Institute of Engineering and Technology, Lucknow

Evaluation scheme & Syllabus

For

M.Tech.

In

Power& Energy System

Based on

CHOICE BASED CREDIT SYSTEM (CBCS)

(Effective from the session:2020-21)

Institute of Engineering and Technology,Lucknow

(Constituent Institute of DR.A.P.J. Abdul Kalam Technical University, Lucknow

M.Tech : Power& Energy Systems

Semester 1

S. No.	Subject Code	Name of Subject	Periods				Evaluation Scheme					
							Theory			Practical		Subject Total
			L	T	P	Credit	CT	TA	ESE	TA	ESE	
1	MTPE-101	Advanced Power System Analysis	3	0	0	3	20	10	70	-	-	**100**
2	MTPE-102	Solar Energy Conversion	3	0	0	3	20	10	70	-	-	**100**
3	MTPE-011 - MTPE-013	Departmental Elective 1	3	0	0	3	20	10	70	-	-	**100**
4	MTPE-021MTPE-023	Departmental Elective 2	3	0	0	3	20	10	70	-	-	**100**
5	RM-101	Research Process & Methodology	3	0	0	3	20	10	70	-	-	**100**
6	MTPE-151	Power System Simulation Lab	0	0	3	2	-	-	-	20	30	**50**
7	MTPE-152	Renewable Energy Lab	0	0	2	2	-	-	-	20	30	**50**
TOTAL						**18**						**600**

Semester 2

S. No.	Subject Code	Name of Subject	Periods				Evaluation Scheme					
							Theory			Practical		Subject Total
			L	T	P	Credit	CT	TA	ESE	TA	ESE	
1	MTPE-201	Advanced Power Electronics	3	0	0	3	20	10	70	-	-	**100**
2	MTPE-202	Wind Energy Conversion System	3	0	0	3	20	10	70	-	-	**100**
3	MTPE-031 - MTPE-033	Departmental Elective 3	3	0	0	3	20	10	70	-	-	**100**
4	MTPE-041 - MTPE-043	Departmental Elective 4	3	0	0	3	20	10	70	-	-	**100**
5	MTPE-051 - MTPE-053	Departmental Elective 5	3	0	0	3	20	10	70	-	-	**100**
5	MTPE-251	Power Electronics Lab	0	0	3	2	-	-	-	20	30	**50**
7	MTPE-252	Seminar 1	0	0	2	2	-	-	-	50	-	**50**
TOTAL						**18**						**600**

Semester 3												
S. No.	Subject Code	Name of Subject	Periods				Evaluation Scheme					
							Theory			Practical		Subject Total
			L	T	P	Credit	CT	TA	ESE	TA	ESE	
1	MTEE-351	SEMINAR 2	0	0	6	3	-	-	-	100	-	**100**
2	MTEE-352	DISSERTATION	0	0	30	15	-	-	-	200	300	**500**
TOTAL						**18**						**600**

Semester 4												
S. No.	Subject Code	Name of Subject	Periods				Evaluation Scheme					
							Theory			Practical		Subject Total
			L	T	P	Credit	CT	TA	ESE	TA	ESE	
1	MTPE-451	Dissertation (Final)	0	0	36	18				200	400	600
TOTAL						**18**	**600**					

Departmental Elective- I	
MTPE-011	Power System Optimization
MTPE-012	Power System Reliability and Planning
MTPE-013	Policies and Economics of International Energy

Departmental Elective- II	
MTPE-021	Electric Power Distribution System
MTPE-022	Advanced Electric Drives
MTPE-023	Power Quality

Departmental Elective- III	
MTPE-031	FACTS and Custom Power Devices-Application to Power System
MTPE-032	Electric Vehicles

Departmental Elective- III	
MTPE-033	Power System Deregulation

Departmental Elective- IV	
MTPE-041	Smart grid
MTPE-042	Distributed Generation
MTPE-043	Machine Learning Applications to Power System

Departmental Elective- V	
MTPE-051	Power System Dynamics & Control
MTPE-052	Modern Power system Protection
MTPE-053	Synchrophasors- Applications to Power System

MTPE 101 -ADVANCED POWER SYSTEM ANALYSIS

L T P 3 0 0

UNIT I

Network matrix: Physical interpretation of bus admittance and impedance matrices, introduction to admittance matrix formulation, formation of admittance matrix due to inclusion of regulating transformer, development of admittance matrix using singular transformation, modification of admittance matrix for branch addition/ deletion.

