power, Hydro Energy, Tidal Energy, WaveEnergy, Geothermal Energy, Biomass and Fuel Cells.

UNIT-III **(8 hours)**

Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing Solar/Wind: Three phase AC voltage controllers. Power Electronic Interface with the Grid

UNIT-IV **(8 hours)**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT). 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)**

Stand alone operation of fixed and variability speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system 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.

Course Outcomes:

Students will be able to-

1. Understand the concepts of a smart grid and its advantages over the conventional grid
2. Know smart metering techniques
3. Apply smart metering concepts to industrial and commercial installations
4. Formulate solutions in the areas of smart substations, distributed generation, and wide-area measurements
5. Come up with smart grid solutions using modern communication technologies

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

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 AC-DC conversion systems, 6-Pulse and 12-pulse AC-DC Converters, Phase shifting transformers, multipulse diode rectifiers, and multipulse SCR based AC-DC converters.

UNIT-II **(8 hours)**

Voltage and frequency control techniques for inverters. 120^o and 180^o mode of operation of three-phase inverters, basic concepts of switch mode inverter, PWM with bipolar and unipolar switching. Push Pull inverters, switch utilization, Effect of blanking time, space vector modulation, phase sequence control, selective harmonics elimination techniques

UNIT-III **(8 hours)**

Multi-level inverters, concept, advantages of multilevel inverters, types and principle ofoperation, Diode clamped multilevel inverter and cascaded multilevel inverters. multilevel voltage source inverters: two-level voltage source inverter,Cascaded, H bridge multilevel inverter

UNIT-IV **(8 hours)**

DC-DC Converters, Device selection, duty cycle range of practical DC-DC Converters, Continuous and discontinuous conduction mode, Design consideration for RL and RLE loads, Multiphase Choppers, thyristor choppers, Switching control circuits for chopper converters.

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, 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

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), Sizing the propulsion motor, sizing the power electronics, Selecting the energy storage technology, Communications, supporting subsystems, Introduction to energy management and the strategies used in hybrid and electric vehicle

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 POWER DISTRIBUTION SYSTEM (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 thevarious 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 POWER DISTRIBUTION SYSTEM (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,"Electric Power Distribution",Tata Mc Graw Hill Publishing Co.Ltd., Fourth Edition.
2. M.K.Khedkar,G.M.Dhole,"ATextBookofElectricalpowerDistributionAutomation",UniversitySciencePress, New Delhi
3. Anthony J Panseni,"Electrical Distribution Engineering",CRC Press
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 t h e 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 t h e random variable and their probability distribution.
5. Understand stochastic processes and their classification.

Syllabus:

UNIT-I **(8 hours)**

Vector spaces, sub-spaces, Linear transformations, Null spaces and range, Isomorphisms, Matrix representation of linear transformation

UNIT-II **(8 hours)**

Matrix algebra, Systems of linear equations, Matrix representation of linear transformation, Eigen values and Eigen vectors of the linear operator

UNIT-III **(8 hours)**

Linear Programming, Formation of problem, Graphical methods, Linear programming Problems, Simplex method, Duality, Non-linear programming problems, Sensitivity analysis.

Syllabus

MATHEMATICAL METHODS FOR POWER ENGINEERING (MPST122)

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

UNIT-IV **(8 hours)**

Optimization Methods: Mathematical model, Unconstrained problems, Discrete optimization, Search methods, Constrained problems, Robust optimization, Lagrange method, Kuhn-Tucker conditions

UNIT-V **(8 hours)**

Random Variables, Distributions Independent Random Variables, Marginal and Conditional distributions , Elements of stochastic processes

REFERENCES:

1. Kenneth Hoffman and Ray Kunze, "LinearAlgebra",2nd Edition, PHI,1992
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons,2004
3. Irwin Millerand Marylees Miller, John E. Freund's "Mathematical Statistics", 6thEdn,PHI.

2002

4. J. Medhi, "Stochastic Processes", New Age International, NewDelhi.,1994
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002
6. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley,2000
7. Hillier F S and Liebermann GJ, "IntroductiontoOperationsResearch",7th Edition, McGraw Hill, 2001
8. Simmons D M, "Non-Linear Programming for Operations Research", 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 strategies, Continuous and Discontinuous Current modulation, Single-Phase and 3-phase CSI, Modulation of CSI

UNIT-III **(8 hours)**

Over modulation of converters, space vector modulation, Direct torque control technique, 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)**

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions

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 power systems.

UNIT-III **(8 hours)**

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Isolated wind systems, reactive power and voltage control, economic aspects.

UNIT-IV **(8 hours)**

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Solar thermal power generation, PV power generation, designing the PV system for small installations. Electronic Converters for Solar. Maximum Power Point Tracking (MPPT) algorithms. Grid-Connected System and Standalone system.

