University Institute of Technology (UIT)

Silver Wood Estate, H. P. University, Shimla-171005

(NAAC accredited "A-Grade" University)

DEPARTMENT
of
ELECTRICAL ENGINEERING

Course Structure & Syllabus

for

Master of Technology

in

Electrical Engineering

(Power & Energy Systems)

Semester I-IV

Effective for the session 2024-2025 and onwards

Course Structure & Scheme

University Institute of Technology (UIT), HPU Shimla

[Electrical Engineering Department]

M. Tech in Electrical Engineering (Power and Energy Systems)

(i) Semester I

S. No.	Subject Code	Course Title	L	T	P	Hours/ week	Credit	Marks	
								Ext	Int
1	MEE-1001	Power System Analysis and	4	0	0	4	4	100	50
2	MEE-1002	Advanced Relaying and Protection	4	0	0	4	4	100	50
3	MEE-1003	Renewable and Distributed Generation Systems	4	0	0	4	4	100	50
4	MEE-1004	Optimization Technique	4	0	0	4	4	100	50
5	MEE-1005	Power System Design & Analysis Lab	0	0	4	4	2	50	50
6	MPEE-XXXX	Elective-I	4	0	0	4	4	100	50
Total			**20**	**0**	**4**	**24**	**22**	**850**	

(ii) Semester II

S. No.	Subject Code	Course Title	L	T	P	Hours/ week	Credit	Marks	
								Ext	Int
1	MEE-2001	Power Generation Operation & Control	4	0	0	4	4	100	50
2	MEE-2002	Power Systems Restructuring and Deregulation	4	0	0	4	4	100	50
3	MEE-2003	Grid Integration of Renewable Energy	4	0	0	4	4	100	50
4	RM-1001	Research Methodology	3	0	0	3	3	100	50
5	MPEE-XXXX	Elective-II	4	0	0	4	4	100	50
6	MEE-2004	Power and Energy System Simulation Lab	0	0	4	4	2	50	50
Total			**19**	**0**	**2**	**23**	**21**	**850**	

(iii) Semester III

S. No.	Subject Code	Course Title	L	T	P	Credit	Marks	
							Ext	**Int**
1.	EE-301	Dissertation Phase - I	0	0	24	12	250	100
		Total	**0**	**0**	**24**	**12**	**250**	**100**

(iv) Semester IV

S. No.	Subject Code	Course Title	L	T	P	Credit	Marks	
							Ext	**Int**
1.	EE-401	Dissertation Phase - II	0	0	30	15	250	100
		Total	**0**	**0**	**30**	**15**	**250**	**100**

Total Credits of the Program = 70

**The dissertation evaluation shall be done twice in a semester (mid-semester at the internal level and end semester at the external level by the Departmental Master Program Committee (DMPC) under the Faculty of Engineering and Technology as mentioned on the last page).*

DETAILED SYLLABUS

Name of the Course	Power System Analysis and Design		
Course Code	**MEE-1001**	**Credits-4**	**L-4, T-0, P-0**
Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Seminar 10%, Attendance 10%)			**Max Marks: 50**
Instructions			
For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.			
For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.			

Course Objectives

- To develop a detailed understanding of the range of analysis tools applied to the operation, design and investigation of modern electric power systems.
- To Model and predict the operation of power system components, including three phase fault studies, stability studies and power system security.
- To enable the students to understand the load flow techniques and monitoring of power system that cause the smooth and reliable operation of complex power system.

SECTION	COURSE CONTENTS
SECTION A	Load Flow: power flow analysis, Newton Raphson method, decoupled and fast decoupled method. Optimal Power Flow: Formulation of the Optimum power flow problem, Solution of Optimum Power flow problem using Gradient method and linear programming technique. Contingency evaluation: Necessity of contingency evaluation in power system, contingency ranking for real and reactive contingencies, method of distribution factors for line and generation outages
SECTION B	Sequential solution technique. Fault Studies: Analysis of three phase symmetrical and unsymmetrical faults in phase and sequence domain, phase shift in sequence quantities due to transformer, open circuit faults. Stability Studies.
SECTION C	Transient stability analysis, swing equation, stability of multimachine system using modified Euler method and Runge-Kutta method. Power System Security: Factors affecting security, State transition diagram, contingency analysis using network sensitivity method and AC power flow method.