UNIT II

Complex power flow: Analytical formulation of complex power flow solution, Gauss-Seidal method of power flow, Newton Raphson method of power flow, algorithm for solving power flow problem using N-R method in rectangular form, algorithm for solving power flow problem using N-R method in polar form, fast decoupled load flow method.

UNIT III

Power System Stability: Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study. Transient stability: Assumptions for transient stability, derivation of swing equation, swing equation for synchronous machine connected to infinite bus, swing equation for a two machine system.

UNIT IV

Solution of swing equation by Euler and RungeKutta method, equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine. Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing, electric braking, voltage regulators, fast governor action, high speed excitation system.

UNIT V

Voltage stability: Definition and classification of voltage stability, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, expression for critical receiving end voltage and critical power angle at voltage stability limit for a two bus power system, PV and QV curves, L index for the assessment of voltage stability.

REFRENCES:

1. J.J Grainger&W.D. Stevenson, “Power System Analysis”, McGraw Hill,2003
2. A.R. Bergen & Vijay Vittal, “Power system analysis”,Pearson,2000, 2.
3. L.P Singh, “Advanced Power System Analysis and Dynamics”, NewAge International, 2006.
4. G.L. Kausic, “Computer Aided Power System Analysis”, Prentice Hall India, 1986.
5. A.J. Wood, “Power generation. Operation and control”, John Wiley,1994.
6. P.M Anderson, “Faulted Power System analysis”, IEEE Press,1995.
7. Power system Analysis by Charles A: Gross John Wiley &Sons.

MTPE 102-SOLAR ENERGY CONVERSION

UNIT I **L T P 3 0 0**

INTRODUCTION:

Trends in energy consumption-world energy scenario, energy resources and their availability, conventional and renewable sources, need to development new energy technologies.

UNIT II

PHOTOVOLTAIC ENERGY CONVERSION: Solar radiation and measurement, solar cell and their characteristics, influence of insulation and temperature, PV arrays, electrical storage with batteries, solar availability, switching devices for solar energy conversion, maximum power point tracking.

UNIT III

POWER CONDITIONING SCHEMES: DC power conditioning converters, MPPT algorithm, AC power conditioners, line commuted inverters, synchronised operation with grid supply, harmonic problem.

UNIT IV

DESIGN & MODELING OF SOLAR ENERGY SYSTEMS: F Chart method, φ– F Chart method, Utilizability modelling& simulation of Solar Energy Systems.

UNIT V

ECONOMIC ANALYSIS OF SOLAR ENERGY SYSTEMS: Life cycle analysis of Solar Energy Systems, Time Value of Money, Evaluation of Carbon Credit of Solar Energy Systems.

REFRENCES:

1. Mukund R Patel,"Wind and Solar Power Systems", CRC press, 2004
2. Rai G D,"Wind Power Energy Resources", Khanna Publishers New Delhi 2002
3. Daniel Hunt V," Wind Power - A Hand Book of WECS", VAN NOSTREND CO.
4. Thomas Markvart and Luis Castaser," Practical Hand Book of Photovoltaics Elsevier Publications, UK ,200
5 .A.Duffie& W.A. Beckman:“Solar Engineering of Thermal Process”, 4thEdition, Wiley
6. S.A.Kalogirou: Solar Energy Engineering, Academic Press, 2013.

MTPE 011- POWER SYSTEM OPTIMIZATION TECHNIQUES

L T P 3 0 0

UNIT –I

Introduction to optimization and classical optimization techniques Linear Programming: Standard form, geometry of LPP, Simplex Method pf solving LPP, revised simplex method, duality, decomposition principle, and transportation problem.

UNIT –II

Non-Linear Problem (NLP): One dimensional methods, Elimination methods, Interpolation methods, Unconstrained optimization Techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods.

UNIT –III

Dynamic Programming: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem CPM and PERT.

UNIT –IV

Genetic Algorithm: Introduction to genetic Algorithm, working principle, coding of variables, fitness function. GA operators; Similarities and difference s between Gas and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA.

UNIT –V

Applications to Power system: Economic Load Dispatch in thermal and Hydro-thermal system using GA and classical optimization techniques, Unit commitment problem, reactive power optimization. Optimal power flow, LPP and NLP techniques to optimal flow problems.