UNIT-V **(8 hours)**

Solar Water Pumps, Solar street lights, Battery sizing, Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

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.
4. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
5. S. P. Sukhatme and J.K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 3rd ed., 2008.
6. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
7. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
8. B.H. Khan, "Non-Conventional Energy Resources", McGraw Hill 2nd Edition 2017.
9. G.D. Rai, "Non-Conventional Sources of Energy", Khanna Publishers, 4th Edition, 2009

Syllabus

DIGITAL PROTECTION OF POWER SYSTEM (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

DIGITAL PROTECTION OF POWER SYSTEM (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)**

Modelling of Synchronous Generator:

Synchronous Machines: Per Units systems, Park's Transformation (modified), Flux-linkage equations. Power Delivered by Generator, Synchronizing Generator connected to an Infinite. Bus, Instantaneous Power Output, Applications, Synchronous Operation, Steady-state Model, Simplified Dynamic Model.

UNIT-II **(8 hours)**

Modelling of Excitaion System:

Role of Synchronous Machine Excitation in Controlling Reactive Power, Excitation System, Excitation System Modeling, Excitation System Standard Block Diagram, System Representation by State Equation, Prime Mover Control System.

UNIT-III **(8 hours)**

Dynamics of a Synchronous Generator:

Sub-transient and transient inductance and Time constants, Ccalculation of Initial Conditions, System Simulation, Consideration of Other Machine Model, Inclusion of SVC Model.

UNIT-IV **(8 hours)**

Single machine system Modeling:

Small Signal Analysis with Block Diagram Representation, Synchronizing and Damping Torque Analysis, Small Signal Model: State Equation, Nonlinear Oscillations Hopf Bifurcation.

UNIT-V **(8 hours)**

Multi-machine System: Simplified system Model, Detailed models: Detailed models, Inclusion of Load and SVC dynamics, Modal Analysis of Large Power Systems, Case Studies.

REFERENCES:

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotias Publication, 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 the market.

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)**

Introduction to restructuring of power industry:
Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process, Introduction to issues involved in deregulation, Load elasticity, Social welfare maximization, vertically integrated systems, deregulated power systems across the world.

UNIT-II **(8 hours)**

Fundamentals of Economics:
Introduction, Consumer behavior, Supplier behavior, Market equilibrium, Relationship between short-run and long-run average costs, Perfectly competitive market, Market models based on contractual arrangements, Comparison of various market models

UNIT-III **(8 hours)**

Transmission Congestion Management:
Introduction, Classification of congestion management methods, Calculation of ATC, Non-market methods, Market based methods, Nodal pricing, Inter-zonal Intra-zonal congestion management,
Price area congestion management, Capacity alleviation Method.

UNIT-IV **(8 hours)**

Ancillary services, Types, Load-generation balancing related services, Voltage control and reactive power support services, Black start capability service, Co-optimization of energy and reserve services

UNIT-V **(8 hours)**

Market power and generators bidding:
Attributes of a perfectly competitive market, Imperfect competition, Market power, Optimal bidding, Risk assessment Hedging, Transmission pricing, Tracing of power, IT applications in restructured markets, Working of restructured power systems.

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", John Wiley and Sons, 2002.
3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Bollen, "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. Fundamentals of Power System economics by Daniel Kirschen and Goran Strbac, John Wiley & Sons Ltd, 2004.
6. Operation of restructured power systems Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, Kluwer Academic Pub., 2001

Syllabus

ADVANCED DIGITAL SIGNAL PROCESSING (MPST232)

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

UNIT I:
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

UNIT 2:
Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters Impulse invariancemethod, Bilinear transformation method.

UNIT 3:
FIR filter design using window functions. Comparison of IIR and FIR digital filters Basic IIR and FIR filter realization structures. Signal flow graph representations Quantization process and errors Coefficient quantization effects in IIR and FIR filters

UNIT 4:
A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow of oscillations and zero Input limit cycles in IIR filter, Linear Signal Models

UNIT 5:
l pole, All 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 signalestimation, Mean square error estimation, Optimum FIR and IIR Filters

Suggested reading

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

Course Objectives: -Students will be able to:

1. To understand the difference between discrete-time and continuous-time signals.
2. To understand and apply Discrete Fourier Transforms (DTFT)

Course Outcomes:-

Students will be able to:

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

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

UNIT-II **(8 hours)**

Torque Equation Analysis of Simple DC Machines using the Primitive Machine 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 form Dynamical 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 Energy efficient 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, 5th 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, Memories I/O Ports, Serial Communication Timers, Interrupts, Programming

UNIT-III **(8 hours)**

Intel 8051 – Assembly language programming Addressing-Operations, Stack & Subroutines, Interrupts-DMA

UNIT-IV **(8 hours)**

PIC 16F877- Architecture Programming, Interfacing 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 applications, Stepper 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 distribution sector, industries etc.

Course Outcomes:

Students will be able to-

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.
2. Acquire knowledge about SCADA architecture and the various advantages and disadvantages of eachsystem.
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 distribution sector, industries etc.

Syllabus

UNIT-I **(8 hours)**

Introduction to SCADA:
Evolution of SCADA, SCADA definitions, SCADA Functional requirements and Components, SCADA Hierarchical concept, SCADA architecture, General features, Benefits.

UNIT-II **(8 hours)**

SCADA System Components:
Remote Terminal Unit (RTU), Interface units, Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Programmable Logic Controller (PLC), Intelligent Electronic Devices (IED),

UNIT-III **(8 hours)**

SCADA System Components:
SCADA Server, SCADA/HMI Systems, SCADA Control systems and Control panels, Communication Network, Monitoring and supervisory functions,

Syllabus

SCADA SYSTEM AND APPLICATIONS (MPST242)

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

UNIT-IV **(8 hours)**

Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, Communication media like Fiber optic, PLCC etc. Interface provisions and communication extensions, synchronization with NCC, DCC

UNIT-V **(8 hours)**

SCADA Applications in Power System:
Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning. SCADA Design case study.