SECTION D	State Estimation: Introduction, power system monitoring, energy management system (EMS), SCADA, function of state estimator, maximum likelihood estimation.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Develop model of power system components suitable for various power system studies.

CO2: Carry out studies required for the modern power system operation during normal/abnormal condition.

CO3: Simulate and analyze contingencies required to ensure power system security.

CO4: Understand the hierarchy of power system control.

CO5: Understand the techniques involved in the condition monitoring of power systems.

Text Books:

1. Modern Power System Analysis by D. P. Kothari and I. J. Nagrath, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Power System Analysis by Hadi Saadat, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Computer Aided Power System Analysis by George L. Kusic, Prentice Hall of India (P) Ltd., New Delhi.
4. Computer Modelling of Electric Power System by J. Arrilaga, C. P. Arnold, B. J. Harker, John Wiley & Sons. K. Mahailnaos.
5. Understanding FACTS Concepts and Technology of Flexible AC Transmission System by N.G. Hingorani and L.Gyugyi.

Name of the Course	**Advanced Relaying and Protection**		
Course Code	**MEE-1002**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**
Instructions			
For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.			
For Candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.			

Course Objectives

- To understand the general philosophy of protection, selection criteria, parameters of protection and fault calculations.
- To identify the need and type of relays and their applications with design.
- To enable the students to understand the concept of modern coordinated control and protection of power system.

Section	Course Content
Section A	Static Relays: Advantages of static relays – Basic construction of static relays – Level detectors – Replica impedance – Mixing circuits – General equation for two input phase and amplitude comparators -Duality between amplitude and phase comparators. Amplitude Comparators: Circulating current type and opposed voltage type – rectifier bridge comparators, Direct and Instantaneous comparators.
Section B	Phase Comparators: Coincidence circuit type – block spike phase comparator, techniques to measure the period of coincidence – Integrating type – Rectifier and Vector product type – Phase comparators. Static Over Current Relays: Instantaneous over-current relay – Time over-current relays-basic principles – definite time and Inverse definite time over-current relays.
Section C	Static Differential Relays: Analysis of Static Differential Relays – Static Relay schemes – Duo bias transformer differential protection – Harmonic restraint relay. Static Distance Relays: Static impedance-reactance – MHO and angle impedance relay-sampling comparator – realization of reactance and MHO relay using sampling comparator.
Section D	Multi-Input Comparators: Conic section characteristics -Three input amplitude comparator – comparator-switched distance schemes – Poly phase distance schemes – phase fault scheme – three phase scheme – combined and ground fault scheme. Microprocessor Based Protective Relays: (Block diagram and flowchart approach only) – Over current relays – impedance relays – directional relay – reactance relay – Generalized mathematical expressions for distance relays – MHO and offset MHO relays.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify different power system protection techniques and fault calculations and evaluation.

CO2: Describe principles like differential protection, distance protection, overcurrent protection and carrier current protection.

CO3: Apply principles and algorithms of digital protection schemes and microprocessor based relay in power system.

CO4: Assess the results obtained by applying above techniques of protection.

Books and References

1. Digital protection for power systems by A. T. John and A K Salman- -IEE power series-15, Peter Peregrines Ltd, UK.
2. The art and science of protective relaying by C.R. Mason, John Wiley & Sons.
3. Protective Relays, Vol. 1&2 by A.R. Warrington, Chapman and Hall.
4. Power system protection static relays with microprocessor applications by T S. Madhav Rao, Tata McGraw Hill Publication.
5. Protective Relaying, Principles and Applications by Blackburn, J. Lewis, Marcel Dekker, Inc.
6. Digital Protection, Protective Relaying from Electromechanical to Microprocessor by Singh L.P, John Wiley & Sons.

Name of the Course	Renewable and Distributed Generation Systems		
Course Code	**MEE-1003**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:

The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To illustrate the concept of distributed generation
- To analyse the impact of grid integration
- To understand storage technologies, and distribution protection system
- To study concept of Microgrid and its configuration.

