SYLLABUS

MASTOR OF TECHNOLOGY

ELECTRICAL ENGINEERING

SEMESTER SCHEME

Two Year Degree Course

M.Tech. , First Year Examination, 2014-2015

M.Tech. , Second Year Examination, 2015-2016

JODHPUR NATIONAL UNIVERSITY
JODHPUR

JODHPUR NATIONAL UNIVERSITY
(Faculty of Engineering & Technology)
Department of Electrical Engineering
M.Tech (Power System)

I Semester Scheme

S.No.	Subject Code	Subject	Lectures	Tutorials	Practical	Exam. H.	Theory		Practical & Sessional		Total
							Internal	External	Internal	External	
1	MEE101	Strategic Management	4	2	-	3	50	100	_		150
2	MEE102	Advanced Power System,Performance & Regulation	4	2	-	3	50	100			150
3	MEE103	Instrumentation	4	2	-	3	50	100			150
4	MEE104	Fuzzy Logics & Neural Networks	4	2	-	3	50	100			150
5	MEE105	Power System-I Lab	-	-	6	3			50	50	100
		Total	16	8	6	15	**200**	**400**			**700**

II Semester Examination Scheme

S.NO.	Subject Code	Subject	Lectures	Tutorials	Practical	Exam. H.	Theory		Practical & Sessional		Total
A. Theory Papers							Internal	External	Internal	External	
1	MEE201	Power System Stablitiy	4	2	-	3	50	100			150
2	MEE0202	Power System Analysis	4	2	-	3	50	100			150
3	MEE203	Elective - 1	4	2		3	50	100			150
4	MEE204	Elective - 2	4	2		3	50	100			150
5	MEE205	Power System Simulation Lab	-	-	6	3			50	50	100
		Total	16	8	6	15	200	400			**700**

Note:- List of Elective subject may be amended by Dean, Faculty E&T

	List of Elective Subject 1
MEE203.1	Electric Drives & Their Control
MEE203.2	Control of Electrical Machines
MEE203.3	Excitation Control of Synchronous Machines
MEE203.4	Power System Planning & Reliability
	List of Elective Subject 2
MEE204.1	E.H.V.A.C./D.C Transmission
MEE204.2	Economic Operation & Control of Power System
MEE204.3	Power Generation and Renewable Energy Sources
MEE204.4	High Voltage Engineering & Insulation Coordination

S.No.	Subject Code	Subject	Lectures	Tutorials	Practical	Exam. H.	Theory		Practical & Sessional		Total
A. Written Papers							**Internal**	**External**	**Internal**	**External**	
1	MEE301	Elective - 1	4	2	-	3	50	100			**150**
2	MEE302	Elective - 2	4	2		3	50	100			**150**
		Total (A)	8	4	0	6	100	200			**300**
B. Practical and Sessional											
3	MEE303	Seminar (Literature Survey & Presentation)	-	-	6	3	50	50			**100**
		Total (B)									**100**
		Total (A) + Total (B)									**400**
	MEE301.1	**List of Elective Subject - 1** Advanced Power Switchgears & Protection									
	MEE301.2	Advanced Power Electronic									
	MEE301.3	Flexible AC transmission System									
	MEE301.4	Pattern Recognition									
		List of Elective Subject - 2									
	MEE0302.1	Surge Phenomena and High Voltage Engineering									
	MEE302.2	Power Quality									
	MEE302.3	Communication &Distribution Automation									
	MEE302.4	Power System Dynamics									

IV Semester Scheme

S.No.	Subject Code	Subject	Lectures	Tutorials	Practical	Exam. H.	Theory		Practical & Sessional		Total
							Internal	**External**	**Internal**	**External**	
B. Practical and Sessional											
1	MEE401	Dissertation Work	-	-			100	100			200
		Grand Total					100	100			**200**

Total Marks : 700+700+400+200=2000

MEE101 Strategic Management

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

Basics of Management: Scientific management: Fredrick Winslow Taylor; Henry foyal's administrative Management; Managerial Roles; Managerial skills.

a. **Managing Change**: Need for change; Paradigm shifts; Organization inertia; Leadership committed to change; Strategy of managing change; case studies highlighting steps needed for managing change successfully.

b. **Crisis Management**: Contingencies; contingency planning; Visualizing possible majors problems for the organization in the foreseeable future; Preparing an organization and its staff to deal with such problems; case studies.

c. **Innovation and Creativity**: Encouraging creativity at all levels; Innovation; key for future leadership; Innovation for product; process or the organization itself; Increment improvement v/s quantum jump.

d. **Entrepreneurship**: Need of the hour: Entrepreneurship; Developing qualities for entrepreneurship; Calculated Risk; Entrepreneurship within an organization.

e. **Work study and Re-engineering: Productivity**; Methods of improving productivity by changes in the manufacturing process as well as by better utilization of assts; Re-engineering the product process as well as the organizational set up.

f. **Managing Intangibles**: Management at different levels in an organization; Organizational culture; Leadership effective leadership for overall success; Motivation; Developing a diverse workforce; Negotiations within the organization; Attitudes and Behavior.

g. **Communication Skills**: Communication Basic: Written and Verbal communication, Presentation skill, Meetings and their effective; organization; Dealing / Interacting with customers.

h. **Quality and Customer Care**: Quality Management; Reliability of product; Defect and Defect Analysis; Total Quality; Economics of Quality; Quality Standards and ISO-9000; Customer care and important outcome of quality and quality relationship.

i. **Safety and Ergonomics**: Safety its practice at all levels; Safety training; Importance of safety; Cost of neglecting safety; Environment and need to maintain a clean and healthy environment; Ergonomics-a new term combining nature and its inhabitants.

