DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, UTTAR PRADESH, LUCKNOW

Syllabus

For

M.Tech.

POWER SYSTEM

1. ELECTRICAL POWER SYSTEM

(Effective from the Session: 2016-17)

EVALUATION SCHEME FOR MTECH COURSES (POWER SYSTEM)

EFFECTIVE FROM SESSION 2016-17

SEMESTER-I

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
							THEORY			PRACTICAL		
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTPS-101	COMPUTER AIDED POWER SYSTEM ANALYSIS	3	0	0	3	20	10	70			100
2	MTEE-102	POWER SYSTEM OPERATION & CONTROL	3	0	0	3	20	10	70			100
3		DEPARTMENTAL ELECTIVE-I	3	0	0	3	20	10	70			100
4		DEPARTMENTAL ELECTIVE-II	3	0	0	3	20	10	70			100
5		RESEARCH PROCESS & METHODOLOGY	3	0	0	3	20	10	70			100
6	MTPS-151	CAD OF POWER SYSTEM LAB			3	2				20	30	50
7	MTPS-152	HIGH VOLTAGE LAB			2	1				20	30	50
	TOTAL					18						600

SEMESTER-II

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
							THEORY			PRACTICAL		
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTPS-201	ADVANCED POWER SYSTEM STABILITY	3	0	0	3	20	10	70			100
2	MTPS-202	ADVANCED PROTECTIVE RELAYING	3	0	0	3	20	10	70			100
3	MTPS-03?	DEPARTMENTAL ELECTIVE-III	3	0	0	3	20	10	70			100
4		DEPARTMENTAL ELECTIVE-IV	3	0	0	3	20	10	70			100
5	MTEE-05?	DEPARTMENTAL ELECTIVE-V	3	0	0	3	20	10	70			100
6	MTPS-251	ADVANCED POWER SYSTEM LAB	0	0	3	2				20	30	50
7	MTPS-252	SEMINAR-I	0	0	2	1				50		50
	TOTAL					18						600

SEMESTER-III

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
							THEORY			PRACTICAL		
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTPS-351	SEMINAR-II	0	0	6	3				100		100
2	MTPS-352	DISSERTATION	0	0	30	15				200	300	500
	TOTAL					18						600

SEMESTER-IV

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
							THEORY			PRACTICAL		
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTPS-451	DISSERTATION(FINAL)	0	0	36	18				200	400	600
	TOTAL					18						600

EVALUATION SCHEME FOR MTECH COURSES (POWER SYSTEM)
EFFECTIVE FROM SESSION 2016-17

CODE	ELECTIVE-I
MTPS-011	EHVAC AND HVDC TRANSMISSION
MTPS-012	ADVANCED CONTROL SYSTEM
MTEE-013	NON CONVENTIONAL ENERGY SOURCES & ENERGY CONVERTERS
	ELECTIVE-II
MTEE-021	FACTS
MTPS-021	ADVANCED MICROPROCESSORS & ITS APPLICATIONS
MTEE-023	ENERGY MANAGEMENT SYSTEMS
	ELECTIVE-III
MTPS-031	POWER SYSTEM RELIABILITY
MTPS-032	DISTRIBUTED GENERATION
MTPS-033	POWER SYSTEM PLANNING
	ELECTIVE-IV
MTPS-041	DEREGULATION & CONGESTION MANAGEMENT
MTPS-042	POWER SYSTEM RESTRUCTURING
MTEE-041	NEURAL NETWORKS & FUZZY SYSTEM
	ELECTIVE-V
MTEE-051	SMART GRID
MTEE-052	POWER QUALITY
MTEE-053	OPTIMIZATION TECHNIQUES

I YEAR (I SEMESTER)

MTPS-101 COMPUTER AIDED POWER SYSTEM ANALYSIS

L	T	P
3	0	0

Objective & Outcome of learning

To emphasize the fundamentals of Power System analysis while employing a Computer for computational purposes. This course will handle three basic problems of short circuit studies, flow studies and the transient stabilities which are computationally intensive. At the end the student will be in a position to develop his own program for such purposes and feel more confident while using various software available in the field.

I. Network Matrices Evaluation of Bus Admittance matrix (YBUS), Bus impedance matrix (ZBUS), Branch Impedance matrix (ZBT), and Loop Impedance matrix (ZLOOP) by singular and nonsingular transformations.

II. Short Circuit Studies Formulation of ZBUS for single phase and three phase networks, transformation of network matrices using symmetrical components ; short circuit studies using computers, sparssty oriented studies.

III. Load Flow Studies Representation of off-load and on-load tap changing and phase shifting transformers and d.c. link; decoupled and fast decoupled methods, sparsity technique; introduction to load flow of integrated ac/dc system.

IV. Stability Studies Network formulation for stability studies for different types of loads, (constant impedance, constant current and constant power loads), digital computer solution of swing equation for single and multi-machine cases using Runge-Kutta and predictor-corrector methods, effects of exciter and governor on transient stability Fast Transient Stability Solution.

