**Semester - II**

| DIGITAL PROTECTION OF POWER SYSTEMS (IPCC) | | | |
|---|---|---|---|
| Course Code | MEPS201 | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 03:02:00 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 10-12 Lab slots | Total Marks | 100 |
| Credits | 04 | Exam Hours | 3 hours |

**Course objectives:**

| **MODULE-1** |
|---|
| Overview of Static relays, Transmission line protection, Transformer protection, Need for digital protection. Digital Relays- Basic elements of a digital relay and their functions, signal conditioning subsystem, conversion subsystem, digital relay subsystem |
| **MODULE-2** |
| Signal processing techniques– Sinusoidal based algorithms, Fourier analysis-based algorithms, Least squares based algorithm, Discrete Fourier Transforms, Wavelet Transforms, and Kalman Filtering. Travelling Wave Protection scheme, Digital Protection of Transformers, Infinite Impulse Response Filters, Finite Impulse Response filters |
| **MODULE-3** |
| Correction of errors introduced by Instrument Transformers- PTs and CTs, detection of unsaturated fragment of wave shape, CT saturation correction procedure. |
| **MODULE-4** |
| Decision making in Protective Relays – Deterministic decision making, Statistical Hypothesis testing, Decision making with multiple criterion, Adaptive decision schemes, Adaptive Differential protective scheme. |
| **MODULE-5** |
| Applications of Fuzzy Logic and ANN for power system protection, Fault location algorithm, Wide Area Monitoring and Protection |

**PRACTICAL COMPONENT OF IPCC** *(May cover all / major modules)*

| Sl.NO | Experiments |
|---|---|
| 1 | Simulation of Relaying Algorithms for numerical protection. |
| 2 | 3- ϕ Differential Relay. |
| 3 | To Observe Trip Time of Microcontroller Based Over/Under Frequency Relay. |
| 4 | To Observe Trip Time of Microcontroller Based Reverse Power Relay |
| 5 | General Considerations on Protection Devices |
| 6 | Protection of Transmission lines using Digital Relays. |
| 7 | Checking the Operation the Protection Devices with Differential Current. |

| | |
|---|---|
| 8 | Selectivity among Protection Devices. |
| 9 | **Can be Demo experiments for CIE** |
| 10 | **Can be Demo experiments for CIE** |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

### CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

### CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experiments shall be conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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### SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component**).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

**Suggested Learning Resources:**

**Books**


1. Computer Relaying for Power Systems, A.G.Phadke, James S.Thorp, John-Wiley and sons, 2009, 2/e
2. Digital Signal Processing in Power System Protection and Control, Waldemar Rebizant, Janusz Szafran, Andrzej Wiszniewski, Springer Publication, 2011, 1/e
3. Digital Protection for Power Systems, A.T.Johns and S.K.Salman, IEE Power Series 15, 1997
4. Digital Power System Protection, Singh, Prentice-Hall of India Pvt. Limited, 2007, 1/e
5. Understanding Digital Signal Processing, Orhan Gazi, Springer, 2017, 2/e
6. Fundamentals of Power System Protection, Paithankar Y.G, PHI, 2010, 2/e
7. Protective Relays-their Theory and Practice, A R C Warrington, Chapman & Hall Ltd., 1968


**Web links and Video Lectures (e-Resources):**

1. https://onlinecourses.nptel.ac.in/noc20_ee73/preview
2. NPTEL :: Electrical Engineering - Power System Protection (web contents)
3. NPTEL :: Electrical Engineering - NOC:Power System Protection and Switchgear (video lectures)

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Recognize the advantages of digital relays over conventional relay | |
| CO2 | Apply the suitable signal processing techniques for protection | |
| CO3 | Understand the adaptive criterion for relay decision making | |
| CO4 | Identify the new developments in protective relaying and applications | |
| CO5 | Apply Fuzzy Logic and ANN for Wide Area Monitoring and Protection | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| EHV AC TRANSMISSION | | | |
|---|---|---|---|
| Course Code | MEPS202 | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- 