Suggested Books:

1.Principles of Management by Charles WL Hill and steven L Mcshane; Tata McGrawh-Hill' New Delhi; 2008

2.Principles of Management by PC Tripathi and PN Reddy; Tata McGrawh-Hill' New Delhi; 1991.

3.Organizational Behavior by John W. Newstrom and Keith Danis; Tata McGrawh-Hill' New Delhi; 2002

MEE102 ADVANCED POWER SYSTEM, PERFORMANCE AND REGULATION

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

FACTS: Problem of AC transmission systems, basic principle of power flow control of: an AC transmission line. Basic types of FACTS CONTROLLERS. Brief description of FACTS controllers. STATCOM static voltage and. phase. angle regu1ators, thyristor switched and thyristor Controlled series capacitors, Unified Power Flow Controller. Distribution Automation: Introduction to distribution automation. Concepts of communication-Power line carrier, radio communication, fiber optics, satellite communication and sensors. Introduction to supervisory control .and data acquisition (SCADA), Standard & protocols. Brief description of an automation system.Performance: Supply code, Grid standards & Grid code, National load dispatch center, Regional load dispatch centre. State load dispatch centre, standard of performance. Regulation: Duty of distribution licensee. Open access, Power Marketing & pricing, Responsibility of consumers, captive generating plant. Class of consumers, Redressal of grievances-electricity Act - 2003.

References:

Power System Analysis: Operation and Control-Second Edition by Cbakrabati Abhijit, Halder Sunita (PH INDIA),

Power System Optimization-Kothari D P , Dhillon J S (PH India)

Electridty ACT 2003 .

ElectricalPower Planning for Regulated and Deregulated Markets by Arthur Mazer. April 2007 (WILEY)

Grid Standards , and standard 0f performance issued by RERC.

FACTS overview published by CIGRE & IEEE PE5-1995, ref IEEE 95 TP 108.

Understanding Facts, Concepts and Tech. of Flexible . . .

A.C. Trans. system by N.G. Hingorani- (Standard Publishers) Seller: Indus International

MMEE103 INSTRUMENTATION

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

1. GENERALIZED APPROACH TO A MEASURING SYSTEM:

Functional description, Input Output configuration, Methods of correction for Interfering and -modifying inputs, predominance characteristic of instruments Error analysis.

2. SYSTEM PERFORMANCE MEASUREMENT:

System inputs; system linearing and distortion, sine wave testing, pulse testing, random signal testing, Pseudo random binary sequences and their applications..

3. FEEDBACK MESURING SYSTEM AND INVERSE TRANSDUCERS:

Feedback for control and measurement, Force and torque balance, current balance, Heat flow balance, voltage balance, temperature balance, Inverse transduces.

4. DATA TRANSMISSION AND TELEMETRY:

Modulation and encoding methods, transmission media, Bandwidth and noise restriction. Statistical measurements, multiplexing.

5. DATA PROCESSING, DISPLAY AND RECORDING:

Data display, Data recording, Data logging, Data acquisition and Data processing.

BOOKS RECOMMENDED.

1.Instrumentation Measurement and feedback By: Barry E.Jones TataM.Graw,Hill- latest Editions, Indian Publication.-

2.Measurement system Application and Design - Fourth Edition By: Emest O. Doebelin ,Mc Graw Hill International Addition

3.Instrumentation for Engineers and scientist -.2009 By: John Turner & Martyn Hill,Oxford University Press

4.Intelligent Instrumentation By: George C Barney Prentice - Hall of India Prentice - Hal1- Economic Design

MEE104 NEURAL NETWORKS AND FUZZY LOGIC

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

Neural Networks Characteristics. Characteristics of. Neural networks, Historical development of neural networks principles, artificial neural networks Terminology, Models of neuron, Topology, Basic learning laws.

Learning Rules: The Perceptron, Linear seperability, Hebbs rule, delta rule, widrow & Hoff LMS rule, Correlation learning rule, instar and outstar learning rules. Unsupervised learning, competitive learning, K-means clustering algorithm, Koheneri's feature maps Different **Neural Network**: Basic Learning law in RBF nets, Back propagation method, feed forward network, ART network.

Application of Neural Nets: Pattern recognition, application of BPN, optimization, associative memories, vector quantization, applications in speech & decision making Fuzzy Logic: Basic concept, fuzzy v/s crisp logic set, variables, membership function, operation's inference, techniques, defuzzification, basic inference algorithm. Application

Of Fuzzy Logic, Fuzzy system design & implementation. .