REFERENCES:

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of AmericaPublications, USA, 2004
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK,2004
3. William T. Shaw, "Cybersecurity for SCADA systems", 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",Penn Well 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, Backpropagation Learning, Variation of Standard Back propagation Neural Network, Feedback networks and Radial Basis Function Networks

UNIT-II **(8 hours)**

Fuzzy Logic, Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Knowledge Representation and Inference Mechanism, Minmax Composition, Defuzzification Method, 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. System Identification using Fuzzy and Neural Network

Syllabus

ARTIFICIAL INTELLIGENCE TECHNIQUES (MPST244)

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

UNIT-IV **(8 hours)**

Genetic algorithm, History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization. Introduction to evolutionary program, Applications.

UNIT-V **(8 hours)**

Hybrid Systems: Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.

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

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Syllabus

POWER SYSTEM ANALYSIS LAB (MPSP-101)

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.

Course Outcomes:

Students will be able 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 (MPSP-102)

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

Course Objectives:

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

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:

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 behind transient 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 (MPSP-201)

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 (MPSP-202)

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:

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:

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

Infinite bus 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

Infinite bus 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 world simulationsoftware

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 various optimization techniques such as PSO, GA.

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Syllabus

MOET-391: Industrial Internet of Things

L T P :3 0 0 **Credit 3**

Unit 1: Introduction (8 Hours)

Introduction to IoT, IoT Vs. IIoT, History of IIoT, Components of IIoT -Sensors, Interface, Networks, People &Process, Hype cycle, IOT Market, Trends& future Real life examples, Key terms of IoT–IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining & Manipulation; Role of IIoT in Manufacturing Processes Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges and Benefits in implementing IIoT.

Unit 2: Architectures (8 Hours)

Overview of IoT components: Various Architectures of IoT and IIoT, Advantages & disadvantages, Industrial Internet -Reference Architecture; IIoT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT. SENSORS AND INTERFACING: Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACnet, Current, M2M etc.

Unit 3: Protocols and Cloud (8Hours)

Need of protocols; Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, BACnet, BLE, Modbus, SPI, I2C, IIoT protocols –COAP, MQTT, 6LoWPAN, LWM2M, AMPQ IIoT cloud platforms: Overview of COTS cloud platforms, Predix, PTC Thing Worx, Microsoft Azure etc. Data analytics, cloud services, Business models: SaaS, PaaS, IaaS.

Unit 3: Security (8Hours)

Introduction to web security, Conventional web technology and relationship with IIoT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network security techniques Management aspects of cyber security.

UNIT 5: Digital Twin (8 Hours)

Introduction to Digital Twin, need for Digital Twin, Elements of Digital Twin, Digital Twin process design and information requirements, Digital twin conceptual architecture -create, communicate, Aggregate, Analyze, Insight, Act, driving business value through digital twin. DIGITAL TWIN FOR ASSET: Digitalizing asset behaviour using simulated mathematical modelling and building Digital Twin -Need, Benefits, Architecture, Models and Use cases -Predictive and Prescriptive maintenance.

Syllabus
MOET391: Industrial Internet of Things

Text Books

1. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, by Daniel Minoli, Bernd Scholz-Reiter, Florian, Willy Publication
2. Digital Twin Technologies and Smart Cities by Farsi, M., Daneshkhah, A., Hosseinian-Far, A., Jahankhani, H., Springer International Publishing, 2020.
3. Architecting the Internet of Things, by Michahelles, Springer, 2011

Reference Books

1. The Internet of Things Connecting Objects to the Web" by Hakima Chaouchi, Willy Publications
2. The Internet of Things: Key Applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, 2nd Edition, Willy Publications
3. Inside the Internet of Things (IoT), Deloitte University Press
4. Internet of Things-From Research and Innovation to Market Deployment; By Ovidiu & Peter; River Publishers Serie

Five thoughts from the Father of the Internet of Things; by Phil Wainewright -Kevin Ashton

Course Outcomes

At the end of this course the student will be able to:

1. Understand the elements of IoT to build a total control plane in an Industrial application.
2. Apply M2M protocols for development of IoT Applications.
3. Learn and understand the concept of digitalization and data acquisition.
4. Build smartfactory based on the concepts
5. Build Industrial Digital Twins.

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Syllabus

MOET392: Neural Computing Systems and Applications

L T P :3 0 0 **Credit 3**

Unit 1: (8 Hours)

Introduction: Basic Model of Neuron, Characteristics, Neural Computing Structure and Functioning of Biological Brain & Neuron, Concept of learning/training, biasing effects in ANNS, Artificial Neuron model, Basic Specifications of Brain. Optimization theory of linear and non-linear functions, Gradient methods of optimization.

Unit 2: (8 Hours)

Learning Methods and Architectures: Delta-rule for training, LMS Algorithm, Limitations of Perceptron network, Introduction of Hebb's Law and Oja's Rule, Multilayer networks and Training using Back Propagation Algorithm.