References :

1. G.W. Stagg and A.H. El-Abiad, computer Methods in Power system Analysis Mc Graw Hill, 1971
2. G.L. Kusic, Computer Sided Power system Analysis Prentice Hall International, 1986
3. L.P. Singh, Advanced Power System Analysis and Dynamics, Wiley Eastern,
4. J. Arrillage and C.P. Arnold “Computer Analyzing Power Sysem” john Wiley Singapore 1990.
5. P. Kundur “Power System Stability and Control” Mc Graw Hill, New York 1993.
6. A.R. Bergen and V.Vittal, “Power System Analysis” Englewood, Cliff, N.J. Prentice Hall, 2000.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power System
(ii) IET Research Journal on Generation, Trans and Distribution
(iii) NPTEL Course on Electrical Engg.

MTEE-102 POWER SYSTEM OPERATION AND CONTROL

L T P
3 0 0

Objective & Out come of learning.

To impart knowledge about the structure and control aspect of the power system operation. This includes SCADA, optimal economic operations, AGC control, excitation and reactive power control, system security and the elements of FACTS control. At the end of the course a student will be able to do operations at a Load dispatch centre or planning such operations.

1. Introduction:

Large scale power systems-their interconnections and operation ; load dispatch centre and control centre, introduction to centralized and decentralized controls ; various operational stages of power system ; power system security.

2. Economic Operation:

Problem of unit commitment, system constraints, incremental fuel cost, economic load scheduling with and without transmission losses, penalty factor, loss coefficient, incremental transmission loss ; optimal power flow problem ; optimal operation of hydro-thermal system.

3. Load Frequency Control :

Concept of load frequency control, speed governing systems and its representation, automatic control, modeling of single area and multiarea systems, tie line control, supervisory control ; automatic generation control including excitation system; optimum load frequency controller, PID controller.

4. Voltage Reactive Power Control

Concept of voltage control, methods of voltage control, reactive power injection, control by tap changing transformer, series compensation, static VAR compensation, Excitation system & stabilizer, rate feedback controller, PIDcontroller.

5. State Estimation:

State estimation, linear and nonlinear models, detection and identification of measurement errors.

6. Flexible AC Transmission System :

Concept and objectives, basic FACTS controllers:
TCR,FC-TCR, TSC, SVC, STATCOM, TCSC, SSSC, PAR and UP FC

References:

1. O.I. Elgerd, “Electric Energy System Theory”, Mc Graw Hill, 1971
2. Leon K. Kirchmayer, “Economic operation of Power Systems” Wiley Eastern Ltd.,
3. A. Chakrabarti, D.P. Kothari and A.K. Mukhopadhyay, “Performance Operation and Control of EHV Power Transmission Systems”, Wheeler Publishing Co.
4. A. J. Wood & B.F. Wolfenberg “Power Generation Operation and control” Second Edition John Wiley & Sons.
5. D.P. Kothari & J.S. Dhillon “Power System Optimization” Prentice Hall, 2004.
6. HG Hingorani and L Gyugyi “Understanding FACTS”, New York, IEEE Press 2000.
7. K.R. Padiyar “FACTS Controllers in Power Transmission and distribution” New Age Delhi, 2007.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power System
(ii) IEEE Transactions on Power Delivery
(iii) IET Research Journal on Generation, Transmission and Distribution
(iv) NPTEL Courses on Electrical Engg.

MTPS-151 COMPUTER AIDED DESIGN OF POWER SYSTEM LABORATORY

L T P
0 0 3

List of Experiments:

1. Solution of simultaneous Algebraic equations by Gauss-Elimination,
2. Crout's method and Cholesky method Solution of Simultaneous differential equations by RK-4 and Modified Euler's method
3. Formation of Ybus using two dimensional arrays by inspection method
4. Formation of Ybus using Sparsity Technique
5. Load flow by Gauss Seidel, Newton Raphson and Fast Decoupled methods using two-dimen

MTPS-152 HIGH VOLTAGE LAB

L T P
0 0 2

List of Experiments:

1. Testing of transformer oil according to IS:6792
2. Testing of solid insulation with tape electrodes
3. Generation High D.C. Voltages and measurement through sphere gaps
4. Generation High A. C. voltages and measurement through sphere gaps
5. Generation of High A. C. voltages through cascaded transformers
6. Impulse voltage generation through Marx generator
7. Impulse voltage generation though simulation
8. Trace the field through electrolytic tank
9. Generation and visualization of corona in corona cage
10. Capacitance and loss factor measurement
11. A report on visit to high voltage laboratory

Note: At least eight practical's shall be performed depending on availability of the equipment

ELECTIVE-I

MTPS-011 EHVAC AND HVDC TRANSMISSION

L T P
3 0 0

Objective & Outcome of learning.

To provide an in-depth understanding of the different aspects of Extra High Voltage A.C. and D.C. Transmission system design and Analysis. At the end student will be able to design commercial transmission systems.

1. Introduction:

Need of EHV transmission, comparison of EHV AC & HVDC transmission, mechanical considerations of transmission line.

2. EHV AC Transmission

Parameters of EHV lines, Voltage gradient in bundle conductors lines, conductor sizing, over-voltages due to switching, Ferro resonance. Insulation coordination line insulators and clearances, Corona & its effects, power loss, audible noise and radio-interference, long distance transmission with series and shunt compensations, principle of half wave transmission, flexible ac transmission

3. HVDC Transmission :

Types of dc links, terminal equipments & their operations, HVDC control system, reactive power control, harmonics and filters, multiterminal dc (MTDC) system, ac/dc system analysis, protection of terminal equipments. HVDC transmission based on voltage source-converters.