Books:

1.Fuzzy systems design principles, building Fuzzy IF-THEN rule bases by riza C.Berkin & trubatch. JeeeBcss
2.Vegna Naryanan - Artificial neural networks
3.Bart Kosko- Neural networks & Fuzzy Logic
4.Simon Kaykin - Neural Network person Lpe
5.Neural Network - Satish Kumar
6.Fundamental of Neural Network - Laurent Forself

MEE105 POWER SYSTEM I LAB

Teaching Hrs.L-0, T-0, P-6 Exam. Hrs.: 3 Hrs.
Marks: 100(50 Internal & 50 University)

1. Introduction to MATLAB
2. Simulate Swing Equation in Simulink (MATLAB)
3. Modelling of Synchronous Machine.
4. Modelling of Induction Machine.

MEE201 POWER SYSTEM STABILITY

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Synchronous Machines**	Modelling of cylindrical rotor synchronous machine, flux linkage equations, voltage equations and equivalent circuit, real and reactive power control. Modelling of salient pole synchronous machine (Two – axis model), flux linkage equations, Park's transformation, current and voltage equations. Transient and subransient effects, reactances and time constants of synchronous machines.Equivalent circuits, vector diagrams, power angle equations and characteristics under steady state and transient conditions
II	**Steady State and Dynamic Stabilities**	Development of swing equation, linearization of Swing equation. Steady state stability of single machine connected to an infinite bus system and two machine systems. Coherent and non-coherent machines. Swing equation including damping effect. Introduction to dynamic stability of power system. Introduction to classical model of multi machine system.
III	**Transient Stability**	Equal area criterion and its application to transient stability studies under common disturbances including short circuits. Critical clearing angle and critical clearing time. Numerical solution of swing equation by step-by-step method. (i) Multi machine Transient Stability: Numerical methods for solution of differential equations: Modified Euler Method, Runge – Kutta fourth order method. Multi machine transient stability studies using modified Euler method and Range – kutta fourth order method. (ii) Factors affecting steady state and transient stabilities. Methods of improving steady state,dynamic and transient stabilities, series capacitor compensation of lines, excitation control, power stabilizing signals, High speed circuit breaker, auto – recolsing circuits breaker, single pole and selective pole operation, by pass valving and Dynamic braking.

Text / Reference Books:

1. Power system stability by K.R. PADIYAR, B.S. Publications Hyderabad
2. Power System Stability and Control by P. Kundur,McGraw-Hill International Editions
3. Power System Control and Stability by P.M. Anderson , A.A Fouad Galgotia Publications, New Delhi, 2003.
4. Power system control and stability P.M. Anderson and A.A. Fouad John wiley Sons
5. Power System Voltage Stability"- C.W.TAYLOR, Mc Graw Hill, 1994
6. Power System Dynamics: Stability and Control" – K.R.PADIYAR, II Edition, B.S.Publicationsvv

MEE202 Power System Analysis

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Fault Analysis**	Positive, Negative and Zero sequence equivalent circuits of lines, two and three winding transformers and synchronous machines. Analysis of shunt and series faults,effect of neutral grounding.Admittance and Impedance Model and Network Calculations: Calculation of Z-bus, Y-bus.Algorithm for the formation of bus admittances and impedance matrices, Fault calculation using Z-bus
II	**Load Flow Studies**	Formulation of load flow problem. Various types of buses. Gauss-Siedel,Newton-Raphson and Fast Decoupled Algorithms.Calculation of reactive power at voltage controlled buses in the Gauss-Siedel interactive method using Y-bus. Representation of transformers-Fixed tap setting transformer, Tap changing under load transformers, Phase shifting transformers, Comparison of methods for load flow studies.
III	**Power System Security and State Estimation**	Concepts of security states and security analysis in power system, State estimation in power system

Text / Reference Books:

1. Electrical Energy Systems Theory - by O.I.Elgerd, Tata Mc Graw-Hill Publishing Company Ltd, 2nd Edition
2. Modern Power System Analysis - by I.J.Nagrath & D.P.Kothari, Tata Mc Graw-Hill Publishing Company ltd, 2nd edition
3. Power System Analysis : Ravindra Nath and M.Chandar, PHI Pub.
4. Power System Analysis by J.J Grainger,. and W.D Stevenson, Tata Mc Graw-Hill Publishing Company

MEE203.1 Electric Drives & Their Control

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Characteristics of Electric Motors**	Characteristics of DC motors, 3-Phase induction motors and synchronous motors, Starting and braking of electric motors
II	**Dynamics of Electric Drives**	Mechanical system, Fundamental torque equations, components of load torques, Dynamic conditions of a drive system, Energy loss in transient operations, Steady State Stability, Load equalization.
III	**DC Motor Drives**	Starting, Braking and Speed Control, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Phase controlled converter fed DC drives, Dual-converter control of DC drive, Supply harmonics, Power factor and ripple in motor current, Chopper Control DC drives, Source current harmonic in Choppers
IV	**Induction Motor Drives**	Starting, Braking and transient analysis, Calculation of energy losses, Speed control, Stator voltage control, Variable frequency control from voltage and current sources, Slip power recovery-Static Scherbius and Cramer drives
V	**Synchronous Motor Drives**	Starting, Pull in and braking of synchronous motors, Speed control – variable frequency control, Cyclo converters control. Brushless DC Motor, Linear Induction Motor, Stepper Motor and Switched Reduction Motor Drives: Important features and applications.
VI	**Energy Conservation in Electrical Drives**	Losses in electrical drive system, Measures for energy conservation in electric drives, Use of efficient motor, Energy efficient operation of drives, Improvement of power factor and quality of supply.