REFERENCES:

1. Rao S. S “Optimization: Theory and Application Wiley Eastern Press”, 2nd edition 1984.
2. Taha H.A., Operations Research –An Introduction, Prentice Hall of India, 2003.
3. Fox, R.L., „Optimization methods for Engineering Design, Addition Wiley, 1971.
4. K. Deb, “Multi-objective Optimization using Evolutionary Algorithms”, Wiley, 2002

MTPE 012-POWER SYSTEM RELIABILITY & PLANNING

L T P 3 0 0

UNIT I

SYSTEM PLANNING:

Introduction, Objectives & Factors affecting to System Planning, Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning.

Load forecasting: Classification and characteristics of loads. Approaches to load forecasting. Forecasting methodology. Energy forecasting.

UNIT II

RELIABILITY:

Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost.

Basic Reliability Concepts: General reliability function, Markov Chains and processes and their applications, simple series and parallel system models.

UNIT III

GENERATION PLANNING AND RELIABILITY:

Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods, Interconnected System, Factors Affecting Interconnection under Emergency Assistance

UNIT IV

TRANSMISSION PLANNING AND RELIABILITY:

Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.

Transmission System Reliability Evaluation: Average interruption rate method. The frequency and duration method. Stormy and normal weather effects.

UNIT V

DISTRIBUTION PLANNING AND RELIABILITY:

Radial Networks, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices, Parallel & Meshed Networks, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Breaker Failure.

REFERENCES:

1. R.L. Sullivan “Power System Planning”, Tata McGraw Hill Publishing Company Ltd.
2. Roy Billinton & Ronald N. Allan “Reliability Evaluation of Power System”, Springer Publication
3. T. W. Berrie “Electricity Economics & Planning”, Peter Peregrinus Ltd., London.
4. Dasari, S., Electric Power System Planning, IBT Publishers (1999).
5. TuranGonen, “Electric Power Distribution system Engineering”, Second edition, Taylor & Francis ,2007.

MTPE 013 -POLICIES AND ECONOMICS OF INTERNATIONAL ENERGY

L T P 3 0 0

UNIT I

Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics. Discovery of various energy sources: Energy Sources and Overall Energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and Projected future demands. Energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc. Depletion of energy sources and impact exponential rise in energy consumption on economies of countries and on international relations.

UNIT II

Chemical and Nuclear: Non Proliferation, Energy Security, Energy Consumption and its impact on environmental climatic change. International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EUCountries. International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal. Future Energy Options: Sustainable Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies, parameters of transition.

UNIT III

Energy resources & Consumption: Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources.

UNIT IV

Status of Nuclear and Renewable Energy: Present Status and future promise Energy Policy Issues: Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future. Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs)

UNIT V

Energy Policy:Global Energy Issues, National & State Level Energy Issues, National & State Energy Policy, Industrial Energy Policy, Energy Security, Energy Vision. Energy Pricing & Impact of Global Variations. Energy Productivity (National & Sector wise productivity).

REFERENCES:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams (Wiley Eastern).
2. Energy policy for : B.V. Desai (Wiley Eastern),
3. Modelling approach to long term demand and energy implication: J.K.Parikh.
4. Energy Policy and Planning: B.Bukhootsow.
5. TEDDY Year Book Published by Tata Energy Research Institute (TERI),
6. World Energy Resources: Charles E. Brown, Springer2002.
7. International Energy Outlook' -EIA annual Publication
8. Heat and Thermodynamics – M.W. Zemansky (McGraw Hill Publication
9. Principles of Energy Conversion: A.W. Culp (McGraw Hill International edition.)
10. BEE Reference book: no.1/2/3/4.

MTPE 021 -ELECTRIC POWER DISTRIBUTION SYSTEM

UNIT I **L T P 3 0 0**

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

UNIT II

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

UNIT III

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

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

UNIT IV

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

UNIT V

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

REFERENCES:

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi.
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press.
4. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press

MTPE 022- ADVANCD ELECTRIC DRIVES

L T P 3 0 0

UNIT I

Unit-I Review of electric motors & Solid state converters: Speed control techniques of DC, Induction & synchronous motor, Converters, inverters, chopper and cyclo converter operation, Effects of power electronic equipment's on load side & supply side.

Review of closed loop controllers, sensors &transducers: PI, PID, Variable structure. AC, DC & Pulse tacho-generators.

UNIT II

DC Drives: Converter & chopper fed DC drive, Reversing, Starting, Regenerativebreaking,four quadrant operation, and High power application.

