# GONDWANA UNIVERSITY, GADCHIROLI

## TEACHING AND EXAMINATION SCHEME (SEMESTER PATTERN CHOICE BASED CREDIT SYSTEM)

**PROGRAM**: MASTER OF TECHNOLOGY IN ELECTRICAL POWER SYSTEM  
**PROGRAM CODE**: EP  
**FACULTY**: ENGINEERING AND TECHNOLOGY  
**DURATION**: TWO YEARS

### I- SEMESTER

<table>
<thead>
<tr>
<th>Unique Subject Code (USC)</th>
<th>Course Type</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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### Laboratories/ Practical

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Elective – I (x) : 
(A) Electrical Power Quality 
(B) Processor Applications in Power Systems 
(C) Power system Optimization 
(D) EHV Transmission 
(E) Switchgear and Protection
## Program

**Program:** Master of Technology in Electrical Power System  
**Program Code:** EP  
**Faculty:** Engineering and Technology  
**Duration:** Two Years

### II– Semester

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| PEPS2 6 | E  | Seminar          | - | - | 2 | 1 | - | - | - | - | - | - | - | 50 | -  | 50  | 25 |

| TOTAL | 12 | 08 | 4 | 18 | - | - | - | - | 400 | - | - | - | 150 |

| SEMESTER TOTAL | 24 | 18 | - | - | 550 |

Elective – II (x) :
(A) Computer Applications in Power Systems
(B) Advanced Electrical Drives
(C) Power System Planning & Reliability
(D) High Voltage Engineering
(E) Power system Design
# Gondwana University, Gadchiroli

**Teaching and Examination Scheme (Semester Pattern Choice Based Credit System)**

**Program:** Master of Technology in Electrical Power System  
**Program Code:** EP  
**Faculty:** Engineering and Technology  
**Duration:** Two Years

### III - Semester

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| Laboratories/ Practical | | | |
|-------------------------| | |
| PEPS3 3 E | Industrial Training | - | 5 | 5 | - | - | - | - | - | - | 150 | 50 | 200 | 100 |
| PEPS3 4 E | Pre-Dissertation | - | 6 | 5 | - | - | - | - | - | - | 100 | 50 | 150 | 75 |

<p>| TOTAL | | | |
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| SEMESTER TOTAL | 24 | 18 | 350 |

Elective – III (x) : (A) AI Techniques to Power System (B) Power System Deregulation
(C) Advanced Control System (D) Generation Planning and load dispatch (E) PLC & SCADA

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PROGRAM CODE : EP
FACULTY : ENGINEERING AND TECHNOLOGY
DURATION : TWO YEARS
IV– SEMESTER
Semester I

Energy Management and Auditing

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Unit 1:

Unit 2:
Energy Management & Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments energy management, Roles and responsibilities of energy Manager and Accountability, Financial analysis techniques, Financing options, Energy performance contracts and role of ESCOs. Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques energy consumption, Production, Cumulative sum of differences.

Unit 3:
Energy Efficiency in Electrical system: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, Energy efficient transformers; Induction motors efficiency, motor retrofitting, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Energy efficiency measures in lighting system, Electronic ballast, Occupancy sensors, and Energy efficient lighting controls. Factors affecting selection of DG system, Energy performance assessment of diesel conservation avenues

Unit 4:

Unit 5:
**Energy Performance Assessment**: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, Fans and pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method. Financial Analysis: simple payback period, NPV, IRR,

**Text Books**:  
1. Handbook of Electrical Installation Practice., By Geoffry Stokes, Blackwell Science  
2. Designing with light: Lighting Handbook., By Anil Valia, Lighting System  

**Application of Power Electronics in Power Systems**

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<tr>
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**Unit 1:**
**Introduction**: Steady state and dynamic problems in AC systems- Transmission interconnections-Flow of power in an AC system- Loading capability- Power flow and dynamic stability considerations of a transmission interconnection- Relative importance of controllable parameters.

**Unit 2:**
**FACTS Controllers**- Basic types of FACTS controllers- Brief description and definitions- Benefits from FACTS technology- HVDC or FACTS.