Text / Reference Books:

1 Electric Drives & Their Control by Richard M crowder
2. Electric Drives & Their Control by Werner Leonhard
3. Electric Drives & Their Control by Vedam Subrahmanyam

MEE203.2 CONTROL OF ELECTRICAL MACHINES

Teaching Hrs.
L-4, T-2 P-0
University (100)}

Exam Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) &

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	Electrical Machines Control	Electrical Machines as objects of automatic control, their equation of motion : the d.c. and a.c. machines and the synchronous machines components of automatic control, tech generator , rotary amplifier , synchros and related devices, concepts of links , aperiodic , oscillating and integrating links , configuration of automatic regulation systems for electrical machines stabilizing devices, selection of systems gain. Effects of small Parameters on regulating systems with time lag. Design of automatic regulating systems, intermittent regulation systems. Transient response stability

Text/ Reference Book

1. Electric Machinery by A.E. Fitzgerald, Stephen D.Umans, Charles Kingsley, Tata Mcgraw Hill, 6ht Edition, 2003.
2. Electric Motor & Drives: Modeling, Analysis and Control by R. Krishnan, Prentice Hall of India, 2001
3. Brushless permanent magnet and reluctance motor drives by T.J.E Miller Clarendon Press, Oxford, 1989
4. Control of Eectrical machine by Bhattacharya , S.K.Singh , Brijinder

MEE203.3 EXCITATION CONTROL OF SYNCHRONOUS MACHINES

Teaching Hrs.
L-4, T-2 P-0
University (100)}

Exam Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) &

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**EXCITATION CONTROL OF SYNCHRONOUS MACHINES**	Thyristor control in dual and single converter, excitation systems. Excitation systems. Excitation control by speed, frequency and power singles. Control and protection of brushless excitation systems. Excitation control of synchronous compensators, synchronous motors and reversible synchronous compensators. Longitudinal Transverse excitation control of synchronous generators and synchronous compensators. Microprocessor control of excitation systems. Introduction to super conducting excitation systems

Text / Reference Books:

1. **Excitation Control System By J. Machowsai**
2. **Refer various IEEE Papers Excitation Control Of Synchronous Machines**

MEE203.4 Power System Planning & reliability

Teaching Hrs.
L-4, T-2 P-0
University (100)}

Exam Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) &

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Load Forecasting**	Classification and characteristics of loads, Approaches to load forecasting, Forecasting methodology, Energy forecasting.
II	**Basic Probability Theory**	Review of probability concepts, Probability distribution, Application of binomial distribution to engineering problem, Probability distribution in reliability evaluation, Network modeling and evaluation of simple and complex systems, System reliability evaluation using probability distribution, Frequency and duration methods.
III	**Generation System Reliability Evaluation**	Concept of LOLP, Evaluation of indices for isolated system, Generation system, Reliability analysis using the frequency and duration methods.
IV	**Transmission System Reliability Evaluation**	Evaluation of LOLP and indices for an isolated transmission system using frequency and duration method.
V	**Distribution System Reliability Evaluation**	Reliability analysis of radial system with perfect and imperfect switching.

Text / Reference Books:

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1. Power System Planning By R.L. Sullivan, Heber Hill, 1987
2. Power System Reliability Evaluation By Roy Billington Gordan & Breach Scain Publishers, 1990
3. Reliability modelling in Electric Power System Eodrenyi By J.Eodrenyi, John Wiley, 1980.

MEE204.1 EHV A.C. D.C Transmission

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2 P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Introduction**	Bulk power transmission over long distance, Need for EHV transmission, Problem of EHV transmission power handing capacity and surge impedance loading, Current carrying capacity of conductor, Choice of economic voltage
II	**Bundled Conductors**	Properties of bundled conductors, Geometric mean radius of bundle,Inductance and capacitance, Voltage gradients of conductors, Maximum surface voltage gradients of bundled conductors, Comparison of maximum surface electric fields for bundled and single conductor lines, Electrostatic fields of EHV lines. Effect of ES fields of humans, Animals and plants.
III	**Series and Shunt Compensation**	Effect of series capacitors, Location of series capacitors. Sub-synchronous resonance in series-capacitor compensated lines and counter measures, Shunt compensation-variation of no load receiving end voltage. Static VAR systems: TCR, TCR-FC, TSC-TCR and MSC-TCR schemes
IV	**HVDC Transmission**	HVDC transmission, kind of dc links, light activated thyristor, series and parallel connection of thyristors. Scheme of converter station, 12 – pulse convecter, converter unit, converter operation, fitters, reactive power source, ground return and ground electrode.
V	**HVDC Link**	Control of HVDC link, Converter control characteristics, firing angle control and extinction angle control. Comparison between AC and DC transmissions Applications of HVDC transmission. Power modulation and power control of HVDC lines.