References:

1. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering" Revised Second Edition, John Wiley.
2. K.R. Padiyar, "HVDC Power Transmission System", Second revised Edition,New Age Int. 2012
3. S. Rao, "EHV-AC and HV DC Transmission Engineering Practice", Khanna Publishers.
4. Arrillaga J "High Voltage Direct current Transmission" 2nd Edition (London) Peter Peregrinus, IEE, 1998.
5. Hingorani HG and Gyugyi L "Understanding FACTS-concepts and Technology of Flexible AC Transmissions Systems" New York, IEEE Press,2000.
6. Padiyar K R "FACTS controllers in Power Transmission and distribution" New Delhi, New Age Int. publishers 2007.

Related e-Journals & books: for advanced work.

(i) IEEE Transmissions on Power Delivery
(ii) IEEE Transmission on Power System
(iii) IET Research Journal on Generation Transmission and Distribution
(iv) NPTEL Course on Electrical Engineering.

MTPS-012 ADVANCED CONTROL SYSTEM

L T P
3 0 0

Objective & Outcome of learning

This course will help students to learn about the state space analysis applied to control system using matrices and different methods of analyzing nonlinear as well as discrete control systems. The course also introduces to the students the basic concepts of optimal, adaptive and robust control systems. At the end of the course the students shall be able to handle different control system problems in nonlinear as well as discrete domain.

1. States Space Analysis:

Review of the state space representation of continuous linear time invariant system, conversion of state variable models to transfer functions and vie-versa, transformation of state variable, solution of state equations, state and output controllability and observability.

2. Analysis of Nonlinear Systems:

Common physical non linearites , singular points, phase plane analysis, limit cycle, describing function method and stability analysis, jump resonance, linearization of nonlinear system. Lyapunov stability , methods for generating lyapunov function , statement of lure problem, circle criterion, popov criterion.

3. Analysis of Discrete System:

Discrete time signals and systems, z-transformation, modeling of sample hold circuit, pulse transfer function, solution of difference equation by z-transform method , stability analysis in z-plane.

4. Basic concepts of optimal control, adaptive control and robust control system.

References:

1. K.Ogata, “Modern Control Engineering”, Prentice Hall of India , 1999
2. Norman S.Nise, “Control System Engineering”, John Wiley & Sons, 2001
3. Kuo B.C., “Digital Control System”, Saunders College publishing, 1992
4. M.Gopal , “Digital Control and state variable methods”, Tata Mcgraw Hill, 1997
5. M.Gopal , “Modern Control System Theory”, Wiley Eastern, 1993
6. K.Ogata, “ Discrete Time Control System”, Prentice Hall International, 1987.

Related Journals and Booksfor applications and advanced works.

(i) IEEE Transactions on Control SystemTechnology
(ii) IET Research Journal on ControlTheory & Applications
(iii) NPTEL Courses on Electrical Engineering

MTEE-013

NON CONVENTIONAL ENERGY SOURCES & ENERGY CONVERTERS

L T P
3 0 0

Objective & Out come of learning.

This course is designed for the development of self study and seminar delivery skills in Non-conventional Energy Sources. The total course structure covers wind energy, Solar Energy and Fuel Cell Technologies. Subparts of each topic will be allotted to each student who will then deliver the talk during scheduled lecture hours to be evaluated by participants & the teacher.

1. Introduction:

Various non-conventional energy resources-importance, classification, relative merits and demerits

2. Solar Energy:

Solar photovoltaics: Introduction, solar radiation & its relation with photovoltaic effect. Solar cell material; silicon mono & poly crystalline, raw material other than silicon. Different types of solar cell construction and design, flat plate arrays:-optimal system sizing & protection. Photovoltaic concentration, photovoltaic systems-standalone, PV-hybrid, grid-interactive. Stationary and tracking panels, maximum power point tracking, energy storage, converter & inverter systems & their control. Application-water pumping & power plants, cost & economics, recent developments.

3.Solar thermal:

Thermal characteristics of solar radiation, solar collectors:-materials, types, focussing. Solar thermal power plant-layout and arrangement, solar cooling, recent Developments.

4. Wind Energy:

Wind power and its sources, site selection criterion, wind characteristics, momentum theory, Classification of wind machines. Wind mills-different design & their control, wind generators-different types, wind farms & grid. Wind generation in India. Issues of wind integrations-intermittent supply, economics, governmental regulations & subsidies. Wind penetration & its effects, economic issues, recent developments, international scenario.

5. Fuel Cell:

Basic construction & principle of operation of fuel cell, Gibbs-Helmholtz equations, thermodynamic free energy and conditions of equilibrium, classification of fuel cell, different types of fuel cell:-direct type-low or medium temperature alkaline type, low temperature ion exchange membrance, direct high temperature fuel cells, Redox fuel cells, operation characteristic. Fuel cell power plants & its integration with wind and solar photovoltaic systems, smart grids.