UNIT III

AC Drive: Inverter & cyclo converter fed drive, Vector control, Sensor less operation, Linear electrical motor concept, Synchronous motor drive.

UNIT IV

SpecialDrives: Switched reluctance& permanent magnet brushless DC Operation, Converters, Characteristics & Control, PLC based drives.

Servo drives & stepper motor- AC & DC Servomotor, Stepper motor, Control techniques, Controllers, Micro stepping, Sensor less operation.

UNIT V

Power Quality & energy Conservation- Line Side pollution, standards, Harmonic elimination techniques in converter, Filters, Energy efficient electric motors, Pay back periods, Energy conservation through sold state control.

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REFERENCES:

1. Ned Mohan, T.M. Undeland, W.P. Robbins, Power Electronics-Converters, Applications and design", John Wiley & Sons.
2. J.M.D. Murphy, F.O. Turnbull, "Power Electronic Control of AC motors", Pergamon Press.
3. P.C. Sen, D.C. drive, Pergamon Press
4. B.K. Bose, Power Electronics & AC drive prentice Hall.
5. Dubey G.K. "Power semi-Conductor controller drives, Prentice Hall.
6. VedamSubramanyam, "Electrical Drives".
7. T.J.E. Miller, Switched Reluctance & P.M. B.L. DC motor, Pergamon Press

MTPE 023-POWER QUALITY

L T P 3 0 0

UNIT I

Electric power quality phenomena: - Impacts of power quality problems on end users, Power quality standards, power quality monitoring.

Power quality disturbances: - transients, short duration voltage variations, long duration voltage variations, voltage imbalance, wave-form distortions, voltage fluctuations, power frequency variations, power acceptability curves.

UNIT II

Power quality problems: poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage.

UNIT III

Transients: Origin and classification- capacitor switching transient-lighting-load switching-impact on users-protection mitigation.

UNIT IV

Harmonics: harmonic distortion standards, power system quantities under non sinusoidal conditions-harmonic indices-source of harmonics-system response characteristics-effects of harmonic distortion on power system apparatus –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response- Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.

UNIT V

Power quality conditioners: Shunt and series compensators, DSTATCOM-dynamic voltage restorer, Unified Power Quality Conditioners (UPQC)..

REFERENCES:

1. Ghosh Arindam and Ledwich Gerard, 'Power quality enhancement using custom power devices' Springer.
2. Arrillaga J., Watson N. R. and Chen S., 'Power System Quality Assessment' Wiley.
3. Caramia P, Carpinelli G and Verde P, 'Power quality indices in liberalized markets' – Wiley .
4. Angelo Baggini 'Handbook of Power Quality' – Wiley.
5. . Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso, "Electrical Power System Quality", McGraw Hill
6. C. Sankaran, Power Quality CRC Press, USA 3. Wilson E. Kazibwe, "Electrical Power Quality Control Techniques", Van Nostrand Reinhold.

MTPE151-POWER SYSTEM SIMULATION LAB

L T P 0 0 3

LIST OF EXPERIMENTS:

1. Formation of Y-BUS matrix using MATLAB coding.
2. MATLAB coding N-R load flow in polar coordinates.
3. Load flow calculation using MATLAB and PST package.
4. Optimal power flow using PSAT.
5. Distribution load flow.
6. Symmetrical and unsymmetrical fault studies.
7. Voltage Instability Analysis.
8. Harmonic Analysis.
9. Economic Load Dispatch with Hydro thermal power plants.
10. Simulation of Facts controllers
11. Simulation of single -area and Two -area Systems.

NOTE- Minimum of 8 experiments are to be conducted.

MTPE 152RENEWABLE ENERGY LAB

L T P 0 0 2

LIST OF EXPERIMENTS:

1. To determine the efficiency of Solar PV panel at different irradiance levels
2. To determine the efficiency of a wind turbine for different wind speeds
3. Test the Capabilities of the Hydrogen Fuel Cells and Capacitors
4. Effect of Temperature on Solar Panel Output
5. Variables Affecting Solar Panel Output
6. Effect of Load on Solar Panel Output
7. Wind Turbine Output: The Effect of Load
8. Test the Capabilities of Solar Panels and Wind Turbines

MTPE 201-ADVANCE POWER ELECTRONICS

L T P 3 0 0

UNIT I

SWITCHING VOLTAGE REGULATORS :

Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, C'uk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator.