Unit 3: (8 Hours)

Introduction to Implementation of Neural Networks: Simulation & Hardware applications, Causal Neural Networks, Probabilistic Neural networks and Adaptive Non-linear Networks.

Unit 4: (8 Hours)

Hopfield Nets: Architecture, Energy functions, Growth Algorithms, Training Algorithms, Associative Memory and Short Term Memory, Genetic Algorithms.

Unit 5: (8 Hours)

Model of an Artificial Neuron: Transfer functions, ADALINES, MADALINES, Taxonomies used in ANNS. Logistic, TAN- Hyperbolic, Sigmoid, Threshold, Ramp, Exponential Functions used in Neural networks.

Text books:

1. Philip D. Wasserman, "Neural computing: Theory and Practice", Van Nostrand Reinhold edition 1989.
2. Clifford Lau, "Neural Networks: Theoretical foundations and Analysis, IEEE Press edition 1987.
3. G. Hadley, "Nonlinear and Dynamic Programming", Addison-Wesley edition 1970.

Reference books:

1. B. Yegnanarayana, "Artificial Neural Networks", Prentice-Hall of India edition 2009.
2. S. Haykin, "Neural Networks", Pearson Education edition 1999.
3. Li Ming Fu, "Neural Networks in Computer Intelligence", Tata McGraw Hill, India edition 2003.

COURSE OUTCOMES: After completing the course, student will able to:

1. Define and illustrate the basic model of neuron, its structure, characteristic and functions.
2. Show the skills to develop different algorithms applied in neural computing.
3. Demonstrate and analyze rules used in neural computing applications.
4. Explain model development of artificial neuron based neural computing.
5. Basis of implementation of neural network.

Syllabus

MOET393: Distributed Generation & Micro-Grids

L T P :3 0 0 **Credit 3**

Unit 1: Introduction (8 Hours)

Conventional power generation: advantages and disadvantages, Energy crises, Non - conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

Unit 2: Distributed Generations (DG) (8 Hours)

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

Unit 3: Impact Of Grid Integration (8 Hours)

Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Unit 4: Basics of a MICROGRID (8 Hours)

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.

Unit 5: Control and Operation of MICROGRID (8 Hours)

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids

References:

1. Amirnaser Yezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
2. Dorin Neacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, “Solar Photo Voltaics”, PHI learning Pvt. Ltd., New Delhi, 2009
4. J.F. Manwell, J.G “Wind Energy Explained, Theory Design and Applications,”. McGowan Wiley publication, 2nd Edition, 2009. 5. D. D. Hall and R. P. Grover, “Biomass Regenerable Energy”, John Wiley, New York, 1987.
6. John Twidell and Tony Weir, “Renewable Energy Resources”, Taylor and Francis Publications, Second Edition, 2006.

COURSE OUTCOMES:

The student will have ability to

1. Describe the conventional power generation
2. Analyze the concept of distributed generation and installation
3. Design the grid integration system with conventional and non-conventional energy sources
4. Design the dc and ac micro grid
5. Analyze power quality issues and control operation of micro grid

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Syllabus

MOET394: Fundamentals of Electric and Hybrid Vehicles

L T P : 3 0 0

Credit 3

Unit 1: Introduction to Electric Vehicles (8 Hours)
Evolution of Electric Vehicles, EV configurations - Fixed and variable gearing, Single and multiple-motor drives, In-wheel drives, Parameters of EV systems - Weight and size parameters, Force parameters, Energy parameters, Performance parameters

Unit 2: Hybrid EV systems (8 Hours)
HEV configurations - Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Power flow control in Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Case Study

Unit 3: Electric Propulsion Systems (8 Hours)
DC motor drives, Induction motor drives, Permanent-magnet motor drives, Switched reluctance motor drives and their role in EV and HEV systems. Performance study of electrical propulsion system with respect to application.

Unit 4: Energy Sources in EV and HEV systems (8 Hours)
Electrochemical Batteries – Terminology, Specific Energy, Specific Power, Energy Efficiency in Lead-Acid Batteries, Nicked based batteries, Lithium based batteries, Requirement of Ultra capacitors – Features, Principle of operation and Performance of UC, High Speed Flywheels – Operating Principles, Power capacity, Flywheel technologies, Hybrid Energy Storage Systems, Fuel Cell – Principle of Operation and Performance

Unit 5: EV Auxiliary Systems (8 Hours)
Battery characteristics and chargers, Battery indication, Temperature control unit, Power Steering Unit, Auxiliary Power Supply, Navigation system. Case Study: Public and Domestic Charging Infrastructure for Electric Vehicles.

References Books:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2 nd edition, 2009.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Course Outcomes:
After completion of this course, student will be able to

1. Differentiate among different types of Electric and Hybrid Vehicles and their configurations.
2. Decide suitable electric propulsion system for EV and HEV.
3. Determine the rating of energy source requirement of EV and HEV.
4. Analyse the role of auxiliaries in Electric and Hybrid Vehicles
5. Knowledge of charging Infrastructure for Electric Vehicles.