References;

1. F.C. Treble, “Generating electricity from sun”, pergamon press, U K
2. Tapan Bhattacharya, “Terrestrial solar photovoltaics”, Narosa publishing house, New Delhi, 1998.
3. G.D. Rai, “Non-conventional energy resources”, Khanna Publishers, New Delhi, 2003.
4. S.P. Sukhatme, “Solar energy principles of thermal collection and storage”,McGraw-Hill publishing company, limited, New Delhi, 1984.
5. C.J. Winter, L.C. Sizmann and Van-Hull, “Solar power plants”, Sringer-Verlog publishers, 1991.
6. N.G. Clavert, “Wind Power Principle, their application on small scale”, Calvert Technical Press edition, published 2004.
7. “Fuel Cell Handbook” (Fifth Edition) by EG&G Services, Parsons, Inc. Science Applications International Corporation.
8. I Earnest and T. Wizelius “Wind Power Plants and Projects development” PHI, 2010.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power Delivery
(ii) IEEE Transactions on Power System
(iii) IEEE Transactions on Energy Conversion
(iv) IET Research Journal on Renewable Power Generation.
(v) NPTEL Courses on Electrical Engg.

ELECTIVE-II

MTEE-021 FACTS

L T P
3 0 0

Objective & Outcome of learning
To impart advanced knowledge about the FACTS – systems involving their applications in long Bulk power Transmission line, in distribution systems, in custom Power and improving stability & voltage profile in power system. This is a new technology which has found acceptance in Power Industry. At the end of the course the student should be able to design power and distribution system using various FACT devices.

1. Basic Issues Involved in Bulk Power Transmission:
Angle stability, voltage stability, power flow control and sub-synchronous resonance (SSR).

2. Basic Issues Involved in Power distribution Systems:
Harmonics, load unbalance, poor power factor and voltage interruptions.

3. Introduction of Basic FACTS devices:
SVC, STATCOM,TCSC, SSSC and UPFC. Introduction to concepts of Custom Power (CP) devices

4. Introduction to CP devices:
DSTATCOM, DVR, UPQC. Modelling of SVC, STATCOM,TCSC, SSSC and UPFC.

5. Case Study
DSTATCOM in Current Control Mode: Reference current generation techniques.
DSTATCOM in voltage control Mode: Reference voltage generation, DVR reference voltage generation.

References:

1. N.G. Hingirani and L.Gyugi, Understanding FACTS, IEEE Press, 1999.
2. Y.H. Song and A.T. Johns, "Flexible AC Transmission Systems (FACTS), IEEE, 1999.
3. M.H.J. Bollen, " Understanding Power Quality Problems:, IEEE Press, 2000.
4. R.c. dugan, M.F. Mc Granaghan and H.W. Beaty, "Electric Power Systems Quality", Mc Graw Hill,1996.
5. K.R. Padiyar, "FACTS controllers in Power Transmission and Distribution", New Age, New Delhi, 2007.

Related Journals and Books for applications and advanced works.

(i) IEEE Transactions on Industrial applications
(ii) IEEE Transactions on Power Electronics
(iii) IEEE Transactions on Power Delivery
(iv) MATLAB Tools on Control and power system
(v) NPTEL Courses on Electrical Engineering
(vi) IET Research Journal on Power Electronics
(vii) IET Research Journal on Generation, Transmission and Distribution.

MTPS-021 ADVANCED MICROPROCESSORS AND APPLICATIONS

L T P
3 0 0

Introduction:
Review of basic microprocessor, architecture and instruction set of typical 8 bit microprocessor

Advanced Microprocessor:
Overview of 16 bit and 32 bit microprocessors, arithmetic and I/O coprocessors, architecture, register details, operation addressing models and instruction set of a 16 bit 8086 microprocessor, assembly language programming, introduction to multiprocessing, multiuser, multitasking operating system concepts, Pentium I, II, III, IV processors, Motorola 68000 processor

Input-Output Interfacing:
Parallel an series I/O, programmed I/O, Interrupt driven I/O, single and multi interrupt levels, use of software polling and interrupt controlling for multiplying interrupt levels, programmable interrupt controller, DMA controller programmable timer/counter, programmable communication and principal interface, synchronous and asynchronous data transfers, standard serial interfaces like RS.232.

Programmable Support Chips:
Functional schematic, operating modes, programming and interfacing of 8255, 8251, 8259 and 8253 with microprocessor.

Memory Interfacing:
Types of Memory: RAM and ROM, interfacing with timing consideration DRAM interfacing

Analog Input & Output:
Microprocessor compatible ADC and DAC chips, interfacing of ADC and DAC with microprocessor, use of sample and hold circuit and multiplexer with ADC.

Micro-controller and Micro-Computer:
Concepts of micro controller and micro computer micro controller (8051/8759) based design. Application of micro computer in online real time control

Microprocessor Development System (MDS):
Single user, time shared and networked MOS, hardware facilities and software support in MDS, development of hardware and application software and hardware software integration in MDS.

Microprocessor Application:
Design methodology, examples of microprocessor applications.

Reference:

1. R.S. Gaonkar, “Microprocessor Architecture, Programming and Application,” Wiley Eastern Limited.
2. B.Ram, “Fundamentals Of Microprocessors and Micro computers,” Dhanpat Rai and Sons.
3. Liu & Gibson, “Micro-Computer System the 8086/8088 family architecture,” Prentics Hall of India.
4. D.V. Hall, “Microprocessors and Interfacing Programming and Software,” McGraw Hill

MTEE-023 ENERGY SYSTEM MANAGEMENT

L T P
3 0 0

Objective & Outcome of learning
To emphasize the important problem of integrated energy management. This involves the improving efficiencies & economics of equipment used including retrofitting. It includes the life cycle savings & pay back period & return of investments. Energy audit is another important area which may be handled here. At the end of the course a student will be better equipped to think in terms of over all system efficiencies & economics.