| **Module-1** |
|---|
| **Introduction to EHV AC Transmission:** Calculations of line and ground parameters: Properties of bundled conductors, inductance and capacitance calculations line parameters for modes of propagation resistance and inductance of ground returns, equivalent circuit of line model |
| **Module-2** |
| **Voltage Gradients of Conductors:** Electrostatics, Field of Sphere, Field of Line Charges and Their , Charge- Potential Relations for Multi-Conductor, Surface Voltage Gradient on Conductors, Examples of Conductors and Maximum Gradients on Actual Lines, Gradient Factors and Their Use, Distribution of Voltage Gradient on Sub- conductors of Bundle |
| **Module-3** |
| **Corona and Radio interference:** corona loss formula factors affecting corona. Audible noise, its characteristics, limits for audio noise, relation between single phase and 3-phase AN levels, radio interference, limits for radio interference fields, CIGRE formula |
| **Module-4** |
| **Over Voltage in EHV Systems:** Switching surges, causes of switching surge over voltages, recovery voltage, Restriking transients, over voltages caused by interruption of low inductance currents, line energization transients, Ferro-resonance over voltages, lightning over voltages, protection against switching and lightning surges, VFTO in GIS, insulation coordination, design example |
| **Module-5** |
| **Power System Grounding:** Functional Requirements of Earthing System, Equipment Earthing, Neutral Point Earthling, design of Substation grounding System, analysis of simple grounding systems, dimensioning of Earth Conductors, Step Potential and Touch Potential, body currents due to touch and step voltages, grounding system safety assessment and Earth Mat design. Measurement of Resistance and Soil Resistivity of Earthing System |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. Extra High Voltage AC Transmission Engineering, Rakesh Das Begamudre, New Age International publishers, 2014, Fourth Edition
2. Power Generation Operation & Control, Allen J Wood & Bruce Wollenberg, 2016, Third Edition
3. Electric Power Transmission System Engineering Analysis and Design, Turan Gonen, CRC Press, 2014, Third Edition
4. Power Systems Grounding, Md. Abdus Salam, Quazi M. Rahman, Springer publishers, 2016

3. Performance, Operation and Control of EHV Power Transmission Systems, A Chakraborti, D.P. Kothari and A.K. Mukhopadyay, T.M.H. (Pub) 1992


**Web links and Video Lectures (e-Resources):**

1. https://www.youtube.com/channel/UCWKPXSjLRz-TAFgFWCfMmGg/videos

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Evaluate parameters of EHV line modelling | |
| CO2 | Analyze Voltage Gradients of Conductors & Distribution of Voltage Gradient on Sub-conductors of Bundle | |
| CO3 | Understand the over-voltage phenomena and methods to limit in EHV AC systems | |
| CO4 | Analyze and evaluate electric field and interference characteristics of EHV AC system | |
| CO5 | Design grounding system for EHVAC systems | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| MODERN OPTIMISATION TECHNIQUES IN POWER SYSTEM. | | | |
|---|---|---|---|
| Course Code | MEPS203 | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- 

| **Module-1** |
|---|
| **Fundamentals Of Optimization:** Definition-Classification of optimization problems-Unconstrained and Constrained optimization- Optimality conditions-Classical Optimization techniques (Linear and non-linear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, Particle swarm optimization, Application of fuzzy set theory). |
| **Module-2** |
| **Evolutionary Computation Techniques:** Evolution in nature-Fundamentals of Evolutionary algorithms-Working Principles of Genetic Algorithm- Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation- Issues in GA implementation- GA based Economic Dispatch solution-Fuzzy Economic Dispatch including losses- Tabu search algorithm for unit commitment problem-GA for unit commitment-GA based Optimal power flow- GA based state estimation. |
| **Module-3** |
| **Particle Swarm Optimization:** Fundamental principle-Velocity Updating-Advanced operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues- Convergence issues- PSO based OPF problem and unit commitment-PSO for reactive power and voltage control- PSO for power system reliability and security. |
| **Module-4** |
| **Advanced Optimization Methods:** Simulated annealing algorithm-Tabu search algorithm-SA and TS for unit commitment-Ant colony optimization- Bacteria Foraging optimization. |
| **Module-5** |
| **Multi Objective Optimization:** Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-Economic Emission dispatch using MOGA-Multiobjective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO) **–**Multiobjective OPF problem. |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2ndEdition, PHI learning private limited, 2010.
2. Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms" , John Wiley and Sons, 2008.
3. Kalyanmoy Deb, "Optimization for Engineering Design",Prentice hall of India first edition,1988.
4. Carlos A.Coello Coello, Gary B.Lamont, David A.Van Veldhuizen, "Evolutionary Algorithms for solving Multi Objective Problems", 2ndEdition, Springer, 2007.
5. SolimanAbdel Hady,Abdel Aal Hassan Mantawy, "Modern optimization techniques with applications in Electric Power Systems" ,Springer,2012.
6. Jizhong Zhu," Optimization of power system operation",John Wiley and sons Inc publication,2009.
7. Kwang Y.Lee,Mohammed A.El Sharkawi, "Modern heuristic optimization techniques", John Wiley and Sons,2008.


