Scheme of Evaluation (Semester-wise)

M.E. (Electrical Engineering)
(POWER SYSTEMS)
(2015-16)

1. **Duration of the Programme**

The normal duration of M.Tech./ME programmes including Thesis will be two academic years (four semesters). The maximum period of completion of the programme including Thesis shall be three academic years (six semesters).

2. **Number of Papers allowed in a Semester**

All students will be required to qualify twelve theory papers and two practical papers during the course. No student will be allowed to qualify more than five theory and one practical paper at the end of first semester and not more than ten theory and two practical papers (including the papers passed in the first semester), at the end of second semester or first year. Two papers will be offered in the 3rd semester.

3. **Conditions for Appearing in End-Semester Examination**

Every student has to appear in two periodic tests as decided by the department and must qualify the same. There will be only one make-up test for those students who are unable to appear in one or both mid-semester tests due to genuine reasons to the satisfaction of Coordinator. Students, whose performance in the class-tests & sessional is not satisfactory, are liable to be detained by the Director from appearing at the University Examinations. The detailed rules of the University Examinations are available in Panjab University, Chandigarh and all students are advised to get the latest copy for guidance and further information.

4. **Examination and Result**

- Minimum marks to pass examination: 50% in the sessional in each subject and 40% in each theory paper. Both the theory and sessional marks will be considered independent of each other. Aggregate pass percentage will be 50%
- Weightage in each subject: 50 marks : Sessional examinations and 50 marks : University Theory Examination
- The students who obtain, in first attempt, 75% or more of the aggregate marks in both theory and sessional and also if the thesis has been adjudged to merit distinction are awarded First Division with Distinction.
• The students who obtain 60% or less than 75% of the aggregate marks in all theory papers and the sessional are awarded First Division.

• The students who obtain less than 60% of the aggregate marks in all the theory papers and the sessional but not less than 40% in each theory paper and 50% in the sessional will be awarded Second Division.

5. **Preliminary Thesis/Thesis**

Four neatly typed or printed copies of Thesis properly bound, shall be submitted to Panjab University through Guide. The examiners shall award marks/grades for the thesis as per the criterion given below:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Grade</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A+</td>
<td>Publication from Thesis in SCI indexed journal.</td>
</tr>
<tr>
<td>4.</td>
<td>B</td>
<td>Presented paper in International Conference.</td>
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</table>
# MASTER OF ENGINEERING (ELECTRICAL ENGINEERING)
## POWER SYSTEMS SPECIALIZATION W.E.F. 2014-15
### Scheme for Examination

## FIRST SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EE-8101</td>
<td>Advanced Power System Analysis</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8102</td>
<td>Power System Operation And Control</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8103</td>
<td>Optimization Techniques</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8104</td>
<td>Digital Control Systems</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8105</td>
<td>Power Quality</td>
<td>4</td>
<td>50</td>
<td>50</td>
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<tr>
<td>EE-8151</td>
<td>Simulation Lab-I</td>
<td>3</td>
<td>50</td>
<td>50</td>
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<td><strong>Total</strong></td>
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<td><strong>23</strong></td>
<td><strong>300</strong></td>
<td><strong>250</strong></td>
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## SECOND SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>EE-8201</td>
<td>Power Systems Dynamics and Stability</td>
<td>4</td>
<td>50</td>
<td>50</td>
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<tr>
<td>EE-8202</td>
<td>EHVAC Transmission</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8203</td>
<td>Advanced Neural Networks and Fuzzy Logic</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>Elective I</strong></td>
<td></td>
<td>4</td>
<td>50</td>
<td>50</td>
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<tr>
<td>EE-8204</td>
<td>Advanced Power Electronic and Drives</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EE-8205</td>
<td>Modeling and analysis of Electrical Machines</td>
<td></td>
<td></td>
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<tr>
<td>EE-8206</td>
<td>Applied Instrumentation</td>
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<tr>
<td><strong>Elective II</strong></td>
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<td>4</td>
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<tr>
<td>EE-8207</td>
<td>Advanced Power System Protection</td>
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<td></td>
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<tr>
<td>EE-8208</td>
<td>Fast Transients in Power Systems</td>
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<td></td>
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<tr>
<td>EE-8251</td>
<td>Simulation Lab-II</td>
<td>3</td>
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<tr>
<td>EE-8252</td>
<td>Research Seminar</td>
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## THIRD SEMESTER