Syllabus

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

M.TECH. (Power Systems) 2nd Year

(Effective from Session 2023-24)

Scheme of Examination for M.Tech. 2nd Year (Power System) Programme

Semester III (effective from 2023-24)

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	AHT 310-AHT313/ MOET 395-MOET 398	Open Elective-2	3	0	0	30	20	50	100		150	3
2	MPSP 301	Seminar	0	0	4			100			100	2
3	MPSP 302	Project	0	0	10			100		150	250	5
4	MPSP303	Dissertation (Phase I)	0	0	12			300		-	300	6
		Total	**3**	**0**	**26**			**550**	**100**	**150**	**800**	**16**

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

Open Elective-2
AHT310: Business Analytics
AHT311: Industrial Safety
AHT312: Operations research
AHT313: Cost Management of Engineering Projects
MOET-395: Energy Auditing and Management
MOET396: Analysis And Design Of Artificial Neural Network
MOET397: Renewable Power Generation Technologies
MOET398: Power System Restructuring and Pricing

Scheme of Examination for M.Tech. 2nd Year (Power System) Programme

Semester IV (effective from 2023-24)

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	MPSP 401	Dissertation (Phase II)	0	0	28			250		-	700	14
		Total	**0**	**2**	**28**			**250**		**450**	**700**	**14**

Scheme of Examination for B.Tech.-M.Tech. dual 1 Year M.Tech (Power System) Programme

Semester III (effective from 2023-24)

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	AHT-301*	Advanced Mathematics	3	1	0	30	20	50	100		150	4
2	MPST101*	Power System Analysis	3	1	0	30	20	50	100		150	4
3	(MOET 391-MOET 394)*	Open Elective-1	3	0	0	30	20	50	100		150	3
4	AHT-302*	Research Methodology and IPR	2	0	0	30	20	50	50		100	2
5	MPSP 301	Seminar	0	0	4			100			100	2
6	MPSP 302	Project	0	0	10			100		150	250	5
7	MPSP303	Dissertation (Phase I)	0	0	12			300		-	300	6
		Total	**11**	**2**	**26**			**700**	**350**	**150**	**1200**	**26**

*Syllabus same as for Regular M.Tech. 1st Year course

Open Elective-1
MOET-391: Industrial Internet of Things
MOET392: Neural Computing Systems and Applications
MOET393: Distributed Generation & Micro-Grids
MOET394: Fundamentals of Electric and Hybrid Vehicles

Scheme of Examination for B.Tech.-M.Tech. dual 1Year M.Tech (Power System) Programme

Semester IV (effective from 2023-24)

S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	MPST102*	Power System stability and Control	3	1	0	30	20	50	100		**150**	4
2	(MPST111/ MPST112/ MPST113/ MPST114)*	1. Renewable Energy System 2. Smart Grid Technology 3. High Power Converters 4. Hybrid Electric Vehicles	3	0	0	30	20	50	100		**150**	3
3	AHT 310-AHT313/ MOET 395-MOET 398	Open Elective-2	3	0	0	30	20	50	100		**150**	3
4	MPSP101*	Power System Analysis Lab	0	0	3		25	25		25	**50**	1
5	MPSP102*	Power System Stability and Control Lab	0	0	3		25	25		25	**50**	1
6	MPSP 401	Dissertation (Phase II)	0	0	28			250		-	**700**	14
		Total	**9**	**2**	**34**			**450**	**300**	**150**	**1250**	**26**

*Syllabus same as for Regular M.Tech. 1st Year course

Open Elective-2
AHT310: Business Analytics
AHT311: Industrial Safety
AHT312: Operations research
AHT313: Cost Management of Engineering Projects
MOET-395: Energy Auditing and Management
MOET396: Analysis And Design Of Artificial Neural Network
MOET397: Renewable Power Generation Technologies
MOET398: Power System Restructuring and Pricing

Syllabus
BUSINESS ANALYTICS (AHT- 310)

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

Course Objectives

The course should enable the students to:

1. Understanding the Role of Business Analyst in business.
2. Understanding the basic concept of data management and data mining techniques
3. Understanding the basic concept of data management and data mining techniques.
4. To understand the basic concept of machine learning
5. To understand the application of business analysis.

Course Outcomes

Upon successful completion of the course, the student will be able to

1. Gaining Knowledge of basic concept /fundamentals of business analysis.
2. Understand data management and handling and Data Science Project Life Cycle.
3. Understand the data mining concept and its techniques.
4. Understand and Analyzing machine learning concept.
5. Understand the application of business analysis in different domain.

UNIT 1 **(08 Hours)**

Introduction:

What is business analytics? Historical Overview of data analysis, Data Scientist vs. Data Engineer vs. Business Analyst, Career in Business Analytics, What is data science, Why Data Science, Applications for data science, Data Scientists Roles and Responsibility.

UNIT 2 **(08 Hours)**

Data:

Data Collection, Data Management, Big Data Management, Organization/sources of data, Importance of data quality, Dealing with missing or incomplete data, Data Visualization, Data Classification.

Data Science Project Life Cycle: Business Requirement, Data Acquisition, Data Preparation, Hypothesis and Modelling, Evaluation and Interpretation, Deployment, Operations, Optimization.

UNIT 3 **(08 Hours)**

Introduction to Data Mining:

The origins of Data Mining, Data Mining Tasks, OLAP and Multidimensional data analysis, Basic concept of Association Analysis and Cluster Analysis.