**Web links and Video Lectures (e-Resources):**

https://nptel.ac.in/courses/108101040
https://onlinecourses.nptel.ac.in/noc22_ee35/preview
https://nptel.ac.in/courses

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand. | |
| CO2 | Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. | |
| CO3 | Solve specialized linear programming problems like the transportation and assignment problems. | |
| CO4 | Solve network models like the shortest path, minimum spanning tree, and maximum flow problems. | |
| CO5 | Model a dynamic system as a queuing model and compute important performance Measures | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| POWER SYSTEM PLANNING AND RELIABILITY | | | |
|---|---|---|---|
| Course Code | MEPS204 | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- 

| **Module-1** |
|---|
| Generating System Reliability Analysis – I.<br>Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices – Examples |
| **Module-2** |
| Generating System Reliability Analysis – II<br>Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2- level daily load representation - merging generation and load models – Examples |
| **Module-3** |
| Operating Reserve Evaluation: Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units – Modelling using STPM approach. Bulk Power System Reliability Evaluation. Basic configuration – conditional probability approach – system and load point reliability indices – weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures |
| **Module-4** |
| Inter Connected System Reliability Analysis :Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads – Expression for cumulative probability and cumulative frequency |
| **Module-5** |
| Distribution System Reliability Analysis – I (Radial configuration) :Basic Techniques – Radial networks – Evaluation of Basic reliability indices, performance indices – load point and system reliability indices – customer oriented, loss and energy oriented indices – Examples |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. Reliability Evaluation of Power Systems, Roy Billinton and Ronald N. Allan, Plenum press, New York and London, 1996 Second Edition
2. Reliability Modeling in Electric Power Systems, J. Endrenyi, John Wiley and Sons, 1978, First Edition
3. Electricity Economics & Planning, T. W. Berrie, Peter Peregrinus Ltd., London
4. Power System Planning, R.L. Sullivan, Tata McGraw Hill Publishing Company Ltd .


**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand and distinguish characteristics of distribution systems from transmission systems | |
| CO2 | Understand causes and types of failures in distribution transformers | |
| CO3 | To design, analyse and evaluate distribution system design based on forecasted data | |
| CO4 | Identify and select appropriate sub–station location | |
| CO5 | Design and evaluate a distribution system for a given geographical service area from alternate design alternatives | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| CONTROL AND INTEGRATION OF RENEWABLE ENERGY SOURCES | | | |
|---|---|---|---|
| Course Code | MEPS215B | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- 

| **Module-1** |
|---|
| **Introduction:** Electric grid, Utility ideal features, Supply guarantee, power quality, Stability and cost; Importance & Effects of Renewable Energy penetration into the grid, Boundaries of the actual grid configuration, Consumption models and patterns. |
| **Module-2** |
| **Dynamic Energy Conversion Technologies:** Introduction, types of conventional and nonconventional dynamic generation technologies, principle of operation and analysis of reciprocating engines, gas and micro turbines, hydro and wind based generation technologies. |
| **Module-3** |
| **Static Energy Conversion Technologies:** Introduction, types of conventional and nonconventional static generation technologies; Principle of operation and analysis of fuel cell, photovoltaic systems and wind generation technologies; MPPT techniques and its classifications, principle of operation and partial shading effects; Storage Technologies -batteries, fly wheels, super capacitors and ultra-capacitors. |
| **Module-4** |
| **Control Issues and Challenges:** Linear and nonlinear controllers, predictive controllers and adaptive controllers, Load frequency and Voltage Control, PLL, Modulation Techniques, Control of Diesel, PV, wind and fuel cell based generators, Dimensioning of filters, Fault-ride through Capabilities. |
| **Module-5** |
| **Integration of Energy Conversion Technologies:** Introduction & importance, sizing, Optimized integrated systems, Interfacing requirements, Distributed versus Centralized Control, Grid connected Photovoltaic systems – classifications, operation, merits & demerits; Islanding Operations, stability and protection issues, load sharing, operation & control of hybrid energy systems, Solar Photovoltaic applications. IEEE & IEC standards for renewable energy grid integrations. |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. Renewable and Efficient Electric Power Systems, G. Masters, IEEE-John Wiley and Sons Ltd. Publishers, 2013, 2nd Edition.
2. Microgrids and Active Distribution Networks, S. Chowdhury, S. P. Chowdhury, P. Crossley, IET Power Electronics Series, 2012.
3. Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali and Min Dai, John Wiley publishing company, 2010, 2nd Edition.
4. Fundamentals, technologies & Applications, Chetan Singh Solanki, Solar Photovoltaic, PHI Publishers, 2019, 3rd Edition.
5. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Quing-Chang Zhong, IEEE-John Wiley and Sons Ltd. Publishers, 2013, 1St Edition.
6. Power Conversion and Control of Wind Energy Systems, Bin Wu, Yongqiang Lang, Navid Zargari, IEEE- John Wiley and Sons Ltd. Publishers, 2011, 1st Edition.
7. Report on "Large Scale Grid Integration of Renewable Energy Sources - Way Forward" Central Electricity Authority, GoI, 2013.