I. Energy Resources
Perspective on energy resources, Utilization and demand projections, Energy resource definition & classification, Causes of Energy scarcity and social disparity, Energy as a parameter of Techno-Socio-Economic development, Factors solving the energy crunch, Energy system model – Description & qualitative analysis, Acceptability Index and its significance.

II. Concept Of Energy Management
Definition and Significance, Benefits, Classifications, Key Issues - Techno economic Issues, Programmatic and Institutional Issues, Energy management implementation criteria, Approaches of Energy management: Procedural Energy Management Opportunities (PEMOS), Equipment Modifications, Additions or Replacement EMOS (Retrofit EMOS), Research and Development and New Installation (R&DEMOS), Resource or Fuel Substitution (Substitution EMOS), Examples for each. Comparative features.

III. General Principles Of Energy Management-
Proper/Optimal Control, Optimize Capacity, Reduce Loads, More Efficient Equipment and Appliances, More Efficient Processes, Employ Special Techniques to Reduce Losses, Energy Containment, Cascade Energy Use, Energy Conversion & storage Principle. (Introduction with examples & comparative features).

IV. Energy Efficiency Analysis-
Different types of losses involved in Process and industry. First Law of Efficiency, simple examples & calculations, Limitation, Efficiency and its significance Second law of Efficiency – Quality of Energy form, Available work, Coefficient of Performance (COP), Effectiveness, Simple calculations.

V. Energy Economics-
Comparison of alternatives options; Simple economic calculations, Life cycle casting, Life cycle savings, payback period and return of investments. Break Even Analysis & its limitations, Benefit / Cost analysis, Time value of money , Calculation of present worth & present worth factor, Simple calculation of Payback period, solar energy economics.
(I) Case study:-Electric loads- Lighting, Motor and Power; Fluid Flow Control- pump, fan, blower, and compressor; Residential colony.
(II) Planning For Energy Management- Planning phases; Initial phasedecision to Undertake Program, Commitment by Management, Statement of Objectives.

Analysis and simulation phase- Database and information collection, Energy Audit, Computer Analysis and Simulation. Implementation phase- implementation, Monitoring of program, periodic review, Modification, and optimization. Modeling and parameter for planning.

References :
1. C.B. Smith ,'Energy Management Principles' Pergammon Press, 1981
2. Y. Y. Haimes (ed), 'Energy Auditing and Conservation'. Hemisphere Publishing Corporation, New York, 1980.
3. J. S. Hsieh, 'Solar Energy Engineering'. Prentice Hall Inc, New Jersey, 1981.
4. D. Millington.'System Analysis and Design for Computer Applications'. Affiliated East West Press Pvt Ltd, New Delhi, 1981.

Related e-Journals and books for advanced work.
(i) IEEE Transactions on Power Delivery
(ii) IEEE Transactions on Power System
(iii) IEEE Transactions on Energy Conversion
(iv) IET Research Journal on Renewable Power Generation
(v) IET Research Journal on Generation, Trans and Distribution
(vi) NPTEL Course on Electrical Engg.

M.Tech (POWER SYSTEM)

I YEAR (II SEMESTER)

MTPS-201 ADVANCED POWER SYSTEM STABILITY

L	T	P
3	0	0

Objective & Out come of learning.

To impart detailed knowledge about the stability of power system-this happens to be largest control structure in the world. The problem is subdivided into synchronous machine turbine modeling followed by methodologies of dynamic & transient stability studies of large system & methods to improve them. Stability problems of the combined operation of EHV AC and HVDC system are also to be investigated. This will enable a student to plan for large power system studies in a design office.

1. Modeling :

Detailed synchronous machine modeling, modeling of turbine-generator and associated systems, modeling of induction motor and static loads, sub-synchronous resonance (SSR) and system modeling for SSR studies.

2. Dynamic Stability :

Review of stability of single machine connected to infinite bus system, multimachine system stability, role of prime mover, governor and excitation system, design concept of machine and power system stabilizers based on modern control techniques, self excited oscillations and their remedies.

3. Transient Stability :

Single machine and multimachine transient stability considering voltage regulators,governors and supplementary controls, methods of improving transient stability, stability of long lines.

4. Voltage Stability

P-V and Q-V curves, static analysis, sensitivity and continuation method.

5. Stability of AC-DC system

References:

1. E.W. Kimbark, “Power System Stability Vol, I,II III”, John Wiley sons, 1956
2. P.M. Anderson and A.A. Fouad, “Power system Control and Stability” IEEE Press, 1993
3. E.W. Kimbark, “Stability of Large Electric Power System”, IEEE Press, 1974
4. C.W. Taylor, Voltage stability IEEE Press.
5. V.A. Vanikov, “Transient Phenomena in Electric Power system” Pergamon Press
6. P. Kundur “Power System Stability and Control” McGraw Hill, New York 1993.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power Systems
(ii) IET Research Journal on Generation, Trans & Distributed
(iii) MATLAB TOOL BOX on Control and Power System
(iv) DIGISILENT – Version 14 software
(v) NPTEL Courses on Electrical Engg.