UNIT 4 **(08 Hours)**

Introduction to Machine Learning:

History and Evolution, AI Evolution, Statistics Vs Data Mining Vs Data Analytics Vs, Data Science, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Frameworks for building Machine Learning Systems.

UNIT 5 **(08 Hours)**

Application of Business Analysis:

Retail Analytics, Marketing Analytics, Financial Analytics, Healthcare Analytics, Supply Chain Analytics.

Books and References

1. An Introduction to Business Analytics, Ger Koole, Lulu.com, 2019.
2. Essentials of Business Analytics: An Introduction to the methodology and its application, Bhimasankaram Pochiraju, Sridhar Seshadri, Springer.
3. Introduction to Data Science, Laura Igual Santi Seguí, Springer.
4. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education India.

Syllabus

INDUSTRIAL SAFETY (AHT- 311)

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

Course Objectives:

The course should enable the students to:

1. To impart knowledge about various aspects of industrial safety.
2. To impart knowledge about safety and health regulations.
3. To enable the students to identity industrial hygiene and source models.
4. To understand Acts and Rules of industrial safety.
5. To understand the safety management and training.

Course Outcomes:

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

1. Identify the key aspects of industrial safety and mitigate them.
2. Describe various types of solution to problems arising in safety operations and hygiene.
3. Apply principles of OSHA in controlling industrial disasters and losses.
4. Identify various Acts and Rules of industrial safety.
5. Assess the overall performance of safety management and training.

UNIT 1 **(08 Hours)**

Introduction:

History of safety movement -Evolution of modern safety concept, Henrich's Axioms Of Industrial Safety, Concepts Of Safety, Organization For Safety, Organization, Definition, Need & Principles Organizing For Health, Environmental, Activities, Organization Structure, Function & Responsibilities.

UNIT 2 **(08 Hours)**

Safety and Health Regulations:

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT 3 **(08 Hours)**

Industrial Hygiene:

Government Laws and Regulations, OSHA: Process Safety Management, EPA: Risk Management Plan, DHS: Chemical Facility Anti-Terrorism Standards (CFATS) Industrial Hygiene: Anticipation and Identification, Evaluation, Control.

Source Models: Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapors through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis.

UNIT 4 **(08 Hours)**

Acts and Rules:

Indian boiler Act 1923, static and mobile pressure vessel rules (SMPV). motor vehicle rules, mines act 1952,

workman compensation act and rules, electricity act and rules, the building and other construction workers act 1996, Petroleum rules, Explosives Act 1963 Pesticides Act. Factories Act 1948 Air Act 1981 and Water Act 1974.

UNIT 5 **(08 Hours)**

Safety Management and Training:

The importance of training - identification of training needs training methods - programs, seminars, conferences. Evaluation of modern safety concepts, safety management functions, safety organization, safety department, safety committee, safety audit, performance measurements, motivation, employee participation in safety, safety, and productivity.

Books and References

1. Safety Management in industry by NV. Krishnan, Jaico Publishing House, Bombay, 1997.
2. Safety at Work by J.R. Ridey Butterwort London 1983.
3. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
4. Occupational Safety Manual BHEL.
5. Safety Manual. EDEL Engineering Consultancy, 2000.

Syllabus

OPERATIONS RESEARCH (AHT- 312)

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

Objective of the Course

The course should enable the students to:

1. To build capabilities in the students for analyzing different situations in the industrial/ business scenario.
2. To understand and analyze managerial and engineering problems.
3. To understand of various assignment problem in Operation research.
4. To introduce students to the various problem of Transportation.
5. To understand of various network techniques in Operation research.

Course Outcomes

Upon successful completion of the course, the student will be able to

1. To analyze any real-life system with limited constraints and depict it in a model form.
2. Ability to understand role of Linear Programming aids decision making.
3. Imparts knowledge of Assignment problem and its uses.
4. Understand variety of problems such as transportation, travelling salesman etc.
5. Understand different queuing situations and find the optimal solutions using models for different situations.

UNIT 1 **(08 Hours)**

Introduction: Definition and scope of operations research (OR), OR model, solving the OR model, Features and Phases of Operation Research, Types of Operation Research, Limitations of Operation Research, Role of Operational research in decision making.

UNIT 2 **(08 Hours)**

Linear Programming: Introduction of Linear Programming problem, Requirement of LPP, Applications, Advantages, Limitations, Mathematical Formulation of LPP. Graphical solution, Simplex method for maximization and minimization Problems. Applications to management decision making.

UNIT 3 **(08 Hours)**

Assignment Problem: Introduction to assignment problems, need and significance of assignment problem, Algorithm, Hungarian method, simple assignment problems.

UNIT 4 **(08 Hours)**

Transportation Problems: Introduction, Features, need and significance, formulation of transportation problem, Initial basic feasible solution - NWC, Least Cost, Vogel's and MODI Method.

UNIT 5 **(08 Hours)**

Network Models and Simulation: Network models for Project analysis, Phases of project management, guidelines for network construction, CPM- Network construction and time analysis, PERT- Simple problems, need for simulation and managerial perspective of various quantitative techniques.