**Web links and Video Lectures (e-Resources):**

https://nptel.ac.in/courses/103103206
https://archive.nptel.ac.in/courses/108/107/108107113/
https://www.youtube.com/watch?v=cGHlV0EavaQ
https://www.youtube.com/watch?v=sob03s6d5_s
https://www.digimat.in/nptel/courses/video/108107113/L01.html

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the actual configuration of electric grid, its utilization and various scenarios related to the grid. | |
| CO2 | Understand the process of power generation by renewable energy sources and the configuration of various dynamic energy systems. | |
| CO3 | Understand the static generation technologies, its classification and various forms of energy storage and their importance. | |
| CO4 | Acquire knowledge on types of controllers and modulation techniques in order to deal with the different control issues. | |
| CO5 | Analyse the performance of grid connected system. Understand the various standards and quality issues for grid integration. Know IEEE & IEC standards for renewable energy grid integrations. | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| ADVANCED POWER SYSTEM PROTECTION | | | |
|---|---|---|---|
| Course Code | MEPS215C | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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| **Module-1** |
|---|
| **STATIC RELAYS & COMPARATORS:** Static relays - Basic construction of Static relays – Level detectors – Replica Impedance-Mixing circuits-General equation for two input phase and Amplitude Comparators – their types – Duality between Amplitude and Phase Comparator –Conic section characteristics–Three input Amplitude Comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes-Phase faults scheme –Three phase scheme–Combined and Ground fault scheme |
| **Module-2** |
| **TYPES OF STATIC RELAYS:** Instantaneous over current relay – Time over current relays - Basic principles - Definite time and Inverse definite time over current relays, directional over current relays - Static Differential Relays-Analysis of static differential relays–Static relay schemes-Dual bias transformer differential protection – Harmonic restraint relay. |
| **Module-3** |
| **NUMERICAL RELAYS**: Advantages of Numerical Relays – Numerical network-Digital Signal processing– Estimation of Phasors – Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm- practical considerations for selection of Algorithm– Discrete Fourier Transform |
| **Module-4** |
| **DISTANCE RELAYS AND POWER SWINGS:** Static Distance Relays - Static Impedance - reactance - MHO and Angle Impedance relay sampling comparator – Realization of reactance and MHO relay using a sampling comparator. 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 length and source impedance on distance relays. |
| **Module-5** |
| **MICROPROCESSOR BASED PROTECTIVE RELAYS:** Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flowchart approach only).Generalized mathematical expression for distance relays-Measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) - Basic principle of Digital computer relaying. |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**


1. Power System Protection Static Relay, T.S. Madhava Rao, Tata McGrawHill Publishing Company limited, 2nd Edition, 2004.
2. Power system Protection and Switchgear, Badri Ram and D.N. Vishwakarma, Tata McGraw Hill Publication Company limited, 2nd Edition, 2013.
3. Protection and Switchgear, Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Oxford University Press, 2nd Edition, New Delhi, India, 2018.
4. Power System Protection & Switchgear, Oza, B. A., N. C. Nair, R. P. Mehta, et al., Tata McGraw Hill, New Delhi, 1st Edition, 2011.