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<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
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<td></td>
<td>Hrs/week</td>
<td>Internal</td>
<td>External</td>
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<tr>
<td></td>
<td><strong>Elective III</strong></td>
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<tr>
<td></td>
<td>EE-8301</td>
<td>4</td>
<td>50</td>
<td>100</td>
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<td></td>
<td>Power System Deregulation</td>
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<td></td>
<td>EE-8302</td>
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<td></td>
<td>Power System Reliability</td>
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<tr>
<td></td>
<td><strong>Elective IV</strong></td>
<td>4</td>
<td>50</td>
<td>100</td>
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<td>EE-8303</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>HVDC Transmission</td>
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<td></td>
<td>EE-8304</td>
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<td></td>
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<tr>
<td></td>
<td>Flexible AC transmission Systems (FACTS)</td>
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<tr>
<td></td>
<td><strong>EE-8351 Preliminary Thesis work</strong></td>
<td>18</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
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<td>100</td>
<td>200</td>
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</table>

## FOURTH SEMESTER

<table>
<thead>
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<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
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<tr>
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<td>Thesis</td>
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<td><strong>Total</strong></td>
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<td>25</td>
<td>100</td>
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</tbody>
</table>

**Note:**

1. Duration of end semester examination in each theory and laboratory course is three hours.
2. The examination in the subject of thesis is to be conducted jointly by two examiners, one of which will be the thesis supervisor, and the other, an external examiner.
3. The requirement for the award of ME is successful completion of 12 theory courses, 2 practical courses and satisfactory completion of thesis.
EE-8101
ADVANCED POWER SYSTEM ANALYSIS

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.


Recommended Books:-

**EE-8102**  
**POWER SYSTEM OPERATION AND CONTROL**  

**L T P**  
4 0 0  

**External:** 50  
**Sessional:** 50  
**Credits:** 4  

**Note:** Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.  

**Introduction:** System load variation: System load characteristics, load curves - daily, weekly and annual, load-duration curve, load factor, diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves. Overview of system operation: Load forecasting, techniques of forecasting, basics of power system operation and control.  

**Real Power - Frequency Control:** Fundamentals of speed governing mechanism and modelling: Speed-load characteristics – Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases, Economic Dispatch Control. Multi-area systems: Two-area system modelling; static analysis, uncontrolled case; tie line with frequency bias control of two-area system derivation, state variable model.  

**Hydrothermal Scheduling Problem:** Hydrothermal scheduling problem: short term and long term-mathematical model, algorithm. Dynamic programming solution methodology for Hydro-thermal scheduling with pumped hydro plant: Optimization with pumped hydro plant- Scheduling of systems with pumped hydro plant during off-peak seasons: algorithm. Selection of initial feasible trajectory for pumped hydro plant- Pumped hydro plant as spinning reserve unit-generation of outage induced constraint-Pumped hydro plant as Load management plant.  

**Unit Commitment And Economic Dispatch:** Statement of Unit Commitment (UC) problem; constraints in UC: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; UC solution methods: Priority-list methods, forward dynamic programming approach, numerical problems. Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ-iteration method. Base point and participation factors. Economic dispatch controller added to LFC control.  

**Computer Control Of Power Systems:** Energy control centre: Functions – Monitoring, data acquisition and control. System hardware configuration – SCADA and EMS functions: Network topology determination, state estimation, security analysis and control. Various operating states, State transition diagram showing various state transitions and control strategies.  