Books and References

1. Wayne L. Winston, "Operations Research" Thomson Learning, 2003.
2. Hamdy H. Taha, "Operations Research-An Introduction" Pearson Education, 2003.
3. R. Panneer Seevam, "Operations Research" PHI Learning, 2008.
4. V. K. Khanna, "Total Quality Management" New Age International, 2008.

Syllabus

COST MANAGEMENT OF ENGINEERING PROJECTS (AHT-313)

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

COURSE OBJECTIVES: The course should enable the students to:

I. Establish systems to help streamline the transactions between corporate support departments and the operating units.

2. Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units. organizational operating units.

3. Use pseudo profit centers to create profit maximizing behavior in what were formerly cost centers.

COURSE OUTCOMES:

1: Understand the concept of strategic cost management, strategic cost analysis – target costing, life cycle costing and Kaizen costing and the cost drive concept.

2: Describe the decision-making; relevant cost, differential cost, incremental cost and opportunity cost, objectives of a costing system.

3: Understand the meaning and different types of project management and project execution, detailed engineering activities.

4: Understand the project contracts, cost behavior and profit planning types and contents, Bar charts and Network diagram.

5: Analyze by using quantitative techniques for cost management like PERT/CPM.

UNIT-I: INTRODUCTION

Introduction and Overview of the Strategic Cost Management Process. Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision Making.

UNIT-II: PROJECT MANAGEMENT

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents. Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT-III: COST BEHAVIOR AND PROFIT PLANNING

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and

Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement, Planning, Enterprise Resource Planning.

UNIT -IV: TOTAL QUALITY MANAGEMENT

Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT-V: QUANTITATIVE TECHNIQUES

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation Problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Reference Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi.
2. Charles T. Horngren and George Foster Advanced Management Accounting.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.

Web References:

1. https://nptel.ac.in/courses/110/101/110101132/
2. https://nptel.ac.in/courses/105104161/

E-Text Books:

1. https://easyengineering.net/construction-engineering-and-management-by-seetharaman/

Syllabus
MOET395: ENERGY AUDITING AND MANAGEMENT

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

Course Objectives

The course objectives are:

1. To emphasize the energy management on various electrical equipment and metering.
2. To illustrate the energy management in lighting systems and cogeneration.
3. To study the concepts behind the economic analysis and load management.
4. To study the concepts of Metering for energy management.
5. To study the concepts of Economic analysis by studying various models.

Course Outcomes:

Upon completion of the course, the students will be able to

1. Explain the basics of Energy auditing and Energy management.
2. Employ energy management strategies for electric machines and cogeneration.
3. Employ energy management strategies in lighting systems.
4. Devise energy management strategies for metering and instrumentation.
5. Analyse and justify the economics of different energy management strategies.

Unit 1:

Basics of Energy – Need for energy management – Energy accounting - Energy monitoring, targeting and reporting - Energy audit process.

Unit 2 :

Energy management for electric motors – Transformer and reactors - Capacitors and synchronous machines, energy management by cogeneration – Forms of cogeneration – Feasibility of cogeneration – Electrical interconnection.

Unit 3 :

Energy management in lighting systems – Task and the working space - Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Power factor and effect of harmonics, lighting and energy standards.

Unit 4 :

Metering for energy management – Units of measure - Utility meters – Demand meters – Paralleling of current transformers – Instrument transformer burdens – Multi tasking solid state meters, metering location vs requirements, metering techniques and practical examples.

Unit 5 :

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.

Reference Books:

1. Barney L. Capehart, Wayne C. Turner, and William J.Kennedy, 'Guide to Energy Management', 5th Edition, The Fairmont Press, Inc., 2006.
2. Amit K. Tyagi, 'Handbook on Energy Audits and Management', The Energy and Resources Institute, 2003.
3. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.

Syllabus

MOET 396: ANALYSIS AND DESIGN OF ARTIFICIAL NEURAL NETWORK

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

Course Objectives

The course objectives are:

1. To apply artificial neural networks in various electrical and electronics engineering applications.
2. To study different modes of operation in artificial neural network.
3. To study the first generation and second generation neural networks.
4. To study the Neuro adaptive control applications.
5. To study the applications of neural algorithms and systems.

Course Outcomes:

Upon completion of the course, the students will be able to

1. Explain the concepts of biological and artificial neural network.
2. Understand the different modes of operation in artificial neural network.
3. Discriminate the first generation and second generation neural networks.
4. Apply the third generation neural networks.
5. Employ neural network in pattern recognition, forecasting, control, clustering, data mining and decision makingengineering problems.

Unit 1:

Pattern classification – Learning and generalization - Structure of neural networks – Adaline and Madaline - Perceptrons.

Unit 2:

Linear separability – Back propagation – XOR function-Back propagation algorithm - Hopfied and Hamming networks- Kohensen's network - Boltzmenn machine-in and out star network – Art 1 and Art 2 nets.

Unit 3:

Neuro adaptive control applications - ART architecture – Comparison layer – Recognition layer –

ART classification process – ART implementation – Examples.

Unit 4:

Character recognition networks - Neural network control application - connectionist expert systems for medical diagnosis - self-organizing maps.

Unit 5:

Applications of neural algorithms and systems - Character recognition networks, Neural network control application, connectionist expert systems for medical diagnosis.