MTPS-202 ADVANCED PROTECTIVE RELAYING

L T P
3 0 0

Objective & Outcome of learning
To impart advanced knowledge in static & microprocessor based protective relaying which have replaced / replacing the old electromagnetic relays and to a certain extent even the static relays. This also includes the protection schemes of long transmission lines. At the end of the course student will be confident to handle modern Power System relaying systems.

I . Introduction Essential qualities of protection, zones of protection, classification of relays, basic protective schemes.

II. Comparators Transfer impedance, mixing circuits, amplitude and phase comparators and their duality, static realization of amplitude and phase comparators, multi-input comparators.

III. Static Relays Basic construction, input-output devices, merits and demerits of static relays, application of solid state devices.

IV. Static Protection Over current relaying schemes, differential relaying schemes, distance relaying schemes, power swing, carrier protection of long lines, protection of multiterminal lines, new type of relaying criteria, quadrilateral relay, elliptical relay, restricted distance relays.

V. Digital Protection Concept of digital protection, microprocessor based over current and distance relay schemes, generalized interface for distance relays.

References :
1.A.R. Van C. Warrington, “Protective Relays- Their theory and practice Vol.I II”, John Wiley Sons, 1977.
2. B.D. Russel and M.E. Council, “Power System Control and Protection” Academic Press, 1982,
3. T.S.M. Rao, “Power System Protection with Microprocessor Applications” Tata Mc. Graw Hill, 1989 4.
B.Ravindranath and M.Chander, “Power System Protection and Switchgear” Wiley Eastern, 1977 5. S.S. Rao,
“Switchgear and Protection” Khanna Publishers, 1986
6. B.Ram and D.N. Vishwakarma, “Power system Protection and Switchgear” Tata McGraw Hill, 1995 7. W.A.
Elmore (Editor) “Protective Relaying – Theory and applications”, Coral Spring Florida. (ABB Power and T&D Co.)
8. A.G. Phadke and J.S. Thorp “Computer based relaying” Research Studies Press John Wiley 1988.
9. A.T. John and S.K. Salman “Digital Protection of Power System” Peter Paregrinus, IEE Pub 1995.
10. S.H. Horwitz and Arun G. Phadke “power System Relying” John Wiley & Sons (Research Study Press) 1992.
11. IEEE Tutorial Course “Advancement in microprocessor Based Protection & Communication” course
coordinator M.S. Sachdev 97TP 12-70, 1997.
12. J.S. Lewis Blackburn (Editor) “Protective Relaying Principles & Applications” Third Edition, CRC Press 2007.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power System
(ii) IEEE Transactions on Power Delivery
(iii) IET Research Journal on Generation, Trans and Distribution
(iv) NPTEL Course on Electrical Engg.

MTPS-251 ADVANCED POWER SYSTEMS LABORATORY

L T P
0 0 3

1. P-Q Control of Synchronous machine,
2. Simulation of faults for multi machine system on DC network analyzer,
3. Reactive power control of artificial transmission line,
4. Sequence reactances and fault studies on synchronous machine, Reactive control by tap changing transformers,
5. Testing of Static relays,
6. 3 - zone distance Protection scheme,
7. Digital Mapping of distribution Networks, Measurement of High AC voltages using sphere gap, Determination of breakdown strength of oil,
8. Generation of different impulse waveforms.

ELECTIVE-III

MTPS-031 POWER SYSTEM RELIABILITY

L T P
3 0 0

Objective & Outcome of learning
To emphasize the basic principles and advanced methodologies to evaluate the reliability of a large power system. The problem is to be broken down into the reliability of Generation system, transmission system and composite reliability of them. The reliability of distribution system is also included. At the end a student will become familiar with the techniques of large scale power system reliability. This will be very useful in design office in system expansion planning.

I. Basic Probability Theory Probability concepts, rules for combining probability, probability distributions, random variables, density and distribution functions, mathematical expectations, variance and standard deviation.

II. Basic Reliability Evaluation General reliability functions, probability distributions in reliability evaluation, network modeling and evaluation of series, parallel seriesparallel, network modeling and evaluation of complex systems, cut-set method, tie-set method, discrete Markov chains, continuous Markov process, frequency and duration technique concepts, application to multistate problems, approximate system reliability evaluation.

III. Generation System Reliability Generation system models, capacity outage table, recursive algorithm, loss of load indices, inclusion of scheduled outage, load forecast uncertainty, loss of energy indices, expected energy generation, energy limited systems, Gram-Charlier series and its application to generation system reliability evaluation, generating capacity-frequency and duration method.

IV. Interconnected System Probability array method in two inter-connected system, effect of tie capacity, tie reliability and number of tie lines, equivalent assistance unit method for reliability evaluation of inter-connected system, elementary concepts for reliability evaluation of multi-connected systems.

V. Composite Generation and Transmission System Reliability Radial configurations, conditional probability approach, network configurations, conditional probability approach, network configuration, state selection, system and load point indices.
VI. Distribution System Reliability Basic technique and application to radial systems, customer-oriented indices, load and energy indices, effect of lateral distributor protection, effect of disconnects effect of protection failures, effect of load transfer, meshed and parallel networks, approximate methods, failure modes and effects analysis, inclusion of scheduled maintenance, temporary and transient failures, inclusion of weather effects.