Text / Reference Books:

1. High Voltage Engineering by M.S.Naidu and V.Kamaraju – TMH
2. High Voltage Engineering fundamentals by Kuffel and Zungel, Elsavier Publications
3. High Voltage Technology by ALSTOM
4. Extra High Voltage AC Transmission Engineering – Rakosh Das Begamudre, Wiley Eastem ltd., New Delhi – 1987
5. EHV Transmission line reference book – Edision Electric Institute (GEC) 1986
6. Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983

MEE204.2 Economic Operation & Control of Power System

Teaching Hrs.
L-4, T-2 P-0

Exam. Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) & University (100)}

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Economics of Power Generation**	Introduction, cost of electrical energy, expression for cost of electrical energy, depreciation, power plant cost analysis, economics in plant selection, selection of types of generation and types of equipments, factors effecting economic generations and distributions, generating cost, economics of different types of generating plants.
II	**Economical Operations of Thermal Power Plants**	Generator operating cost, input, output curves, heat rate and incremental rate curves of generating units, system constraints, economic dispatch problem, economic dispatch using Newton Raphson method, classical method, Calculation of loss coefficient using Ybus, using Sensitivity Factors: Generation Shift Distribution (GSD) factors, Generalised Generation shift Distribution (GGSD) Factors. Effects of transmission losses, transmission loss coefficients, formula, function of generation and loads, economic dispatch using exact loss formula which is function of real and reactive power, economic dispatch for active and reactive power balance, evaluation of incremental transmission loss, economic dispatch based on penalty factors.
III	**Economical Operations of Hydrothermal Power Plants**	Classification of hydro plants, long-range problem, short-range problem. Hydro Plant performance Model, Glimn-Kirchmayer Model, Hamilton-Lamonts Model, thermal and hydro model for short range fixed head hydrothermal scheduling, equality and inequality constraints, transmission losses, advantages of combined operation, base load, peak load operation requirement, Newton Raphson method for short range fixed head hydrothermal scheduling, reservoir dynamics, equality and inequality constraints, idea of multiobjective generation scheduling.
IV	**Interconnected System**	Merits and demerits, parallel operation of alternators, synchronizing current, power & toque, effect of change of excitation, driving torque & speed of one of the alternators, load sharing and power limit of interconnected stations, voltage, frequency& load control of interconnected stations.

Text / Reference Books:

1. Power Generation Operation and control by Allen J.Wood and B.F. Wollenberg John Wiley & Sons, Second Edition, 1996
2. Economic Control of Interconnected Systems By L.K Kirchmayer.John Wiley & Sons, 1959.
3. Modern Power System Analysis By I.J. Nagrath & D.P Kothari TMH, New Delhi, 2006

MEE204.3 Power Generation Renewable Energy Sources

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2 P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Introduction**	World energy situation. Indian energy scene. Comparative study of thermal, hydro, nuclear and gas power plants. Selection and location of power plants. Impact of thermal, gas, hydro and nuclear power stations on environment, air and water pollution, green house effect (global warning), impact on land. Renewable and non-renewable energy sources. Conservation of natural resources and sustainable energy sources
II	**Efficiency improvement of thermal and gas power plants**	pressurized fluid bed Combustion of coal, combined gas steam plant and cogeneration.
III	**Solar Energy**	Solar radiation, solar radiation geometry, solar radiation on tilted surface. Solar energy collector. Flat- plate collector, concentrating collector – parabolidal and heliostat. Solar pond. Basic solar power plant. Solar cell, solar cell array, basic photovoltaic power generating system.
IV	**Wind Energy**	Basic principle of wind energy conversion, efficiency of conversion, site selection. Electric power generation- basic components, horizontal axis and vertical axis wind turbines, towers, generators, control and monitoring component ts. Basic electric generation schemes- constant speed constant frequency, variable speed constant frequency and variable speed variable frequency schemes. Applications of wind energy.
V	**Geothermal Energy**	Geothermal fields, estimates of geothermal power. Basic geothermal steam power plant, binary fluid geothermal power plant and geothermal preheat hybrid power plant. Advantages and disadvantages of geothermal energy. Applications of geothermal energy. Geothermal energy in India
VI	**Nuclear Fusion Energy**	Introduction, nuclear fission and nuclear fusion. Requirements for nuclear fusion. Plasma confinement - magnetic confinement and inertial confinement. Basic Tokamak reactor, laser fusion reactor. Advantages of nuclear fusion. Fusion hybrid and cold fusion.
VII	**Biomass Energy**	Introduction, biomass categories, bio-fuels. Introduction to biomass conversion technologies. Biogas generation, basic biogas plants-fixed dome type, floating gasholder type, Deen Bandhu biogas plant, Pragati design biogas plant. Utilization of biogas. Energy plantation. Pyrolysis scheme. Alternative liquid fuels – ethanol and methanol. Ethanol production

Text / Reference Books:

1. Wind energy Technology by John F.Walker & N. Jenkins John Wiley and sons, chichester ,U.K, 1997
2. Physics Technology and use of Photovoltaics Van Overstraeton and R.P. Mertens Adam Hilger, Bristol,1996
3. Wind Energy Conversion Systems L.L. Freries Prentice Hall, U.K., 1990

MEE204.4 High Voltage Engineering & Insulation Coordination

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2, P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Conduction and Breakdown in Gases**	Conduction and Breakdown in Gases: Ionization process, Twonsend's current growth equation, current growth in the secondary processes, Twonsend's criterion for breakdown, streamer theory of breakdown in gases, Paschen law, breakdown in non uniform fields and corona discharge
II	**Conduction, Breakdown in liquids and solids**	Pure liquids and commercial liquids, conduction and breakdown in pure liquids, breakdown in solids dielectrics, Intrinsic breakdown, Electromechanical breakdown and thermal breakdown
III	**Generation of High Voltage and Currents**	Generation of high D.C. generation of high alternating voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators
IV	**Measurement of high voltage and currents**	Measurement of high d.c.voltages, Measurement of high a.c. and impulse voltages, Measurement of high d.c., a.c. and impulse currents. Cathode Ray Oscilloscope for impulse voltage and current measurements
V	**Testing of Materials and Apparatus**	Measurement of D.C. resistivity, measurement of dielectric constant and loss factor, partial discharge measurements, testing of insulators, bushing, circuits breakers, transformers and surge divertors
VI	**Over Voltage Phenomenon Insulation Coordination**	Over Voltage Phenomenon Insulation Coordination: Causes of over voltage, lighting phenomenon, switching over voltages and power frequency over voltages in power systems
VII	**Insulation Coordination**	Principle of insulation coordination on high voltage and extra high voltage power systems
VIII	**Gas insulated substations**	Advantages of Gas Insulated Substations, Comparison of Gas Insulated substations and Air Insulated Substations, Design and Layout of Gas Insulated Substations, Description of Various components in GIS

Text / Reference Books:

1. High Voltage Engineering by M.S.Naidu and V.Kamaraju – TMH
2. High Voltage Engineering fundamentals by Kuffel and Zungel, Elsavier Publications
3. High Voltage Technology by ALSTOM

MEE205 POWER SYSTEM SIMULATION II LAB

Teaching Hrs.L-0, T-0, P-6 Exam. Hrs.: 3 Hrs.

Marks: 100(50 Internal & 50 University)

1. Simulate simple circuits using Maker.
2. (a) Modelling of Synchronous Machine with PSS
3. (a) Modelling of Synchronous Machine with FACTS devices
   (b) Simulation of Synchronous Machine with FACTS devices.
4. FACTS Controller designs with FACT devices for SMIB system

MEE301.1 Advanced Power Switchgears & Protection

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2 P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Static Relays**	Introduction, merits and demerits of static relays. Comparators: amplitude and phase comparator, duality between amplitude and phase comparators. Circulating current type phase-splitting type and sampling type amplitude comparators. Vector product type and coincidence type phase Comparators. (ii) CTs & PTs: Current transformer (CT) Construction, measurement CT and protective CT. Type of potential transformers. Steady state ratio and phase angle errors in CTs and PTs. Transient errors in CT and CVT. (i) Static Over Current Relays: Instantaneous over current relay, definite time over current relay, inverse-time over current relay, directional over current relay. (ii) Static Differential Relays: Differential relay scheme, single-phase static comparator, polyphase differential protection. Differential protection for generator and transformer. (i) Static Distance Relays: Impedance relay, reactance relay and mho relay using amplitude and phase comparators. Polarized and offset mho relays. (ii) Carrier Current Protection: Phase Comparison scheme, carrier aided distance protection.
II	**Distance Protection**	Effect of Arc resistance, power swings, line length and source impedance on the performance of distance protection. Out of step tripping and blocking relays. Mho relay with blinders. Quadrilateral and elliptical relays. Selection of distance relays.
III	**Induction Motor Protection**	Various faults and abnormal operating conditions. Protection against faults, unbalance supply voltage, single phasing, over load and mechanical rotor faults, HRC fuses, over-current, percentage differential and earth fault protection. Negative sequence voltage relays and resistance temperature detector relay
IV	**Digital Protection**	Introduction to digital protection, block diagram of digital relay, sampling theorem, correlation with a reference wave, Fourier analysis of analogue and discrete signals, least error squared technique, digital filtering – low pass, high pass, finite impulse response and infinite impulse response fillers. Introduction to digital over-current, transformer differential and transmission line distance protection.