SECTION	COURSE CONTENTS
SECTION A	Introduction: Overview of power, DG definition, Distributed generation advantages and needs, Basic models of DG systems, Integration in power systems. Generation resources: Photovoltaic, Solar-thermal power generation, Wind power generation, Other renewables like geothermal, tidal, wave, etc.
SECTION B	Effects of renewable energy into the grid; Stability, Supply guarantee and power quality, Issues related to bidirectional power flow on network; voltage control, system protection. Energy storage: Battery, Ultra capacitors, Flywheel, Compressed air, etc.
SECTION C	Electric Vehicles: EV interests, Random generation forecast corrections, - EV needs according to users and grid exigencies, Dimension and security according to EV needs, - Batteries and chargers, Standard UNE 61851. EV conductive system.
SECTION D	Micro-Grid: Resources evaluation and needs, Dimensioning integration systems, Optimizing, Case study: multi-generation buildings. Smart grid: Concepts, Application of ICT in smart grid.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Review the conventional power generation

CO2: Analyze the concept of distributed generation and installation
CO3: Design the grid integration system with conventional and non-conventional energy sources
CO4: Design the dc and ac micro grid
CO5: Analyze power quality issues and control operation of micro grid

Text Books:

1. AJ. Pansini, Guide to Electrical Power Distribution Systems, 2005, The Fairmont Press Inc.
2. Ann-Marie Borbely, Jan F. Kreider, Distributed Generation, 200 I, CRC Press.
3. Felix A. Farret and M. Godoy Simoes, Integration of Alternative Sources of Energy, John Wiley and Sons, 2006.
4. Bollen, Hassan, Integration of Distributed Generation in the Power System, Wiley- IEEE Press, 2011 .
5. H. Lee Willis, Walter G. Scott, Distributed Power Generation, Planning & Evaluation, CRC Press Taylor & Francis Group, 2000

Name of the Course	Optimization Technique		
Course Code	MEE-1004	Credits-4	L-4, T-0, P-0
Total Lectures	4 Hours/Week		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To impart knowledge about the principles of optimizationtechniques.
- To introduce the fundamental concepts relevant to classical optimization methods, linear programming, nonlinear programming and dynamicprogramming.
- To enable the students to understand the factors that cause the different optimization methods to provide different solutions for the same mathematicalproblem.

SECTION	COURSE CONTENTS
SECTION A	Introduction to optimization; Objective function; Constraints and Constraint surface; Classification of optimization problems; Optimization techniques – classical and advanced techniques, linear programming (LP) problem; Elementary operations; Graphical method for two variable optimization problem; Examples; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion;
SECTION B	Gradient vectors; Examples; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to inequality constraints; Hessian matrix formulation; Eigen values. Kuhn- Tucker Conditions; Examples, nonlinear programming, one dimensional minimization methods, unconstrained optimization methods, direct search methods, descent methods, 2nd order methods, constrained optimization, indirect methods
SECTION C	Introduction to dynamic programming, sequential optimization; representation of multistage decision process; types of multistage decision problems; concept of sub optimization and the principle of optimality; Recursive equations – Forward and backward recursions
SECTION D	Evolutionary Optimization Techniques: Evolution in Nature-Fundamentals of Evolutionary Algorithms-Working Principles of Genetic Algorithm, Genetic Operators: Selection, Crossover and Mutation, Issues in GA implementation, anatomy of a particle equations based on velocity and positions -PSO topologies - control parameters – GA and PSO algorithms for solving ELD problem.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify different types of optimization techniques and problems.

CO2: Describe techniques like calculus based classical optimization, linear programming, nonlinear programming, dynamic programming.

CO3: Apply principles and techniques described in CO2 to solve sample mathematical and practical optimization problems.

CO4: Assess the results obtained by applying optimization techniques to solve mathematical programming

Text Books:

1. Engineering Optimization: Theory and Practice by S.S. Rao, New Age International (P) Ltd.,New Delhi.
2. Numerical optimization with applications by Suresh Chandera, Jaydeva, and Aparna Mehta Publisher: Narosa
3. An Introduction to optimization by Edvin K.P. Chong, and Stanislaw H. Zak Publisher: John Wiley.
4. Optimization theory and practice by Mohan C. Joshi and Kannan M Moudgalya, Publisher: Narosa.

Name of the Course	Power System Design & Analysis Lab		
Course Code	MEE-1005	Credits-2	L-0, T-0, P-4
Total Lectures	4 Hours/Week		
Semester End Examination	Max Marks: 50	Min. Pass Marks: 20	Max. Time: 3 Hrs.
Internal Assessment: (based on continuous Lab Work Assessment: 20%, Experiment Perpormance:30%, Attendance 10%, Viva:40%)			Max Marks: 50

Course Objectives

- An ability to design a system, component, process to meet desired needs with in realistic constraints.
- To provide skills for developing Simulink model of practical problems and analyzing their results on MATLAB.
- To able the students to demonstrate a mastery in the area of power system design using MATLAB.