References :
1. Billinton R. and Ronald N.A. “Reliability Evaluation of Power Systems”, Pitman Advanced Publishing Program, 1984.
2. Billinton R. and Ronald N.A. “Reliability Evaluation of Engineering Sysems Concepts and Techniques”, Pitman Advanced Publishing Program, 1983.
3. Endrenyi J. “Reliability Modeling in Electric Power Systems”, John Wiley and Sons. 1978

Related e-Journals and books for advanced work.

(i) IEEE Transaction on Reliability
(ii) IEEE Transaction on Power System
(iii) IEEE Transaction on Power Delivery
(iv) IET Research Journal on Generation Trans. And Distribution.
(v) NPTEL Course on Electrical Engg.

MTPS-032 DISTRIBUTED GENERATION

L T P
3 0 0

Objective & Out come of learning.
To emphasize the basic principles of distribution system & the hardware and the software requirements and the data communication. An additional part will deal with balanced and unbalanced load flow in distribution system. At the end of the course a student will be better prepared to work in the area of smart grid.

UNIT I
Need for Integration of Renewable Energy Schemes: Planning, constraints and economics. Grid Integration of Renewable Energy Systems: Wind, biomass gasification and solar systems: Effects on the grid, Renewable energy systems; Interfacing techniques; Innovations required in technology and policy.

UNIT II
Hybrid Energy Systems: Principles and applications; Comparison of schemes; System design concepts; Techno-economic performance; Energy storage schemes and estimation. Interconnection: Distributed power generation schemes using renewable energy sources.

UNIT III
Decentralized Generation Systems : Decentralized generation technologies; Costs and choice of technology, Demand and benefits forecasting and program development, Principles of cost-benefit calculations, Economic and financial analysis of stand-alone electrification projects, Decentralized versus central station generation, Traditional power systems, Load curves and load curve analysis.

UNIT IV
Grid Interconnection Options : The power grid; DG-grid interconnection issues; Case studies of DG-grid interconnections, Case studies of JNNSM grid connected solar power plants of roof top systems and Megawatt systems, Case studies of wind-grid connected power plants.

References:
1. John D. Mc Donald (Editor), “Electrical Power Substation Engineering” CRC Press 2003.
2. W.H. Kersting, “Distribution System Modeling and Analysis” CRC Press 2002.
3. J. Northcote Green, R.G.Wilson,” Control and Automation of Electric Power distribution system”, Taylor and Francis, 2007.
4. R.E. Brown, “Electric Distribution Reliability” CRC Press 2009.

Related e-Journals and books for advanced work.
(i) IEEE Transactions on Power System
(ii) IEEE Transactions on Power Delivery
(iii) IET Research Journal on Generation, Trans and Distribution
(iv) NPTEL Course on Electrical Engg.

MTPS-033 POWER SYSTEM PLANNING

L T P
3 0 0

Objectives of planning – Long and short term planning . Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting.

load forecasting Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

expansion planning Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

distribution system planning overview
Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices

Reference:
1. R.L. Sullivan, "Power System Planning", Tata McGraw Hill Publishing Company Ltd, 2012.
2. X. Wang & J.R. McDonald, "Modern Power System Planning", McGraw Hill Book Company,1994.
3. T. Gonen, "Electrical Power Distribution Engineering", McGraw Hill Book Company, 1986.

ELECTIVE-IV

MTPS-041 DEREGULATION & CONGESTION MANAGEMENT

L T P
3 0 0

Deregulation of Power Sector: Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.

Transmission Pricing:
Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, Postage stamp method, Contract Path method, Boundary flow method, MW-mile method, MVA-mile method, Comparison of different methods.

Congestion Management:
Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.

Text/Reference:
1.Loi Lei Lai,"Power System Restructuring and Deregulation", John Wiley & Sons Ltd.
2.K. Bhattacharya, MHT Bollen and J.C Doolder, Operation of Restructured Power Systems, Kluwer Academic Publishers, USA, 2001. 3.Lorrin Philipson and H. Lee Willis,"Understanding Electric Utilities and Deregulation", Marcel Dekker Inc, New York.
4.Yong-Hua Song, Xi-Fan Wang, Operation of market-oriented power systems, Springer, Germany

MTPS-042 POWER SYSTEM RESTRUCTURING

L T P
3 0 0

Objective & Outcome of learning

To familiarize the students with the important problems of deregulation and open access system which have become implemented in most of the advanced countries. This also includes ISO and pricing & market bidding strategies, congestion Management and auxiliary services. At the end student should feel confident in handling such problems at an ISO centre.

I. Fundamentals of Deregulation Privatization and Deregulation, Motivations for Restructuring the Power Industry

II. Restructuring Models and Trading Arrangements Components of restructured Systems, Independent System Operator (ISO) Functions and Responsibilities, Trading Arrangements (Pool, Bilateral Multilateral), Open Access Transmission Systems

III. Differential Models of Deregulation UK model, California Model, Australian and New Zeeland Models, Deregulation in Asia including India.