**Recommended Books**  

EE-8103
OPTIMIZATION TECHNIQUES

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

PART A

Linear programming. Post-optimality analysis: change in cost vector and requirement vector, addition of a constraint and a variable, linear programming with bounded variables. (Scope as in Chapter 11, sections 11.1-11.5, 11.7 of Reference 2) (7)

Transportation problem. Bounded variables transportation problem (Scope as in Chapter 11, section 11.7 of Reference 3) (3)

Convex Optimization. Convex functions and their properties, convex programming problems, optimality conditions. (Scope as in chapter 7, sections 7.1-7.5 of Reference 1) (9)

Quadratic programming. Wolfe’s Method (Scope as in chapter 7, sections 7.6, 7.7 of Reference 1) (3)

PART B

Nonlinear programming. Feasible directions and linearizing cone, constraints qualification, lagrange multipliers, Farka’Lemma (statement only), Karush-Kuhn -Tucker Conditions, duality in nonlinear programming, special cases of Wolfe dual. (Scope as in Chapter 8, sections 8.1-8.7 of Reference 1) (9)

Unconstrained Optimization: Line search method, Steepest descent method, Newton’s method, Conjugate gradient Method (Scope as in Chapter 9, sections 9.1-9.5, 9.7 of reference 1)

Generalized convex functions. Quasiconvex, quasiconcave, pseudoconvex, pseudoconcave, linear fractional programming (Scope as in Chapter 12, sections 12.1-12.5 of Reference 1) (7)

Recommended Books

EE-8104
DIGITAL CONTROL SYSTEMS

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.


Recommended Books
2) Shinners, S.M. Modern Control System Theory & Design, John Wiley & Sons.
3) Kuo, B.C., Automatic Control System, Prentice Hall.
4) Ogata, K., Modern Control Engineering, Prentice Hall.
7) Related IEEE/IEE Publication.
EE-8105
POWER QUALITY

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.


Power Quality conditioners – shunt and series compensators-Dstatcom-Dynamic voltage restorer-unified power quality conditioners-case studies.

Recommended Books:-


1. Economic Load Dispatch with thermal power plants.
2. Economic Load Dispatch with Hydro thermal power plants.
3. Simulation of Facts controllers
4. Simulation of single -area and Two -area Systems.
5. Load forecasting and unit commitment.
EE-8201
POWER SYSTEMS DYNAMICS AND STABILITY

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.


Recommended Books:-

EE-8202
EHV AC TRANSMISSION

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

Introduction
Role of EHV AC Transmission, standard transmission voltages, average value of line parameters, power handling capacity. Line parameters Properties of bundled conductors, resistance, induction and capacitance of bundled conductor lines, temperature rise of conductors and current carrying capacity.

Voltage gradients on conductors
Charge potential relations for multi-conductor lines, surface voltage gradient on conductors, distribution of voltage gradient on sub conductors of bundle.

Corona Effects
Corona loss, attenuation of traveling waves, audible noise, limits for audible noise, AN measurement and meters, Day night equivalent noise level, limits for radio interference fields, RI excitation function, measurements of RI, RIV, Excitation function.

Switching Over voltages
Origin of over voltages and their types, over voltages due to interruption of low inductive current and interruption of capacitive currents, Reduction of switching surges on EHV systems.

Power frequency over voltages
Problems at power frequency, no-load voltage conditions and charging current, voltage control using synchronous condensers, sub synchronous resonance in series-capacitor compensated lines, state reactive compensating schemes.

Operational aspects of Power flow
Line loadability, effects of over load, reactive power limitations and over voltage problem.

Recommended Books:-
EE-8203
ADVANCED NEURAL NETWORKS & FUZZY LOGICS

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.


Basic Hopfield model, Basic learning laws, Unsupervised learning, Competitive learning, K-means clustering algorithm, Kohonen’s feature maps.


Application of neural nets such as pattern recognition, load forecasting, Optimization, Associative memories, speech and decision-making.


Recommended Books:-

1. Neural Networks-by Simon Haykin
2. Fuzzy logic with engineering application-by Ross J.T(Wiley)
1. Introduction to artificial neural systems-by J.M. Zurada.(Jaico Pub)
2. Fuzzy Neural Control-by Junhong NIE& Derek Linkers(PHI)
EE-8204
ADVANCED POWER ELECTRONICS AND DRIVES

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

Power Semiconductor Diodes

Thyristor
V -1 Characteristics, Turn ON & Turn OFF Characteristics, di/dt and dv/dt protection, Series and Parallel Operation of Thyristors, Thyristor firing circuits, UJT and PUJT, Thyristor commutation Techniques.