List of Experiments

1. To compute the bus admittance matrix (Ybus) for a given power system network.
2. To compute the power-flow solution of a given power system network using the Gauss-Siedel method.
3. To compute the power-flow solution of a given power system network using the Newton-Raphson algorithm.
4. To compute the power-flow solution of a given power system network using the fast-decoupled power-flow algorithm.
5. To compute the bus impedance matrix of a given power system network in MATLAB using Z bus building algorithm.
6. To carry out symmetrical fault analysis in a given power system network using MATLAB.
7. Small signal stability analysis of standard test systems in MATLAB.
8. Determine the critical clearing time for a given single machine infinite bus system.
9. To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.
10. To Determine Fault Currents and Voltages in a Single Transmission Line System With Star-Delta Transformers at a Specified Location for LG and LLG faults by simulation

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Working of Power system problems and model them in MATLAB.
CO2: Analyse, simulate, and design 3 phase converter, cycloconverter and chopper using MATLAB Simulink.
CO3: Design and implementation of power system, modelling and filter design.

Name of the Course	RESEARCH METHODOLOGY		
Course Code	**RM-1001**	**Credits-3**	**L-3, T-0, P-0**
Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates:
Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- To understand the requirements for the research.
- To understand power research components and methods of research.
- To understand some basic concepts of research and its methodologies
- To identify appropriate research topics, select and define appropriate research problem and parameters.

SECTION	COURSE CONTENTS
SECTION A	Research Aptitude: Meaning of Research, Objectives of Research, and Motivation in Research, Types of Research, Research Approaches, and Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done. Research Process: Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis - meaning, types, development of hypothesis and its testing, Meaning & Functions of Research Design
SECTION B	Data Analysis: Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with database statistical functions, using correlation, Multiple Regression, Using Sampling to Analyse Data
SECTION C	Significance of Report Writing : Different Steps in writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Art of scientific writing- Steps to better writing, flow method, organization of material and style, Drawing figures, graphs, tables, footnotes, references etc. in a research paper

SECTION D	Use of Internet in Research Work : Use of internet networks in research activities in searching material, paper downloading, submission of papers, relevant websites for journals and related research work. Introduction to Patent laws etc., process of patenting a research finding, Copy right, Cyber laws.

Course Outcomes

Upon successful completion of course, the students will be able to

CO1: Identify and discuss the role and importance of research in the social sciences.

CO2: Identify and discuss the issues and concepts salient to the research process.

CO3: Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Text Books:

1. Kothari, C. R., "Research Methodology Methods and Techniques", Wiley Eastern Ltd
2. Wayne L. Winston, "Microsoft Excel Data Analysis and Business Modelling", Microsoft Press.
3. Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", Pearson Education.
4. Dawson, C., "Practical Research Methods", UBSPD Pvt. Ltd

Name of the Course	Power Generation Operation & Control		
Course Code	**MEE-2001**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**
Instructions			
For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.			
For Candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.			
Course Objectives • To impart knowledge about the optimization and control of power generation and transmission industry. • To introduce the fundamental concepts relevant to input-output generator characteristics, economic dispatch, unit commitment, hydro thermal scheduling, generation control and optimal power flow. • To enable the students to understand the factors that cause the optimal operation as well as control of power system possible			

SECTION	COURSE CONTENTS
SECTION A	Introduction, Characteristics of power generation units (thermal, nuclear, hydro, pumped hydro), variation in thermal unit characteristics with multiple valves, Economic dispatch with and without line losses, lambda iteration method, gradient method, lambda iteration method, gradient method, Newton's method, transmission losses, a two generation system co-ordination equations, incremental losses, penalty factors, B matrix loss formula (without derivation)
SECTION B	Methods of calculating penalty factors, unit commitment, constraints in unit commitment, spinning reserve, thermal unit constraints, hydro constraints, must run, fuel constraints, priority list method, Dynamic programming method and Lagrange relaxation methods, generation with limited energy supply, take or pay fuel supply contract, composite generation production cost function, gradient search techniques
SECTION C	Hydrothermal co-ordination, long range hydro scheduling, Short-range hydro scheduling, scheduling energy, short term hydrothermal scheduling, Lambda-gamma iteration method, gradient method, cascaded hydro plants, pumped storage hydro scheduling
SECTION D	Load forecasting: preliminary survey, some basic concepts in statistics, sources of error, estimation of deterministic part – estimation of average and trend terms, estimation of periodic components, estimation of stochastic component – time series approach.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify different power generation, operation and control problems.