Text / Reference Books:

1. Power system protection & switchgear by Badri ram & vishwakarma, TMH publication New Delhi 1995.
2. Power System Protection by Madhava Rao TMH
3. Power System by Ravindra Nath and M.Chandar PHI

MEE301.2 Advanced Power Electronic

Teaching Hrs.
L-4, T-2 P-0

Exam. Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) & University (100)}

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Phase Controlled Converters**	Performance measures of single and three-phase converters with discontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three-phase converters
II	**Chopper**	Review of choppers configurations, Steady state analysis of type A Chopper-Minimum and Maximum Currents, Ripple and average load current. Commutation in Chopper Circuits
III	**Inverter**	Performance parameters, voltage control of three phase inverters-Sinusoidal PWM, Third Harmonic PWM, 60 degree PWM and Space Vector Modulation. Harmonic reductions
IV	**AC Voltage Controllers**	Single and Three Phase AC Controllers. AC Voltage Controller with PWM Control.
V	**Cyclo-converters**	Single phase and three phase Cyclo-converters. Reduction in Output Harmonics. Matrix Converter

Text / Reference Books:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition – First Indian reprint 2004.
2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley & Sons – Second Edition
3. Advanced Power Electronics by Bimal K Bose
4. Advanced Power Electronics By Marian P Karzmienkowski , Ramu Krishna
5. Advanced Power Electronics By Robert warren Fuicksen , Dragan

MEE301.3 Flexible AC transmission System

Teaching Hrs.
L-4, T-2 P-0

Exam. Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) & University (100)}

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Introduction**	Problems of AC transmission systems, power flow in parallel paths and meshed system, factors limiting loading capability, stability consideration. Power flow control of an ac transmission line. Basic types of facts controllers. Advantages of FACTS technology i) Voltage-Sourced Converters: Basic concept of voltage-sourced converters, single and three phase bridge converters. Introduction to power factor control. Transformer connections for 12- pulse, 24 pulse and 48 pulse operations. (ii) Static Shunt Compensators: Mid point and end point voltage regulation of transmission line, and stability improvement. Basic operating principle of Static Synchronous Compensators (STATCOM). Comparison between STATCOM and SVC
II	**Static Series Compensators**	Concept of series capacitive compensation, voltage and transient stabilities, power oscillation and subsynehronous oscillation damping. Introduction to thyristor- switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), and static synchronous series compensator-operation, characteristics and applications. i) Static Voltage and Phase Angle Regulators: Voltage and phase angle regulation. Power flow control and improvement of stability by phase angle regulator. Introduction to thyristor controlled voltage and phase angle regulators (TCVR and TCPAR) (ii) Introduction to thyristor controlled braking resistor and thyristor controlled voltage limiter. (i) UPFC: Unified Power Flow Controller (UPFC), basic operating principles, conventional transmission control capabilities. Comparison of UPFC to series compensators and phase angle regulator. Applications of UPFC. (ii) IPFC: Interline Power Flow Controller (IPFC), basic operating principles and characteristics. Applications of IPFC.

Text / Reference Books:

1. Flexible ac transmission systems (FACTS) by Y.H. Song, and Allan T. Johns Institution of Electrical Engineers Press, London, 1999
2. Concepts and Technology of flexible ac transmission system Hingorani ,L.Gyugyi IEEE Press New York, 2000 ISBN –078033 4588
3. Thyristor - based FACTS controllers for Electrical transmission systems by R .Mohan Mathur and Rajiv K.Varma
   IEEE press, Wiley Inter science, ISBN no. 0-471-20643-1, 2002.
4. FACTS controllers for transmission and Distribution systems by K.R.Padiyar New Age international Publishers 1st

MEE301.4 Pattern Recognition

Teaching Hrs.
L-4, T-2 P-0

Exam. Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) & University (100)}

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Principles of pattern recognition**	Principles of pattern recognition. Feature selection and extraction Decision theoretic approach for deterministic and probabilistic cases.
II	**Linear decision functions**	Linear decision functions for multiclass Problem. Distance functions clustering criteria minimum distance, K- means and isodata clustering algorithms. Likelihood functions Bayes Classifier for normal patterns. Deterministic approach perceptron and reward punishment approach
III	**Syntactic approach**	Syntactic approach to pattern recognition. Pattern representation by primitives. Pattern grammar. Syntax analysis Top down and Bottom-up parsing. Automation and their design
IV	**Applications**	Applications to handwritten and printed characters, electrocardiograms and electrical circuit.

Text / Reference Books:

1. Principle of Pattern Recognition – Gorgalez &Thompson
2. Syntratic Pattern Recognition – K.S.F.U
3. Imaging Processing by Rofael C-genzalez , Richard Eugene Woods
4. Imaging Processing by John C Russ
5. Imaging Processing by shehrzad Qureshi

MEE302.1 Surge Phenomena and High Voltage Engineering

Teaching Hrs.
L-4, T-2 P-0

Exam. Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) & University (100)}

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Wave terminology**	Wave terminology development of wave equations, terminal problems, lattice diagrams.
II	**Power systems surges**	Origin and nature of power systems surges, wave shapes, attenuation, effects of shielding by ground wires and masis, tower footing- resistance. Travelling waves, Multi-velocity waves, methods of measuring tower footing resistance, voltage across insulator strings
III	**Voltage Dynamic**	Dynamic over-voltages during surges and system faults, systems recovery voltage characteristics
IV	**Grounding**	Methods of neutral grounding and their effects on systems behaviour, Insulation coordination, requirement in surge protection of lines and equipment.
V	**Impulse generator**	Impulse generator development. Impulse testing technique, power frequency h.v. transformers., cascade connection , H.V.D.C generators, test with power frequency and d.c. voltages. Large current generating and measurement technique. Partial discharge testing. High voltage and high current testing of power equipment. Field investigations. Magnetic links. Their calibration and mounting, klydenographs potential deviders and cathode ray oscillograps

Text / Reference Books:

1. High Voltage Engineering by M.S.Naidu and V.Kamaraju – TMH
2. High Voltage Engineering fundamentals by Kuffel and Zungel, Elsavier Publications
3. Fundamentals of Gaseous Ionization and plasma Electronics by Essam Nasser – Wiley - Inter Science
4. High Voltage Technology by ALSTOM
5. Extra High Voltage AC Transmission Engineering – Rakosh Das Begamudre, Wiley Eastem ltd., New Delhi – 1987
6. EHV Transmission line reference book – Edision Electric Institute (GEC) 1986.