**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Describe the construction of static relay and identify the advantages of static relay over electromagnetic relay Analyse the importance of reliability in various fields | |
| CO2 | Explore the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi input comparators, static differential and distance relays | |
| CO3 | Describe instantaneous, definite time and inverse definite minimum time over current relays. | |
| CO4 | Analyze the concept of power swings on distance relays and to identify the microprocessor based protective relays and their operation | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
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**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| THERMAL SCIENCE AND ENGINEERING | | | |
|---|---|---|---|
| Course Code | MEPS215D | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- 

| **Module-1** |
|---|
| First and second law of thermodynamics, Thermal fluid systems, Standard cycles, Mixtures of gases, Heat transfer, Fluid mechanics, Practical examples, Use of steam tables. Theory of heat conduction. |
| **Module-2** |
| Mathematical and numerical analysis of two dimensional heat conduction with and without internal heat generation. |
| **Module-3** |
| Mathematical and numerical analysis of transient and periodic state heat conduction. Theory of convective heat transfer, Boundary layer theory. |
| **Module-4** |
| Heat transfer in duct flow, laminar and turbulent, Heat exchangers, Radiation heat transfer, between black and grey bodies. |
| **Module-5** |
| Laws of radiation heat transfer, Numerical solution of radiation network analysis. |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

1. Thermal engineering by Sarkar, Tata McGraw Hill
2. Thermodynamics: An Engineering Approach by Yunus A Cengel; Michael A Boles, McGraw Hill
3. 3. Heat and Mass Transfer: Fundamentals and Applications by Yunus A Cengel; Afshin J. Ghajar, McGraw Hill
4. Fundamentals of Thermal - Fluid Sciences by Yunus A. Cengel, McGraw Hill

**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Learn application of basic concepts of heat and mass transfer. However, mathematical hands on practice will be carried out to assess the various heat transfer methods. | |
| CO2 | Acquire knowledge about the use of the various mathematical tools and thermodynamic graphs will also be addressed and discussed. | |
| CO3 | Understand requirement of steam as a working substance for power generation or for process and space heating etc. | |
| CO4 | Understand the Classification of Boilers, mounting and accessories, Boiler performances equivalent evaporation and boiler efficiency. | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| DISTRIBUTION SYSTEM PLANNING AND AUTOMATION | | | |
|---|---|---|---|
| Course Code | MEPS216A | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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| **Module-1** |
|---|
| Distribution System Planning: Planning and forecasting techniques – Present and future – Role of computers- Load Characteristics- Load forecasting using ANN – Load management – tariffs and metering of energy |
| **Module-2** |
| Distribution Transformers: Types – Three phase and single phase transformers – connections – causes and types of failures in distribution transformers<br>Primary distribution systems and Distribution Sub–Stations: Distribution substations –Bus schemes – comparison of switching schemes- Substation location and rating- Types of feeders – voltage levels |
| **Module-3** |
| Voltage Drop and Power Loss Calculations: Three phase primary lines – Copper loss – Distribution feeder costs – Loss reduction and Voltage improvement in rural networks<br>Capacitors In Distribution Systems: Effects of series and shunt capacitors – justification for capacitors – Procedure to determine optimum capacitor size and location |
| **Module-4** |
| Distribution System Automation: Reforms in power sector – Methods of improvement – Reconfiguration – Automation – Communication systems – Sensors –Basic architecture of Distribution automation system – software and open architecture – RTU and Data communication – SCADA requirement and application functions – Communication media for distribution system automation- Communication protocols for Distribution systems – IEC 61850 and IEEE 802.3 standards |
| **Module-5** |
| Distribution system management: Integrated sub–station metering system – Revenue improvement – issues in multi–year tariff and availability based tariff |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. Electric Power Distribution, Automation, Protection and Control, James A Momoh, CRC press, 2001
2. Electric Power Distribution, A. S. PABLA, TMH,2000
3. Electric Power Distribution Engineering, Turan Gonen, Mc-Graw Hill,1986
4. A Textbook of Electric Power Distribution Automation, Dr. M.K. Khedkar, Dr. G.M. Dhole, Laxmi Publications Ltd., 2010