UNIT II

RESONANT CONVERTERS:

Introduction, need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies.

UNIT III

MULTI-LEVEL CONVERTERS:

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters.

UNIT IV

MULTIPULSE CONVERTERS:

Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ….) converters, Different phase shifting transformer (Y-Δ1, Y-Δ2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications.

HVDC TRANSMISSION:

Introduction, Operation of 12-pulse converter as receiving and sending terminals of HVDC system, Equipment required for HVDC System and their significance, Comparison of AC and DC transmission, Control of HVDC transmission.

UNIT V

FACTS DEVICES:

Importance of reactive power compensation, Flow of power in AC system and conventional control mechanisms, Definition of Flexible ac Transmission Systems (FACTS) and brief description, possible benefits from FACTS, Thyristor- Controlled Reactor (TCR), Fixed CapacitorThyristor-Controlled Reactor (FC-TCR), Thyristor-Switched capacitor and Reactor, Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSCTCR), STATCOM configuration and operating principle, Static characteristics of SVC and STATCOM Comparison of SVC and STATCOM, Principle of series compensation, Introduction to Static Synchronous Series Compensator, Advantages and limitation of SSSC, Introduction to UPFC and operating principle.

REFERENCES:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India, 3rd ed., 2009.
3. . Bin Wu, “High Power Converters and AC Drives”, John Willey & sons, Inc., 2006.
4. Derek A. Paice “Power Electronic Converter Harmonics – Multipulse Methods for Clean Power”, IEEE Press, 1996. 5. Muhammad H. Rashid , “Power Electronics Handbook”, Elsevier, 3rd ed., 2011.
5. P.C.Sen, “Modern Power Electronics ”, S. Chand and Co. Ltd., New Delhi, 2000.
6. Vijay K. Sood, “HVDC and FACTS Controllers Applications of Static Converters in Power Systems”, Kluwer Academic Publishers, Boston, 2004.
7. L. Umanand, “Power Electronics Essentials and Applications”, Wiley India Ltd., 2009

MTPE 202-WIND ENERGY CONVERSION SYSTEM

UNIT I **L T P 3 0 0**

Introduction: Modern wind turbines, wind resources, wind vs. traditional electricity generation, technology advancements, material Usage. Applications: grid connected power, industrial applications, stand-alone system, water pumping, offshore prospects.

Wind Resource Assessment: Introduction, spatial variation, time variations, seasonal and monthly variability, diurnal variations. Characteristics of steady wind: turbulence, types of turbulence models, turbulence intensity, wind power density. Weibull wind speed distribution function: Estimating Weibull distribution factor.

UNIT II

Wind Measurement: Vertical profiles of the steady wind. Wind speed measurement parameters, Monitoring station instrumentation, cup anemometer, propeller anemometer, Ultrasound anemometer, wind vane, data loggers, remote wind speed sensing techniques- Sodar, Lidar, SAR, LWS, Satellite remote sensing.

Aerodynamics: Aerofoil, two dimensional airfoil theory, relative wind velocity. Wind flow models, wind flow pattern. Axial momentum theory, Momentum theory, blade element theory. Wind machine characteristics.

UNIT III

Wind Turbines: Historical development. Classification of wind turbines. Turbine components.

Wind turbine design: Introduction, rotor torque and power, Power control, braking systems. Turbine blade design. Blade material, SERI blade sections,. Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations.

UNIT IV

Electrical and Control systems: Introduction to electricity and magnetism. Classification of generators, AC circuits, Synchronous generators, Induction generators, Variable speed generators. Control systems. Power Collection system. Power quality, wind farm and generation protection, interface protection, losses in generation.

Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries..

UNIT V

Wind Farm Design: Introduction, wind flow modelling, use of capacity factor for wind farm design, planning of wind farm. Siting of wind turbines, ecological indicators, layout of wind farm, initial site selection, micro siting, wake model. Economics of Wind Systems: Cost calculation, annual energy output, time value of money, capital recovery factor, depreciation

REFRENCES:

1. SirajAhmed:"Wind Energy-Theory and Practice" Second Edition, PHI Learning Pvt. Ltd, New Delhi, 2011.
2. Garg L Johnson: "Wind Energy Systems" Prentice Hall. Inc, New Jersey,1985.