IV. Operational and Control Bidding strategies, Forward and future market, Market Power, Available Transfer Capability, Congestion Management, Ancillary services.

V. Wheeling charges and pricing Wheeling methodologies, pricing strategies.

References :

1. F.C. Sscweppe, M.C. Carmanis, R.D. Tabor, and RE Robin “Spot Pricing of Electricity” Norwell, M.A., Kluwer 1998.
2. M. Shahidehpour, H. Yamin and Z Li “Market Operations in Electrical Power System” New york, IEEE/ Wiley Inter science, 2002.
3. D. Krischen and G. Strabac “Fundaments of Power System Economics” New York, Wiley 2004.
4. S. Stoft “Power System Economics” New York, John Wiley 2002.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power System
(ii) IET Research Journal on Generation, Trans and Distribution
(iii) NPTEL Course on Electrical Engg.

MTEE-041 NEURAL NETWORKS AND FUZZY SYSTEM

L T P
3 0 0

A. Neural Networks :

1. Basics :

Simple neuron, nerve structure and synapse, concept of neural network multilayer nets, auto-associative and hetero-associative nets, neural network tools (NNTs), artificial neural network (ANN) and traditional computers.

2. Neural Dynamics :

Neurons as functions, neuronal dynamic systems, signal functions, activation models

3. Synaptic Dynamics :

Learning in neural nets, Unsupervised and supervised learning, signal hebbian learning competitive learning, differential hebbian learning, differential competitive learning single layer perception models, the back propagation algorithm.

4 Applications :

Applications in load flow study, load forecasting detection of faults in distribution system and steady state stability, neural network simulator, applications in electric drive control.

B. Fuzzy System :

5. Basics :

Fuzzy sets and systems, basic concepts, fuzzy sets and crisp sets, fuzzy set theory and operations, fuzzy entropy theorem, fuzzy and crisp relations, fuzzy to crisp conversions.

6. Fuzzy Associative Memories :

Representation of fuzzy sets, membership functions, basic principle of interference in fuzzy logic, fuzzy IF-THEN rules, fuzzy systems and algorithms, approximate reasoning, forms of fuzzy implication, fuzzy inference engines, fuzzification/defuzzification

7. Applications :

Fuzzy control system design and its elements, fuzzy logic controller applications of fuzzy control in electric drive, power system, measurement and instrumentation.

References :

1. Bart Kosko, “Neural Networks fuzzy systems”, Prentice Hall International
2. George J. Klin, & Tina A. Polger, “Fuzzy Sets, uncertainty and Information”,
3. Russel C. Ebehart Roy W. Dobbins, “Neural Network PC tools”, Academic press Inc.
4. Martin T. Hagan, H.B. “Neural Network design”, Thomson Demuth Mark Beate, Asia Pvt Ltd.
5. Simon Haykin “Neural Network and Learning machines” Third Edition, PHI learning, new Delhi,2011.
6. J.R. Jang, C. Sun and E. Mizuatani, “Neuro-fuzzy Soft computing: A Computational Approach to learning and Machine Intelligence.” PHI, 2011.

ELECTIVE-V

MTEE-051 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

Microgrids and Distributed Energy Resources: Concept of microgrid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuelcells, microturbines, 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.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "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 Press

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication

MTEE-052 POWER QUALITY

L T P
3 0 0

1. Power Quality Problems and Monitoring :

Introduction, surges, voltage sag and swell, over voltage, under voltage, outage voltage and phase angle imbalances, electrical noise, harmonic, frequency deviation monitoring.

2. Solution to power quality problems : Design, measures to minimize the frequency and duration of outages in distribution systems, voltages regulators, harmonic filters, power conditioners, uninterruptible power supplies, emergency and standby power systems, application of power conditioners.

3 Minimization of disturbances at Customer site : Power quality standards, standard test waveforms, power distribution system design, measure to minimize voltage disturbances.

References :

1. Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso, "Electrical Power System Quality", McGraw Hill
2. C. Sankaran, Power Quality CRC Press, USA
3. Wilson E. Kazibwe, "Electrical Power Quality Control Techniques", Van Nostrand Reinhold.
4. M. H. J. Bolen "Understanding Power Quality Problems", IEEE Press 2000.
5. J. Arrillaga, N.R. Watson, S. Chen "Powr System Quality Assessment", John Wiley, 2000.

MTEE-053 OPTIMIZATION TECHNIQUES

L T P
3 0 0

1.Linear programming –
formulation-Graphical and simplex methods-Big-M methodTwo phase method-Dual simplex method-Primal Dual problems.

2.Unconstrained one dimensional optimization techniques -
Necessary and sufficient conditions –Unrestricted search methods-Fibonacci and golden section methodQuadratic Interpolation methods, cubic interpolation and direct root methods.

3. **Unconstrained n dimensional optimization techniques –**
direct search methods – Random search –pattern search and Rosen brooch's hill claiming methodDescent methods-Steepest descent, conjugate gradient, quasi -Newton method.

4.Constrained optimization Techniques-
Necessary and sufficient conditions – Equality and inequality constraints-Kuhn-Tucker conditions-Gradient projection method-cutting plane method- penalty function method .

5.Dynamic programming-
principle of optimality- recursive equation approach-application to shortest route, cargo-loading, allocation and production schedule 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 Welsey, 1971.