**Web links and Video Lectures (e-Resources):**

https://www.youtube.com/channel/UCWKPXSjLRz-TAFgFWCfMmGg/videos

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand and distinguish characteristics of distribution systems from transmission systems | |
| CO2 | Understand causes and types of failures in distribution transformers | |
| CO3 | To design, analyse and evaluate distribution system design based on forecasted data | |
| CO4 | Identify and select appropriate sub–station location | |
| CO5 | Design and evaluate a distribution system for a given geographical service area from alternate design alternatives | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
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| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| DEMAND SIDE MANAGEMENT AND INTEGRATION OF ENERGY | | | |
|---|---|---|---|
| Course Code | MEPS216B | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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| **Module-1** |
|---|
| Introduction and Concept of DSM-The concepts and methods of DSM -Load control, Energy efficiency, Load management; DSM planning, design, marketing; Impact assessment. Customer load control- Direct, Distributed, and Local control, Interruptible load; Configuration of control system for load control; Assessment of Impact on load shape. |
| **Module-2** |
| Strategic Conservation and Load Management Technologies-Strategic conservation via improving building envelope, Air-conditioning, Lighting; Electric motor, and other industrial processes and equipment; Load shifting and load leveling through Thermal Energy Storage. |
| **Module-3** |
| Programs & Incentives for Customers, Customer Incentives, Program Marketing Design and PenetrationType of incentives and programs, Program design; Use of Analytic Hierarchical Process for assessment of Customer Acceptance and Program penetration. |
| **Module-4** |
| Assessment of Impact on System Load Shape Energy Audit and assessment of customers' load shape for different customer groups; Impact of DSM programs on load shapes in customer groups, Categorized in economic sub sectors, and by geographical location, Cost/Benefit Analysis and Feasibility of DSM Program DSM program costing and Load Shape Impact on system; DSM program cost/benefit and Feasibility; Environmental benefits. |
| **Module-5** |
| Integrated Electric Utility Service under Deregulated Situation. Institutional, Legal, and Political environments and the stages of development of Electric Utility Service; The mechanism of competition and development of the financial environment for economic utilization of resources for electric service |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

1. Demand Side Management, Jyothi Prakash, TMH Publishers.
2. Energy management hand book by W.C.Turner, John Wiley and sons 3. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern, 2005.

**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Learn special skills particularly on the load management and control strategies. | |
| CO2 | Learn the different schemes to find/calculate demand/load of particular sector | |
| CO3 | Learn the working of different Instruments/Devices used to measure/calculate Demand/load of particular sector | |
| CO4 | Decide the true energy pricing for each particular site specifically. | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| TRANSIENTS IN POWER SYSTEM | | | |
|---|---|---|---|
| Course Code | MEPS216C | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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| **Module-1** |
|---|
| **Lightning Overvoltages:** Classification of over voltages- Mechanism and parameters of lightning flash, protective shadow, striking distance, electro geometric 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. |
| **Module-2** |
| **Switching And Temporary Overvoltages:** Switching transients – concept – phenomenon – system performance under switching surges- Ferranti Effect, Temporary overvoltages – load rejection – line faults – ferroresonance, VFTO. |
| **Module-3** |
| **Travelling Waves On Transmission Line:** Circuits and distributed constants, wave equation, reflection and refraction – behaviour of travelling waves at the line terminations – Lattice Diagrams – attenuation and distortion – multiconductor system and multivelocity waves. |
| **Module-4** |
| **Insulation Co-Ordination:** Insulation co-ordination –volt –time characteristics, Insulation strength and their selection Evaluation of insulation strength standard BILs-Characteristics of protective devices, applications, location of arresters – insulation co-ordination in AIS and GIS. |
| **Module-5** |
| **Computation of Power System Transients:** Computation of transients using electromagnetic transient program-Modelling of power system components- Simple case studies - Application of simplified method: single line station, two line station, gas insulated substations, comparison with IEEE and IEC guides. |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**


1. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.
2. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 2012.
3. Andrew R. Hileman, "Insulation Coordination for Power Systems", CRC press, Taylor & Francis Group, New York, 1999.
4. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
5. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Second edition) Newage International (P) Ltd., New Delhi, 2006.
6. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
7. IEEE Guide for safety in AC substation grounding IEEE Standard 80-2000.
8. Working Group 33/13-09 (1988), 'Very fast transient phenomena associated with Gas Insulated System', CIGRE, 33-13, pp. 1-20.
9. R. Ramanujam, "Computational Electromagnetic Transients: Modeling, Solution Methods and Simulation", I.K. International Publishing House Pvt. Ltd, New Delhi -110 016, 2014