**Unit 3:**
**Static shunt compensators and Static series compensation**: Objectives of shunt compensation-Methods of controllable VAR generation- Objectives of series compensation- Variable impedance type series compensation (only TCSC), Switching converter type series compensation (only SSSC) Static voltage and phase angle regulators- Objectives of voltage and
phase angle regulators- TCVR and TCPAR, Switching converter based voltage and phase angle regulators.

**Unit 4:**

**Load compensation using DSTATCOM:** Compensating single phase loads- Ideal three phase shunt compensator structure-Series compensation of power distribution system- Rectifier supported DVR-DC Capacitor supported DVR- Fundamental Frequency series compensator characteristic

**Unified Power Quality Conditioner:** UPQC configuration-Right shunt UPQC characteristic-Left shunt UPQC characteristic

**Unit 5:**

**HVDC:** Development of HVDC Technology, DC versus AC Transmission, Selection of Converter Configuration. Rectifier And Inverter Operation, Digital Simulation of Converters, Control of HVDC Converters and Systems, Individual Phase Control, Equidistant Firing Controls, Higher Level Controls.

**Text Books**

5. Yong Hua Song “Flexible AC transmission system” Institution of Electrical Engineers, London
Power System Dynamics

Subject Code : PEPS13
Teaching Scheme : 03 L + 02 T = 05 Credit : 04
Evaluation Scheme : 15 IE + 15 ME + 70 ESE Total Marks : 100
Duration of ESE : 3hrs.

Unit 1:

Unit 2:
Dynamics of Synchronous Generator Connected to Infinite Bus: System model, simplified synchronous machine model, calculation of Initial conditions, system simulation, improved model of synchronous machine, inclusion of SVC model.

Unit 3:
Analysis of Single Machine: Small signal analysis, applications of Routh-Hurwitz criterion, analysis of synchronizing and damping torque, state equation for small signal model.

Unit 4:
Power System Stabilizers: Basic concepts of control signals in PSS, structure and tuning, field implementation, PSS design and application, future trends.
Multi-machine System: Simplified model, improved model of the system for linear load, Inclusion of dynamics of load and SVC, introduction to analysis of large power system.

Unit 5:
Voltage Stability: Definition, factors affecting voltage instability and collapse, analysis and comparison of angle and voltage stability, analysis and comparison voltage instability and collapse, control of voltage instability.
Islanding: Necessity for islanding, methods, use, advantages and disadvantages, implication on power system dynamic performance.

Text Book:
1. K.R. Padiyar, Power System Dynamics- B.S. Publications
2. Prabha Kundur, Power System Stability and Dynamics –TMH, New Delhi
Elective -I

Subject Code : PEPS14x
Teaching Scheme : 03 L + 02 T = 05
Evaluation Scheme : 15 IE + 15 ME+70 ESE
Duration of ESE : 3hrs.
Credits : 04
Total Marks : 100

(A) Electrical Power Quality

Unit 1:

Unit 2:
Non-Linear Loads: Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

Unit 3:

Unit 4:
Analysis And Conventional Mitigation Methods: Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI) - Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

Unit 5:
DVR, UPQC – control strategies: PQ theory, Synchronous detection method – Custom power park – Status of application of custom power devices.

Text Books:

(B) Processor Application in Power System

Unit 1:
Introduction: Review of microprocessor, microcontroller and digital signal processors architecture, Fixed and floating-point processors Number formats and operations: Fixed point 16 bit numbers representations of signed integers and fraction, Floating Point Numbers.

Unit 2:
Review of commonly used DSP processors in power electronics applications: introductions to TMS320F2812 and TMS320C2000 processors

Unit 3:

Unit 4:

Unit 5:
DSP Applications in Power Electronics: Speed control of Induction motor, BLDC motor, Digital control of DC/DC converter, LED Lighting. DSP Applications in Power Systems Issues of harmonics and unbalanced currents in power systems, Implementation of Active filters in DSP under balanced and unbalanced condition, harmonic oscillator and 3 phase lock loop, Static VAR Compensator, Hardware in Loop simulations. Design of a DSP controlled Solar PV based
Converter/Inverter system: FPGA- Field Programmable gate Array

**Text Books:**
2. Modern Power Electronics and AC Drives, B. K Bose, Pearson Education
3. Hamid Toliyat and Steven Campbell, DSP Based Electromechanical Motion Control, CRC Press
5. Code Composer Studio v4
6. www.ti.com

(C) Power System Optimization

Unit 1:
**Introduction to Optimization and Classical Optimization Techniques:** Single variable optimization, multivariable optimization without constraints, multivariable optimization with equality constraints, multivariable optimization with inequality constraints.