Power Transistors
Bipolar Junction Transistors, their steady State & Switching Characteristics, Power MOSFET'S and their steady state & switching characteristics, Gate drive SIT’s & IGBTS's, Series & Parallel Operation, di/dt and dv/dt limitations,

Controlled Rectifiers
Single Phase & Three Phase full Converters with R-L load, Single phase &:three phase dual converters, Power factor improvement technique.

A.C. Voltage Controllers
Principle of phase control, Single phase and three phase full controllers, Cycloconvertor, A.C. voltage Controllers with PWM Control, Effects of source & Load Inductances.

D.C Choppers
Chopper Classification, Thyristor Chopper Circuits, Chopper Circuit Design.

PWM Inverters
Principle of Operation, Performance parameters, single phase bridge invertors and their voltage Control, Harmonic Reduction, Inverter Circuit Design.

Recommended Books:-
1. M.H. Rashid , Power Electronics Circuits Devices application, PHI.1994
EE-8205
MODELING AND ANALYSIS OF ELECTRICAL MACHINES

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

Principles of Electromagnetic Energy Conversion, General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system.

Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.

Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form; Application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis model in arbitrarily rotating reference frames


Special Machines - Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modelling and self controlled operation; Analysis of Switch Reluctance Motors.

Recommended Books

3. Miller, T.J.E., „Brushless permanent magnet and reluctance motor drives, Clarendon
EE-8206
APPLIED INSTRUMENTATION

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

1. Transducers, Classification of Transducers, including analog and digital transducers, Selection of Transducers Static and Dynamic response of transducer System.
3. Telemetry: Basic Principles, Proximity & remote Action Telemetry systems, Multiplexing, Time Division and frequency division.
5. Fibre Optic Technology for data transmission, Supervisory Control and Data Acquisition Systems (SCADA), Q-meter.
6. Electrical noise in control signals, its remedial measures.

Recommended Books:-

1. W.D. Coopper & A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, PHI.
4. Electrical Transducers for Industrial Measurement by pH Mansfield.
5. Instrumentation systems by Mani Sharma, Rangan.
6. Principles & Methods of Telemetry by Borden & & Thagnel.
7. Telemetry Method by Foster.
EE-8207
ADVANCED POWER SYSTEM PROTECTION

External: 50
Sessional: 50
Credits: 4

**Note:** Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

**Static Relays:-**
Advantages of static relays-Basic construction of static relays-Level detectors-Replica impedance Mixing circuits-General equation for two input phase and amplitude comparators-Duality between amplitude and phase comparators.

**Amplitude Comparators**
Circulating current type and opposed voltage type-rectifier bridge comparators, Direct and Instantaneous comparators.

**Phase Comparators**
Coincidence circuit type-block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type-Phase comparators.

**Static Over Current Relays**
Instantaneous over-current relay-Time over-current relays basic principles—definite time and Inverse definite time over-current relays.

**Static Differential Relays**
Analysis of Static Differential Relays—Static Relay schemes—Duo bias transformer differential protection—Harmonic restraint relay.

**Static Distance Relays**
Static impedance-reactance—MHO and angle impedance relay sampling comparator—realization of reactance and MHO relay using sampling comparator.

**Multi-Input Comparators**
Conic section characteristics-Three input amplitude comparator, Hybrid comparator-switched distance schemes, Poly phase distance schemes, Phase fault scheme, Three phase scheme, Combined and ground fault scheme.

**Power Swings**
Effect of power swings on the performance of distance relays—Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.
Microprocessor Based Protective Relays

(Block diagram and flowchart approach only)-Over current relays, impedance relays, directional relay, reactance relay, Generalized mathematical expressions for distance relays, measurement of resistance and reactance, MHO and offset MHO relays, Realization of MHO characteristics, Realization of offset MHO characteristics, Basic principle of Digital computer relaying.