**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Analyse various sources of transients | |
| CO2 | Compute possible overvoltages in power systems | |
| CO3 | Predict overvoltages in power system using travelling wave theory | |
| CO4 | Compute overvoltages using EMTP with multiple sources | |
| CO5 | Coordinate the insulation level of the power system | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
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**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
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**Semester- II**

| POWER SYSTEM DEREGULATION | | | |
|---|---|---|---|
| Course Code | MEPS216D | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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| **Module-1** |
|---|
| Indian power sector-past and present status, overview of growth of power sector in India. Players in the Indian power sector. Reforms in the Indian power sector. Fundamentals of Economics: Consumer and supplier behaviour, Market equilibrium. |
| **Module-2** |
| Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service - ancillary service –Co-optimization of energy and reserve services. |
| **Module-3** |
| Deregulation of power industry, restructuring process, issues involved in deregulation, competitive market structure of deregulated power system, operation and control aspects of deregulated power system. |
| **Module-4** |
| Transmission Open Access and Pricing Issues: Introduction, power wheeling, transmission open access, cost components in transmission, pricing of power transactions, transmission open access and pricing mechanisms in various countries. |
| **Module-5** |
| Transmission Congestion Management and Pricing- transmission cost allocation methods, LMP, FTR and Congestion Management. Role of FACTS devices in competitive power market, Available Transfer Capability, Distributed Generation in restructured markets. |

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

## Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

## Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Books**


1. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.
2. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" Pub., 2001.
3. W. H. J. R. Dunn, M. A. Rossi, B. Avaramovic: Impact of market restructuring on power systems operation, IEEE computer Applications on Power Engineering, vol. 8, January 1995, pp 42–47.
4. Understanding electric utilities and de-regulation, Lorrin Philipson, H. Lee Willis, Marcel Dekker Pub., 1998.


**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

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**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the need for restructuring of Power Systems, discuss different market models, and market power. | |
| CO2 | Understand the functioning and planning activities of Independent System Operator (ISO). | |
| CO3 | Understand the different utilizes participated in electricity market. | |
| CO4 | Understand transmission open access pricing issues and congestion management. | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3 | | | | | | | | | | |
| CO4 | | | | | | | | | | |
| CO5 | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| POWER SYSTEMS COMPUTATION LAB -1 | | | |
|---|---|---|---|
| Course Code | MEPSL207 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 1:0:2 | SEE Marks | 50 |
| Credits | 2 | Exam Hours | 03 |

**Course objectives:**

- .

| Sl.NO | Experiments |
|---|---|
| 1 | Develop program for $Y_{bus}$ Matrix using Singular Transformation Method. |
| 2 | Develop program for $Y_{bus}$ Matrix with Tap change Transformer using inspection method. |
| 3 | Develop program for $Z_{bus}$ using building algorithm procedure. |
| 4 | Develop program for Performance of Transmission Line models. |
| 5 | Develop program for Gauss Seidel Load Flow Analysis. |
| 6 | Develop program for Newton Raphson Load Flow Analysis (Polar coordination). |
| 7 | Develop program for Fast Decoupled Load Flow Analysis. |
| 8 | Develop program for Short Circuit Analysis (LG, LLG and LLL Faults) |
| 9 | Develop program for security analysis and contingency ranking using load flow. |
| 10 | Develop the program to solve economic load dispatch problem without and with loss. |
| 11 | Develop program to study the effect of pole placement on system. |
| 12 | Develop program to convert the given transfer function into diagonal canonical form. |
| | **Demonstration Experiments ( For CIE ) if any** |

**Course outcomes (Course Skill Set):**

At the end of the course the student will be able to:

- .

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

**Continuous Internal Evaluation (CIE):**

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14$^{th}$ week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marks is scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

**Semester End Evaluation (SEE):**

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly

by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

**Suggested Learning Resources:**

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**Web links and Video Lectures (e-Resources):**

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**Skill Development Activities Suggested**

- 

**Course outcome (Course Skill Set)**

At the end of the course the student will be able to :

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | | |
| CO2 | | |
| CO3 | | |

**Program Outcome of this course**

| Sl. No. | Description | POs |
|---|---|---|
| | | |
| | | |

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | |
| **CO2** | | | | | | | | | | |
| **CO3** | | | | | | | | | | |
| **CO4** | | | | | | | | | | |
| **CO5** | | | | | | | | | | |
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