Unit 2:
**Linear Programming Problem:** Standard form, simplex method, big-M method.

Unit 3:
**Non-Linear Programming Problem:** Uni-modal function, elimination methods – unrestricted search, Fibonacci method, direct search method – random and grid search methods, indirect search methods – steepest descent and conjugate gradient method.

Unit 4:
**Dynamic Programming:** Multistage decision process, concept of sub-optimization and principle of optimality, LP as a case of dynamic programming.

**Genetic Algorithm:** Introduction to genetic algorithm, working principle, coding of variables, fitness function, GA operators, similarities and differences between GA and traditional methods, unconstrained and constrained optimization using GA

Unit 5:
**Applications to Power System:** Unit commitment problem, economic load scheduling, reactive power optimization, optimal power flow problem, optimum generation planning, network planning by mathematical optimization.

**Text Books:**
2. Power System Optimization, D. P. Kothari and J. S. Dhillon, Prentice Hall of India
4. Optimization for Engineering Design – Algorithms and Examples, Kalyanmoy Deb
(D) EHV Transmission

Unit 1:

Unit 2:
**Traveling Waves and Standing Waves:** Line Energization with Trapped - Charge Voltage. Reflection and Refraction of Traveling Waves. Transient Response of Systems with Series and Shunt Lumped Parameters. Principles of Traveling-Wave Protection Lightning & Lightning Protection, Insulation Coordination Based on Lightning

Unit 3:
**Over Voltages in EHV Systems:** Caused by Switching Operations, Origin of Over Voltages and their Types, Over Voltages Caused by Interruption of Inductive and Capacitive Currents, Ferro-Resonance Over Voltages, Calculation of Switching Surges, Power Frequency Voltage Control and Over Voltages, Power Circle Diagram.

Unit 4:

Unit 5:

**Text Books:**
1. A. Chakrabarti, D.P.Kothari, A.K. Mukhopadhyay ,“Performance, operation & control of EHV
power transmission system”, wheeler publications
2. Rakosh Das Begamudre, ”Extra high-voltage A.C. transmission Engineering” New Age International Pvt. Ltd.

(E) Switchgear and Protection

Unit 1:
General philosophy of protection - Classification and Characteristic function of various protective relays - basic relay elements and relay terminology - Development of relaying scheme

Unit 2:

Unit 3:
Bus bar protection - line protection - distance protection – long EHV line protection – Power line carrier protection

Unit 4:
Reactor protection – Protection of boosters - capacitors in an interconnected power system

Unit 5:

Text Books:

Lab Practice I

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Practical will be based on courses of Sem-I,

Seminar

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Students will have to deliver a seminar on any topic based on courses of sem-I

Semester II

Advanced Power Electronics

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<td>Credits</td>
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<td>Total Marks</td>
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Unit 1: Overview of Power Semiconductor Devices, DC-DC Converters- Principle of Operation of Buck, Boost, Buck-Boost, flyback, forward, push-pull, half bridge and isolated converters

Unit 2: Input and output filter design, multi output operation of isolated converters

Unit 3: Design of transformers and inductors, modeling of the converters using state averaging techniques

Unit 4: Resonant inverters: DC link inverters, modified circuit topologies for DC link voltage clamping, voltage control-PWM techniques, quasi resonant inverters

Unit 5: DC-DC converters- series resonant and parallel resonant, application of zero voltage and zero current switching for DC-DC converters (buck and boost), inverters for induction heating and UPS
Text Books

5. D.M. Mitchell, DC-DC Switching Regulator analysis, TMH, 1987

Advanced Power System Protection

Subject Code : PEPS22
Teaching Scheme : 03 L + 02 T = 05 Credits : 04
Evaluation Scheme : 15 IE + 15 ME+70 ESE Total Marks : 100
Duration of ESE : 3hrs.

Unit 1:

Unit 2:

Unit 3:

Unit 4:

Unit 5:
Text Books


Renewable Energy systems

Subject Code : PEPS23
Teaching Scheme : 03 L + 02 T = 05
Evaluation Scheme : 15 IE + 15 ME+70 ESE
Duration of ESE : 3hrs.