3. Mukund R Patel,"Wind and Solar Power Systems", CRC press , 2004
4. Rai G D ,"Wind Power Energy Resources", Khanna Publishers New Delhi 2002
5. Daniel Hunt V," Wind Power - A Hand Book of WECS", VAN NOSTREND CO.
6. Thomas Markvart and Luis Castaser," Practical Hand Book of Photovoltaics Elsevier Publications, UK ,200

MTPE 031-FACTS AND CUSTOM POWER DEVICES-AAPPLICATION TO POWER SYSTEM

L T P 3 0 0

UNIT I

Reactive power flow control in Power Systems Control of dynamic power unbalances in Power System Power flow control-Constraints of maximum transmission line loading Benefits of FACTS Transmission line compensation-Uncompensated line - Shunt compensation - Series compensation –Phase angle control.

UNIT II

Reactive power compensation – Shunt and Series compensation principles – Reactive compensation at transmission and distribution level. Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control Comparison between SVC and STATCOM.

UNIT III

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators – TCVR and TCPAR , Operation and Control –Applications , Static series compensation – GCSC,TSSC, TCSC , Static synchronous series compensators and their Control.

UNIT IV

SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC- Basic Principle of P and Q control, Independent real and reactive power flow control- Applications. Introduction to interline power flow controller. Modelling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality problems in distribution systems.

UNIT V

Harmonics, loads that create harmonics, modelling, harmonic propagation, series and parallel resonances, mitigation of harmonics , Passive filters, active filtering – shunt , series and hybrid and their control. Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners,IEEE standards on power quality.

REFRENCES:

1. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New AgeInternationalPublishers, 2007
2. X P Zhang, C Rehtanz, B Pal, “Flexible AC Transmission Systems- Modelling and Control”, SpringerVerlag, Berlin, 2006
3. 3. N.G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K.S.Sureshkumar, S.Ashok ,“FACTS Controllers & Applications”, E-book edition, Nalanda Digital Library, NIT Calicut,2003.
5. G T Heydt , “Power Quality”, McGraw-Hill Professional, 2007
6. T J E Miller, “Static Reactive Power Compensation”, John Wiley and Sons, Newyork, 1982.

MTPE 032-ELECTRIC VEHICLES

UNIT I **L T P 3 0 0**

Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains.

UNIT II

Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor.

UNIT III

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles: - Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle.

UNIT IV

Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges.

UNIT V

Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Simulations and case studies in above mentioned areas.

REFERENCES:

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., “Vehicular Electric Power Systems” Boca Raton, CRC Press, 2003.
2. Husain, I. “Electric and Hybrid Vehicles” Boca Raton, CRC Press, 2010.
3. Larminie, James, and John Lowry, “Electric Vehicle Technology Explained” John Wiley and Sons, 2012.
4. Tariq Muneer and Irene IllescasGarcía, “The automobile, In Electric Vehicles: Prospects and Challenges”, Elsevier, 2017.
5. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Springer, 2013.

MTPE-033 POWER SYSTEM DEREGULATION

L T P 3 0 0

UNIT-I

Deregulation,ReconfiguringPowersystems,unbundlingofelectricutilities,
Backgroundtoderegulationandthecurrentsituationaroundtheworld,
benefitsfromacompetitiveelectricitymarketaftereffectsofderegulation.

UNIT-II

Fundamentals of Economics: Introduction, Consumer behavior, Supplier behavior, Market equilibrium, Various costs of production, Perfectly competitive market, The Philosophy of Market Models: Introduction, Comparison of various market models, Market architecture.

UNIT-III

Powerwheeling,Transmissionopenaccess,pricingofpowertransactions, security management in deregulated environment, and congestion management inderegulation.

UNIT-IV

General description of some ancillary services, ancillary services managementinvariouscountries,andreactivepowermanagementin somederegulatedelectricitymarkets.

REFERENCES:

1. K. Bhattacharya, MHT Bollenand J.C Doolder, "Operation ofRestructuredPowerSystems",KluwerAcademicPublishers, USA, 2001. [Unit-I, II, III, IV&V]
2. Lei Lee Lai, "Power System restructuring and deregulation", John Wiley and Sons, UK.2001.
3. Fred I Denny and David E. Dismukes, "Power System Operations and Electricity Markets", CRC Press, LLC, 2002. [Unit-I, II, III, IV&V].

MTPE 041-SMART GRID

L T P 3 0 0

UNIT I

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid.

UNIT II

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT III

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. 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 Unit(PMU).