MEE302.2 Power Quality

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2 P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Introduction**	Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring
II	**Long Interruptions**	Interruptions – Definition – Difference between failure, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.
III	**Short Interruptions**	Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions
IV	**Voltage sag**	Characterization – Single phase: Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, voltage sag duration.
V	**Voltage sag(Three phase)**	Voltage sag – characterization – Three phase: Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.
VI	**PQ considerations in Industrial Power Systems**	Voltage sag – equipment behaviour of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives
VII	**Mitigation of Interruptions and Voltage Sags**	Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.
VIII	**Power Quality and EMC Standards**	Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys

Text / Reference Books:

1. Understanding Power Quality Problems" by Math H J Bollen. IEEE Press
2. Electric Power Quality by G.T Heydt, Stars in a Circle Publications, Indiana,2nd Edition 1994

MEE302.3 Communication &Distribution Automation

Teaching Hrs. **Exam. Hrs. : 3 Hrs.**
L-4, T-2 P-0 **Exam Marks: 150 {Internal (50) & University (100)}**

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Distribution Automation and the utility system**	Distribution Automation and the utility system : Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software.
II	**Distribution Automation Functions**	DA capabilities, Automation system computer facilities, management processes,Information management, system reliability management, system efficiency management, voltage management, Load management
III	**Communication Systems for DA**	DA communication requirements, Communication reliability, Cost effectiveness, Data rate requirements, Two way capability, Ability to communicate during outages and faults,Ease of operation and maintenance, Conforming to the architecture of data flow
IV	**Communication systems used in DA**	Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio,Microwave satellite. fiber optics, Hybrid Communication systems, Communication systems used in field tests
V	**Technical Benefits**	DA benefit categories, Capital deferred savings, Operation and Maintenance savings, Interruption related savings, Customer related savings, Operational savings, Improved operation, Function benefits, Potential benefits for functions, function shared benefits, Guide lines for formulation of estimating equations
VI	**Economic Evaluation Methods**	Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop Alternatives, Calculate operating and maintenance costs, Evaluate alternatives.
VII	**Economic comparision of alternate plans**	Economic comparision of alternate plans, Classification of expenses and capital expenditures, Comparision of revenue requirements of alternative plans, Book Life and Continuing plant analysis, Year by year revenue requirement analysis, short term analysis,end of study adjustment, Break even analysis, Sensitivity analysis computational aids

Text / Reference Books:

1. IEEE Tutorial Course "Distribution Automation"
   IEEE Working Group on "Distribution Automation
2. Discrete – Time Control System – K . Orata , Pearson Education / PHI 2nd Edition
3. Digital Control & State variable methods by M. Gopal
4. Digital Control System By Kuo Oxford University Press 2nd Edition

MEE302.4 Power System Dynamics

Teaching Hrs.
L-4, T-2 P-0

Exam. Hrs. : 3 Hrs.
Exam Marks: 150 {Internal (50) & University (100)}

CONTENTS OF SYLLABUS

Units	Topics	Details of Coverage
I	**Basic concepts**	Power system stability states of operation and system security system dynamics problems system model analysis of steady State stability and transient stability, simplified representation of Excitation control
II	**Modeling of synchronous machine**	synchronous machine park's Transformation Transformation of flux linkages, Transformation of stator voltage equations and rotor equations.
III	**Analysis**	Analysis of steady state performance, per unit quantities - Equivalent circuits of synchronous machine - determination of parameters of equivalent circuits.
IV	**Excitation system**	Excitation system modeling, excitation systems block Diagram system representation by state equations.
V	**Dynamics of a synchronous generator connected to infinite bus**	system model Synchronous machine model, stator equations rotor equations, Synchronous machine model with field circuit and with field circuit and one equivalent damper winding on q axis (model 1.1), calculation of Initial conditions
VI	**Analysis of single machine system**	small signal analysis with block diagram Representation characteristic equation and application of routh hurwitz criterion Synchronizing and damping torque analysis, small signal model State equations.
VII	**Application of power system stabilizers**	basic concepts in applying PSS, Control signals, structure and tuning of PSS, washout circuit, dynamic compensator analysis of single machine infinite bus system with and without PSS.

Text / Reference Books:

1. Power System Voltage Stability"- C.W.TAYLOR, Mc Graw Hill, 1994
2. Power System Dynamics: Stability and Control" – K.R.PADIYAR, II Edition, B.S.Publications