Reference Books:

1. Martin T. Hagan, Howard B. Demuth, M, and Mark H. Beale ,'Neural network design', Vikas Publishing House,2003.
2. Zurada, J.M., 'Introduction to Artificial Neural Systems', Jaico publishing house, Bombay, 1992.
3. Zimmermann, H.J., 'Fuzzy set theory and its applications', Allied publishers limited, Madras, 2001.

Syllabus

MOET 397: RENEWABLE POWER GENERATION TECHNOLOGIES

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

Course Objectives

The course objectives are:

1. To make aware of various forms of renewable energy.
2. To impart knowledge of the wind energy conversion system and photovoltaic conversion system.
3. To convey about the Grid connected PV systems technology.
4. To teach the Components of Energy in the wind.
5. To the Wind turbine generator systems .

Course Outcomes

Upon completion of the course, the students will be able to:

1. discuss the need and possibility of extracting solar energy and converting into electrical energy using PV cell.
2. Design and analyze stand-alone and grid connected PV system.
3. Describe the dynamics of wind turbine and electrical generator.
4. Select and design suitable configuration of the wind energy conversion system based on application.
5. Suggest, design and analyze hybrid energy systems.

Unit 1:

Sun and Earth - Basic Characteristics of solar radiation - Angle of sunrays on solar collector - Photovoltaiccell - characteristics-equivalent circuit - Photovoltaic modules and arrays.

Unit 2:

PV Systems-Design of PV systems - Standalone system with DC and AC loads with and without battery storage - Grid connected PV systems - Maximum Power Point Tracking.

Unit 3:

Wind energy – Energy in the wind – Aerodynamics - Rotor types – Forces developed by blades - Aerodynamic models – Braking systems – Tower - Control and monitoring system - Design considerations- Power curve - Power speed characteristics - Choice of electrical generators.

Unit 4:

Wind turbine generator systems - Fixed speed induction generator - Performance analysis - Semi variable speed induction generator - Variable speed induction generators with full and partial rated power convertertopologies - Isolated systems - Self excited induction generator - Permanent magnet alternator - Performance analysis.

Unit 5:

Hybrid energy systems - Wind-diesel system - Wind-PV system - Micro hydro-PV system - Biomass- PV-diesel system - Geothermal-tidal and OTEC systems.

Reference Books:

1. Chetan Singh Solanki, 'Solar Photovoltaics -Fundamentals, Technologies and Applications', PHI LearningPvt. Ltd., New Delhi, 2011.
2. Van Overstraeton and Mertens R.P., 'Physics, Technology and use of Photovoltaics', Adam Hilger,Bristol,1996.
3. John F. Walker & Jenkins. N , 'Wind energy Technology', John Wiley and sons, Chichester, UK, 1997.
4. Freries L L ,'Wind Energy Conversion Systems', Prentice Hall, U.K., 1990.

Syllabus

MOET 398: POWER SYSTEM RESTRUCTURING AND PRICING

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

Course Objectives

The course objectives are:

1. To emphasize on the regulated and deregulated power markets .
2. To study the Electricity Pricing and Forecasting.
3. To study the Components of restructured system.
4. To study the Open Access Distribution.
5. To study the Challenges and synergies in the use of IT in power sector.

Course Outcomes:

Upon completion of the course, the students will be able to

1. Explain the deregulated electricity market models functioning around the world.
2. Understand the operational and planning activities in power generation.
3. Solve transmission pricing and understand strategies in congestion management.
4. Study the development of competition in electricity distribution companies.
5. Outline the salient features of Indian Electricity Act and the formation and operation of Indian power exchanges.

Unit 1 : Introduction – Market Models – Entities – Key issues in regulated and deregulated power markets - Market equilibrium - Market clearing price - Electricity markets around the world.

Unit 2: Operational and planning activities of a Genco - Electricity Pricing and Forecasting - Price Based Unit Commitment Design - Security Constrained Unit Commitment design. - Ancillary Services for Restructuring- Automatic Generation Control (AGC).

Unit 3: Introduction - Components of restructured system - Transmission pricing in Open-access system-Open transmission system operation - Congestion management in Open-access transmission systems - FACTS in congestion management - Open-access Coordination Strategies - Power Wheeling - Transmission Cost Allocation Methods.

Unit 4 : Open Access Distribution - Changes in Distribution Operations - The Development of Competition – Maintaining Distribution Planning.

Unit 5 : Power Market Development – Electricity Act, 2003 - Key issues and solution - Developing power exchanges suited to the Indian market - Challenges and synergies in the use of IT in power - Competition - Indian power market - Indian energy exchange- Indian power exchange-

Infrastructure model for power exchanges - Congestion Management - Day Ahead Market - Online power trading.

Reference Books:

1. Loi Lei Lai, 'Power System Restructuring and Deregulation', John Wiley & Sons Ltd., 2001.
2. Mohammad Shahidehpour, Hatim Yamin, 'Market operations in Electric power systems', John Wiley & son ltd.,2002.
3. Lorrin Philipson, H. Lee Willis, 'Understanding Electric Utilities and Deregulation', Taylor & Francis, 2006.
4. Mohammad Shahidehpour, Muwaffaq Alomoush, 'Restructured Electrical Power Systems', Marcel Dekker, Inc.,2001.