UNIT IV

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

UNIT V

Power Quality Management in Smart Grid: 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.

REFERENCES:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. 2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley Blackwell 19
5. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Pre

MTPE 042-DISTRIBUTED GENERATION

L T P 3 0 0

UNIT – I

Need for distributed generation– Renewable sources in distributed generation – Current scenario in distributed generation – Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems.

UNIT – II

Grid integration of DGs– Different types of interfaces – Inverter based DGs and rotating machine based interfaces – Aggregation of multiple DG units – Energy storage elements – Batteries, ultra-capacitors, flywheels.

UNIT – III

Technical impacts of DGs –Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems.

UNIT-IV

Economic and control aspects of DGs– Market facts, issues and challenges – Limitations of DGs – Voltage control techniques, Reactive power control, Harmonics, Power quality issues – Reliability of DG based systems – Steady state and Dynamic analysis.

UNIT – V

Introduction to micro-grids –Types of micro-grids – Autonomous and non-autonomous grids – Sizing of micro-grids – Modeling& analysis – Micro-grids with multiple DGs – Micro-grids with power electronic interfacing units – Transients in micro-grids – Protection of micro-grids – Case studies.

REFRENCES:

1. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.
2. M.GodoySimoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.
3. Robert Lasseter, Paolo Piagi, 'Micro-grid: A Conceptual Solution', PESC 2004, June 2004.
4. F. Katiraei, M.R. Iravani, 'Transients of a Micro-Grid System with Multiple Distributed Energy Resources', International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005.
5. Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson, 'Facility Microgrids', General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

MTPE 043- MACHINE LEARNING APPLICATION TO POWER SYSTEMS

L T P 3 0 0

UNIT 1
Introduction to Machine learning, History and early works, techniques, comparison and relation to artificial intelligence, optimization and statistics.

UNIT 2
Theoretical aspects of ML, different types of Machine Learning algorithms such as Linear regression, Logistic regression, K - Nearest Neighbor, Artificial Neural Networks, Random Forest, and Support Vector Machine, learning approaches: Supervised learning, unsupervised learning, semi supervised learning, reinforcement learning, self learning and association rules.

UNIT 3
Artificial Neural Network, Basic Concept, early NN Architectures, Characteristics, Neural Network architectures, Single layer feed forward Network, Multi layer feed forward network, recurrent networks, Non linear activation operators, learning methods like Back propagation, LM etc., training and testing of ANN.

UNIT 4
Genetic Algorithms: Fundamentals, History, working principal, genetic modeling, encoding, fitness function, Genetic operators: reproduction, cross over, mutation, Similarities and differences between GA and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm.

UNIT 5
Applications of machine learning in power systems operation and control for solving problems of load forecasting, renewable energy forecasting, load flow studies, Economic load dispatch, Unit commitment, power plant monitoring, fault identification and security assessment etc.

REFERENCES:

1. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman
2. Pattern Recognition and Machine Learning, by Christopher Bishop
3. NP Padhy , Artificial Intelligence and Intelligent Systems, Oxford University Press
4. Rajasekaran S. and Pai G.A.V., "Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications", PHI New Delhi.
5. Goldberg D.E. "Genetic Algorithms in Search Optimization & Machine Learning", Addition Wesley Co., New York.
6. . Kalyanmoy Deb "Optimization for Engineering Design", PHI publication.
7. Kevin Warwick, Arthur Ekwue, Raj Agrawal "Artificial intelligence techniques in power

MTPE 051 POWER SYSTEM DYNAMICS AND CONTROL

L T P 3 0 0

UNIT – I

Introduction to Power System Stability: Power System Operation and Control, Stability Problems faced by Power Systems, Impact on Power System Operation and Control.

Analysis of Dynamical Systems :Concept of Equilibria, Small and Large Disturbance Stability, Example: Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using Numerical Integration Techniques, Issues in Modelling: Slow and Fast Transients, Stiff Systems.

UNIT – II

Modeling of a Synchronous Machine Physical Characteristics, Rotor Position Dependent model. D-Q Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine. Synchronous Machine Connected to Infinite Bus.

UNIT – III

Modelling of Excitation and Prime Mover Systems Physical Characteristics and Models, Control system components, Excitation System Controllers, Prime Mover Control Systems., Modelling of Transmission Lines and Loads Transmission Line Physical Characteristics, Transmission Line Modelling, Load Models - induction machine model., Other Subsystems - HVDC, protection systems.