Credits : 04
Total Marks : 100

Unit 1:

Unit 2:
Solar Energy: Solar radiation , factors affecting solar radiation, efficiency calculations, fill factor. Photo voltaic (PV) technology: Present status, - solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , PV system, components, sizing and economics. Peak power operation. Standalone and grid interactive systems. I, II and III generation solar cells, solar panel rating, factors influencing the rating of solar panel.

Unit 3:
Unit 4:
**Other energy sources:** Biomass–various resources, biomass energy conversion overview, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Cofiring, Generation from municipal solid waste, Issues in harnessing these sources. Hydro energy – feasibility of small, mini and micro hydel plants scheme layout economics. Biomass and biogas potential in India, advantages and disadvantages.

Unit 5:

**Text Books**


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**Elective II**

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**(A) Computer Applications in Power Systems**

Unit 1:
**Introduction:** Graph of a power system, incidence matrices, primitive network, formation of network matrices by singular transformation. Representation of power system for computerized analysis: Algorithm for formation of bus impedance matrix, modification for changes in the network. Incidence and network matrices for three phase network, transformation matrices, algorithm for formation of bus impedance matrix for three phase networks.
Unit 3:
**Short Circuit Studies**: Symmetrical component, short circuit analysis of power systems using bus impedance matrix. Short circuit calculations for balanced and unbalanced faults.

Unit 4:
**Load Flow Analysis**: Types of buses, load flow equations, power flow solution through GS and NR methods, decoupled and fast decoupled methods, sparsity, introduction to AC-DC load flow.

Unit 5:
**Transient stability Analysis**: including synchronous machines, system network and loads, solution of swing equation by Euler’s, Euler’s modified and RK2 methods.

**Economic Load Scheduling**: Unit commitment, transmission loss, load scheduling considering transmission losses, unit commitment by dynamic programming method, hydrothermal scheduling.

**Text Books**

(B) Advanced Electrical Drives

Unit 1:
**Fundamentals of Electrical Drives**: Dynamics of electrical drives, components of load torque, classification of load torque, concept of multi-quadrant operation, steady-state stability criteria. DC Drives with phase controlled converters: 1-phase fully controlled converter fed separately excited DC motor, modes of operation, steady-state motor performance equations, mode identification, speed-torque characteristics, operation with controlled fly-wheeling; operation with 1-phase half controlled converter; 3-phase fully controlled converter fed separately excited motor; Pulse width modulated rectifiers, equal pulse-width modulation, sinusoidal pulse width modulation; current control; multi-quadrant operation of fully-controlled converter fed DC motor; Dual converters based drives; Closed loop control of DC drives.

Unit 2:
**DC drives with dc-dc converters**: Principle of Motoring operation of separately excited and series motor with DC-DC converter, Steady-state analysis for time ratio control and current limit control; Regenerative braking; Dynamic and composite braking; multi-quadrant operation with dc-dc converters

Unit 3:
**Control of IM with solid state converters**: Control of IM using VSI: Six step inverter, PWM inverter, braking and multi-quadrant control, VVVF control, Control of IM using CSI: Three-phase CSI, Braking, PWM in a thyristors, CS inverter, PWM with GTO based CSI, Variable frequency drives, Comparison of CSI and VSI based drives. Current controlled PWM inverters:
Unit 4:
**AC voltage controllers:** AC voltage controller circuits, four quadrant control and closed-loop operation; fan/pump and crane/hoist drives; ac voltage controller starters

Slip power controlled IM drives: analysis of stator rotor resistance control, Static scherbius drive: power factor considerations, rating and applications, performance

Unit 5:
**Synchronous motor drives:** Wound field cylindrical rotor motor, equivalent circuits, operation with constant voltage and frequency response: motoring and regenerative braking operations, power factor control and V-curves, operation with current source; Wound field salient pole motor; operation with variable voltage source and constant frequency; Starting and braking when fed from constant frequency source; brushless excitation of wound field machines; Permanent magnet motor operating from a fixed frequency source; Operation with non-sinusoidal supplies.

