Scheme and Syllabus

MASTER OF ENGINEERING
IN
ELECTRICAL ENGINEERING
(POWER SYSTEMS)

UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY
PANJAB UNIVERSITY, CHANDIGARH
(2012-13)
# Scheme for Examination

## MASTER OF ENGINEERING (ELECTRICAL ENGINEERING)

**POWER SYSTEMS SPECIALIZATION W.E.F. 2012-13**

### 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>
</tr>
</thead>
<tbody>
<tr>
<td>EE-8101</td>
<td>Advanced Power System Analysis</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8102</td>
<td>Power System Operation And Control</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8103</td>
<td>Optimization Techniques</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8104</td>
<td>Digital Control Systems</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8105</td>
<td>Power Quality</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8151</td>
<td>Simulation Lab-I</td>
<td>3</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>23</td>
<td>300 250</td>
<td>550</td>
</tr>
</tbody>
</table>

#### SECOND SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE-8201</td>
<td>Power Systems Dynamics and Stability</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8202</td>
<td>EHVAC Transmission</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8203</td>
<td>Advanced Neural Networks and Fuzzy Logic</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td><strong>Elective I</strong></td>
<td>EE-8204 Advanced Power Electronic and Drives</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>EE-8205 Advanced Electrical Machines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE-8206 Applied Instrumentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Elective II</strong></td>
<td>EE-8207 Advanced Power System Protection</td>
<td>4</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>EE-8208 Fast Transients in Power Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE-8251</td>
<td>Simulation Lab-II</td>
<td>3</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td>EE-8252</td>
<td>Research Seminar</td>
<td>2</td>
<td>50 50</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>25</td>
<td>350 250</td>
<td>600</td>
</tr>
</tbody>
</table>
### THIRD SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hrs/week</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>EE-8301</td>
<td>Power System Deregulation</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8302</td>
<td>Power System Reliability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective III</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE-8303</td>
<td>HVDC Transmission</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>EE-8304</td>
<td>Flexible AC transmission Systems (FACTS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE-8351</td>
<td>Dissertation Preliminary</td>
<td>18</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Seminar-I on Dissertation Preliminary</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>26</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

### FOURTH SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Teaching Schedule</th>
<th>Examination(Marks)</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hrs/week</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>EE-8451</td>
<td>Dissertation</td>
<td>20</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Seminar-II on Dissertation</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>20</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

**Note:**
1. Duration of end semester examination in each theory course is three hours.
2. The examination in the subject of Dissertation is to be conducted jointly by two examiners, one of which will be the dissertation supervisor, and the other, an external examiner.
EE-8101
Advanced Power System Analysis

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

External: 50  
Sessional: 50  
Credits: 4

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


Automatic generation control -Review of LFC and Economic Dispatch control (EDC) using the three modes of control viz. Flat frequency – tie-line control and tie-line bias control – AGC implementation – AGC features - static and dynamic response of controlled two area system

MVAR control - Application of voltage regulator – synchronous condenser – transformer taps – static VAR compensators


Recommended Books:

EE-8103
Optimization Techniques

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. Introduction to Optimization:
Statement of an optimization problem, Classification of optimization problems, Optimization techniques, Engg. applications of optimization.

2. Classical Optimization Techniques:
Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with in equality constraints.

3. Linear Programming:
Standard form of linear programming, Graphical solution, Simplex method, Twophase simplex method, Computer implementation of the simplex method, Duality theory.

4. Transportation Problem:
North-West Corner rule, Least cost method, Vogel approximation method, testing for optimality.

5. Non-Linear Programming: One–dimensional minimization methods:
Unimodal function, Dichotomous search, Fibonacci search, Quadratic interpolation method, Cubic interpolation method.

6. Non-Linear Programming-Unconstrained Optimization Techniques:
Random search method, Steepest descent method, Conjugate gradient method, Variable metric method.

7. Non-Linear Programming - Constrained Optimization Techniques:
Interior Penalty function method, Exterior penalty function method.

8. Further Topics in Optimization:
Critical path method (CPM), Program evaluation and review technique (PERT).

Recommended Books:
Digital Control Systems

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. Signal Processing in Digital Control


2. Models of Digital Control Devices & Systems


3. Design of Digital Control Algorithms

Z-Plane specifications of control system design, Digital Compensator Design using frequency response plots, Digital Compensator design using root locus plots, z – Plane Synthesis.

4. Control System Analysis using state Variable Methods

State Variable representation, Conversion of state Variable models to Transfer functions, Conversion of Transfer functions to Canonical state Variable models, Eigen values & Eigen Vectors, Solution of state equations, Concepts of Controllability & Observability, Equivalence between transfer function & State Variable Representation, Multivariable systems.

5. State Variable Analysis of Digital Control Systems:


Recommended Books

b) Shinners S.M. Modern Control System Theory & Design, John Wiley & Sons.  
c) Kuo B.C., Automatic Control System, Prentice Hall.  
d) Ogata K., Modern Control Engineering, Prentice Hall.  
f) Ogata K., Discrete Time Control Systems, Prentice Hall.  
g) 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:

EE-8151
SIMULATION LAB-I

 Marks: 50
 Credits: 2

1. Economic Load Dispatch with thermal power plants.
2. Economic Load Dispatch with Hydro thermal power plants.
3. Simulation of FACT 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

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. 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.

2. 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.

3. 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.

4. 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.

5. 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

External: 50
Sessional: 50
Credits: 4

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


4. 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)
4. Introduction to artificial neural systems-by J.M. Zurada.(Jaico Pub)
5. 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.

1. Power Semiconductor Diodes:

2. Thyristor:
V-I 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.

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

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

5. 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.

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

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

Recommended Books:
EE-8205
Modeling and Analysis of Electrical Machines

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.

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 modeling 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

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.

Fundamentals: Types of relays, their classifications and theory Phase and amplitude comparators. Static Comparators Computer Applications to protective relaying.


Generators and Transformers Protection: CT's and PTs burden and accuracy and their connections. Protection of rotor winding. miscellaneous protection schemes for generators and transformers, Overfluxing protection of transformers.


Bus zone Protection: Types of bus bar faults, Protection requirements, protection schemes and modern trend in bus-bar protection.


Recommended Books:
EE-8208
Fast Transients in Power Systems

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. Origin and nature of power system Transients, Traveling waves on transmission system. The line equation. The shape attenuation and distortion of waves, reflection of traveling waves, Successive reflections, Traveling waves on multi-conductor systems, Transition points on multi conductor circuits.

2. Lightning : Change formation, Mechanism of lighting stroke, Mathematical model of lightning stroke.


5. Protection of transmission systems against surge.

6. High frequency oscillations and terminal transients of transformer.

7. Insulation co-ordination.

References:
EE-8251
Simulation Lab-II

Marks: 50
Credits: 2

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


Recommended Books:

EE-8302
Power System Reliability

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

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

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

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

5. 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 $U \leq 60^\circ$ and $U \geq 60^\circ$. 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.

Reactive Power Control in Electric Transmission Systems, Loading Capability and Stability Considerations. Introduction to FACTS, related concepts and system requirements.

Principles of operation, control schemes and the characteristics of shunt compensation, FACTS devices like statcom, SMES; series compensators like CSE, TCSC, SSSC, combined compensators (UPFC) and phase shifters devices such as SPS, TCPAR.

Application considerations of FACT devices.

Recommended Books:

4. Reactive Power Control in Power Systems, TSE Miller