UNIT-IV

Stability Issues in Interconnected Power Systems Single Machine Infinite Bus System,Multi-machine Systems. Stability of Relative Motion, Frequency Stability: Centre of Inertia Motion. Concept of Load Sharing: Governors. Single Machine Load Bus System: Voltage Stability. Torsional Oscillations.

UNIT – V

Power System Stability Analysis Tools Transient Stability Program, Small Signal Analysis Program, EMTP Programs, Real-Time Simulators.

Enhancing System Stability Planning Measures, Stabilizing Controllers (Power System Stabilizers)., Operational Measures- Preventive Control. Emergency Control.

REFRENCES:

1. K.R.Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.
2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.
3. . P.Sauer&M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997..

MTPE 052-MODERN POWER SYSTEM PROTECTION

L T P 3 0 0

UNIT I

Protective Current & Potential Transformers: Types, Rating, Accuracy, burden, Polarity, connections and Transient Response.

UNIT II

Review of Electromagnetic Relays, relay terminology, basic protection schemes, overcurrent and directional overcurrent relays, distance relays, differential relays. Relay Coordination.

UNIT III

Static Relays: Basic elements, Functional circuits, Generalised theory of two input comparators, Amplitude and Phase comparators, Realization of different relays using comparators. Types of static comparators.

UNIT IV

Protection of transmission lines power transformers, alternators, induction motors.

UNIT V

Bus zone protection. Protection of reactors and capacitors. Digital protection, Digital relaying algorithms.

REFERENCES:

1. Power System Protection & Switchgear By B. Ram, McGraw Hill
2. Power System Protection- Static Relays By T.S.M. Rao Tata McGraw Hill
3. Digital Protection- Protective Relaying from Electromechanical to Microprocessor By L. P. Singh, New Age International
4. Power System Protection By PatraBasu&Choudhary, Oxford & IBH
5. . Protective Relay, Their Theory & Practices Vol. 1 By A.R.C. Warrington, Chapman & Hall UK

MTPE 053-SYNCHROPHASORS APPLICATIONS TO POWER SYSTEM

L T P 3 0 0

UNIT-I

SYNCHROPHASOR FUNDAMENTALS: Fundamentals, Definition and Description, Synchrophasor Attributes – Essential Properties, Applying Synchrophasors – Measurement Principles and Examples, Synchrophasor Technology Infrastructure – Components and Data Flow.

UNIT-II

SYNCHROPHASOR METRICS – USE IN REAL TIME OPERATIONS: Introduction to Synchrophasor Metrics, Phase Angle Differences, Voltage Sensitivity, Frequency Deviations, Oscillations.

UNIT-III

PHASE ANGLE DIFFERENCES: Definition & Importance of Phase Angle Differences for Operations, Importance of PMU Location, Use of Phase Angles in Control Rooms - Line Closing, Case Study – 8 Bus System, Use of Phase Angles in Control Rooms - Islanding & System Separation, Phasor Assisted Line Reclosing.

UNIT-IV

GRID EVENT SIGNATURES – USE IN OPERATIONS TO DETECT & DIAGNOSE GRID EVENTS : Introduction to Grid Event Signatures, Types of Grid Event Signatures - Generation Trip, Line Fault, Line Trip, Load Trip, Islanding, Oscillations, Identify Event Type Using System Frequency Signature, Event Diagnosis - Using Synchrophasor Metrics, Case Study – Generation Trip and Line Trip.

UNIT V

POWER SYSTEM OSCILLATIONS – TYPES, CAUSES, MONITORING: Introduction to Power System Oscillations, Identifying and Analysing Oscillations, Oscillation Monitoring, Oscillation Detection,

REFERENCES:

1. A. G. Phadke and J. S. Thorp, Synchronized Phasor Measurements and their Applications, Springer, 2008.
2. IEEE Transactions, Special Issue in Proceedings of the IEEE and IET proceedings.
3. IEEE standard C37-118, and other standards.

MTPE 251-POWER ELECTRONICS LAB

L T P 0 0 2

LIST OF EXPERIMENTS:

Experiments and computer simulations on:

Single phase, three phase Semi converters and Full converters, DC-DC Choppers using SCRs and Self communicating Devices. Single phase and three phase inverters using IGBTs, AC-AC voltage regulators.

In addition to the above, the Department can offer a few other experiments Minimum of 10 experiments are to be conducted