Text Books

3. Modern Power Electronics and AC Drives, Prentice Hall India, New Delhi, 2002- B.K. Bose
5. Thyristor DC Drives, John Wiley and Sons Ltd., April 1981- P.C. Sen

(C) Power System Planning & Reliability

Unit 1:

Unit 2:

Unit 3:


Text Books

(D) High Voltage Engineering


Unit 2: Generation of High Voltage & Currents: Generation of High D. C. Voltages: voltage doubler, voltage multiplier, electrostatic machines etc.; Generation of High Alternating Voltages: cascade circuits, resonating circuits etc. Generation of transient voltages: Single stage and multistage
impulse generator circuits, tripping and synchronization of impulse generator; Generation of switching surge voltages; Generation of Impulse Currents

Unit 3:
Measurement of High Voltages & Currents: Measurement of High Direct Current Voltages, High Alternating Voltages & Impulse Voltages- use of potential dividers, gaps and other methods of measurement; Measurement of High Direct Currents, High Alternating Currents & High Impulse Currents

Unit 4:
Over Voltage Phenomenon & Insulation Coordination: Natural Causes for Over Voltages, Lightning Phenomenon, Over Voltages Due to Switching Surges, System Faults & Other Abnormal Conditions, Principles of Insulation Coordination on High Voltage & Extra High Voltage Power Systems, concept of statistical factor of safety, risk of failure

Unit 5:
High Voltage Testing of Power Apparatus: High voltage testing of bushings, transformers, cables etc. Non-destructive insulation test techniques: High voltage dielectric loss measurements, discharge measurements

Text Books:

(E) Power System Design

Unit 1:
Power System Components: Location of Main Generating Stations and Substations, Interconnections, Load Dispatch Centers

Unit 2:
Design of Transmission Lines: Selection of Voltage, Conductor Size, Span, Number of Circuits, Conductor Configurations, Insulation Design, Mechanical Design of Transmission Line, Towers, Sag- Tension Calculations
Unit 3:

Unit 4:

Unit 5:

Text Books

Lab Practice II

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Teaching Scheme</th>
<th>Evaluation Scheme</th>
<th>Credits</th>
<th>Total Marks</th>
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<td>02 PR</td>
<td>50 TW + 50 PEE</td>
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Practical will be based on courses of Sem- II,

Seminar

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<td>02 PR</td>
<td>50 TW</td>
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Students will have to deliver a seminar on any topic based on courses of sem-II
**DETAILED EVALUATION PROCEDURE**

<table>
<thead>
<tr>
<th>EXAMINATION</th>
<th>PROCEDURE OF EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE (MID SEMESTER EXAMINATION)</td>
<td>The Mid Semester Examination marks shall be awarded by the concerned Subject Teacher on the basis of candidate’s performance in the written examination conducted by the Department. Usually, the MSE’s of two subjects shall be held on the same day. This will be ONE HOUR examination.</td>
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<tr>
<td>(10-MARKS)</td>
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<tr>
<td>(IE) INTERNAL EVALUATION</td>
<td>The marks allotted for IA shall be awarded by the concerned Subject Teacher on the basis of Candidates performance in:</td>
</tr>
<tr>
<td>(20-MARKS)</td>
<td>Alertness/response in the Class (05)</td>
</tr>
<tr>
<td></td>
<td>Attendance (05)</td>
</tr>
<tr>
<td></td>
<td>Assignments/ Tutorials (10)</td>
</tr>
<tr>
<td>(ESE) END SEMESTER EXAMINATION</td>
<td>The ESE shall be conducted by the University, as per schedule floated by it, as per its governing rules &amp; regulations. This will be THREE HOURS written examination.</td>
</tr>
<tr>
<td>(70-MARKS)</td>
<td>The Theory paper of ESE shall comprise of EIGHT questions in all, out which the Candidate shall be required to answer ANY FIVE. All the Questions shall carry equal marks (14).</td>
</tr>
<tr>
<td>(TW) TERM WORK</td>
<td>The TERM WORK (TW) shall be there for the practical passing head and other passing Heads, for which theory evaluation is not there. The procedure of evaluation is already mentioned under the syllabus of respective head.</td>
</tr>
<tr>
<td>POE (PERFORMANCE &amp; ORAL EXAMINATION)</td>
<td>The POE shall be there for all the passing heads where TW is there. The procedure of evaluation is already mentioned under the syllabus of respective head.</td>
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