Recommended Books:-

EE-8208

**FAST TRANSIENTS IN POWER SYSTEMS**

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

**Note:** Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

**Lightning Overvoltages**
Mechanism and parameters of lightning flash, protective shadow, striking distance, electrogeometric model for lightning strike, Grounding for protection against lightning–Steady-state and dynamic tower-footing resistance, substation grounding Grid, Direct lightning strokes to overhead lines, without and with shield Wires.

**Switching And Temporary Overvoltages**
Switching transients – concept – phenomenon – system performance under switching surges, Temporary over voltages – load rejection – line faults – Ferro resonance, VFTO.

**Travelling Waves On Transmission Line**
Circuits and distributed constants, wave equation, reflection and refraction – behavior of travelling waves at the line terminations – Lattice Diagrams – attenuation and distortion – multi-conductor system and multi velocity waves.

**Insulation Co-Ordination**
Classification of over voltages and insulations for insulation co-ordination–Characteristics of protective devices, applications, location of arresters – insulation co-ordination in AIS and GIS.

**Computation Of Power System Transients**
Modeling of power apparatus for transient studies – principles of digital computation – transmission lines, cables, transformer and rotating machines – Electromagnetic Transient program – case studies: line with short and open end, line terminated with R, L, C, transformer, and typical power system case study: simulation of possible over voltages in a high voltage substation.

**Recommended Books**

1. Introduction to MATLAB Programming.
2. Simulink Modeling using PowerSIM.
3. Case studies using Neural Network/ Fuzzy Logic/GA/PSO toolboxes
4. Simulation of Power Electronics controllers.
5. Optimization studies using GAMS/EUROSTAG
6. Case Studies using power system software
EE-8301
POWER SYSTEM DEREGULATION

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.


Recommended Books:-

2. Mohammad Shahidehpour, and Muwaffaq alomoush, - “Restructured electrical Power systems” Marcel Dekker, Inc. 2001
EE-8302
POWER SYSTEM RELIABILITY

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

Basic Reliability Concepts:
The General reliability function, Hazard rate, MTTF, Markov processes.

Static Generating Capacity Reliability Evaluation
Capacity outage probability tables, loss of load probability method, Frequency and duration approach.

Spinning Generation Capacity Reliability Evaluation
Spinning capacity evaluation, Load forecast uncertainty, Derated capacity levels.

Transmission System Reliability Evaluation
Average interruption rate method, Frequency and duration method, Stormy and normal weather effects, The Markov process approach.

Composite System Reliability Evaluation
Conditional probability approach, two –plant single load system.

Recommended Books:-
EE-8303
H.V.D.C. TRANSMISSION

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

1. **H.V.D.C. Power Flow**: Merits and Demerits of H.V.D.C. over EE.H.V.A.C., Types of H.V.D.C. links. Control of H.V.D.C. links, Analysis of 3-phase bridge converter with grid control overlap angle U <= 60° and U >= 60° Derivation of equivalent circuit of H.V.D.C. link. Basic means of control of HVDC link, CCA, CC & CEA, Control Characteristic, combined characteristics of a converter.

2. Harmonics in H.V.D.C. operation, types of filters used for harmonic elimination.

3. Protection aspects of H.V.D.C. link.

4. Parallel operation of A.C. and D.C. systems.


**Recommended Books:**

EE- 8304
FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

L T P
4 0 0

External: 50
Sessional: 50
Credits: 4

Note: Examiner shall set eight questions covering entire syllabus. Candidate will be required to attempt any five questions.

Introduction

Static Compensators and Regulators
Principles of operation, control schemes and characteristics of shunt compensators like SVC and STATCOM; Principles of operation, control schemes and characteristics of series compensators like GCSE, TSSC, TCSC and SSSC; Voltage and phase angle regulators like TCVR and TCPAR; Combined compensators like UPFC and IPFC.

Applications
Application considerations of FACT devices.

Recommended Books:-
4. Reactive Power Control in Power Systems TSE Miller