CO2: Describe problems like economic dispatch, unit commitment, hydro thermal scheduling, optimal power flow, generation control.

CO3: Apply principles and algorithms of optimization to solve problems described in CO2.

CO4: Assess the results obtained by solving above problems.

Text Books:

1. Power generation operation and control by A.J wood and B.F Wollenberg, Wiley.
2. Electrical Energy system theory by O.I. Elgerd. Tata cGraw Hill, Delhi.
3. Power Systems Analysis by Hadi Saadat, McGraw-Hill Inc.
4. Power system operation and control by K Uma Rao, Wiley-India.

<table>
<tr><td>Name of the Course</td><td colspan="3">Power System Restructuring and Deregulation</td></tr>
<tr><td>Course Code</td><td>MEE-2002</td><td>Credits-4</td><td>L-4, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">4 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.</td></tr>
<tr><td colspan="4">Course Objectives
• To impart knowledge about the restructuring and deregulation of powersector.
• To introduce the fundamental concepts relevant to OASIS, congestion management etc.
• To enable the students to understand the factors related with deregulation of power industry in different countries.</td></tr>
</table>

SECTION	COURSE CONTENTS
SECTION A	Introduction: Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantages of competitive system. Power System Restructuring: An overview of the restructured power system, Difference between integrated power system and restructured power system. Explanation with suitable practical examples. Deregulation of Power Sector: Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, Multilateral trade model.
SECTION B	Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services, Transmission Pricing.
SECTION C	Open Access Same Time Information System (OASIS): Introduction, structure, functionality, implementation, posting of information, uses. Congestion Management: Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC)
SECTION D	Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC). Different Experiences in deregulation: U.S.A, Canada, U.K, Japan, Switzerland, Australia, Sweden, Germany and Indian power system.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify various concepts of restructuring and deregulation of power sector.

CO2: Describe important concepts related with deregulation like market power, OASIS, congestion management etc.

CO3: Apply principal to explain various problems related with deregulation of power sector.

Text Books:

1. Power System Restructuring and Deregulation by Loi Lei Lai, John Wiley & Sons Ltd.
2. Understanding Electric Utilities and Deregulation by Lorrin Philipson and H. Lee Willis, Marcel Dekker Inc, New York, CRC Press.
3. Power System Restructuring Engineering & Economics by Marija llic by Francisco Galiana and Lestor Fink, Kulwer Academic Publisher, USA.

Name of the Course	Grid Integration of Renewable Energy		
Course Code	**MEE-2003**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To understand the requirements for the correct integration of renewable energies into the power grid.
- To understand power electronic components necessary for energy production.
- To study the distributed generation systems..

SECTION	COURSE CONTENTS
SECTION A	**Power system operation:** Introduction on electric grid, Supply guarantees, Power quality and stability, Introduction to renewable energy grid integration, Concept of mini/micro grids and smart grids, Wind, Solar, Biomass, Power generation profiles, Load scheduling.
SECTION B	**Power Electronics**: Introduction to basic analysis and operation techniques on power electronic systems, Functional analysis of power converters, Power conversion schemes between electric machines and the grid, Power systems control using power converters.
SECTION C	Electronic conversion systems application to renewable energy generation systems, Basic schemes and functional advantages, Wind power and photovoltaic power applications. **Power Quality Improvement in Grid Integration:** Power control and management systems for grid integration, Detection systems, Synchronizing with the grid.
SECTION D	Issues in integration of converter based sources, Network voltage management, Power quality management and frequency management, Influence of PV/WECS on system transient response.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the concepts of grid integration using renewable energy sources.

CO2: Apply to use simulation tools in renewable energy system design.

CO3: Apply the concept of power electronics.

Text Books:

1. Distribution System Modeling and Analysis by W H Kersting Second Edition, CRCPres
2. Grid Integration and Dynamic Impact of Wind Energy by V Vittal and R Ayyanar, Springer
3. Design of Smart Power Grid Renewable Energy Systems by A Keyhani Wiley–IEEEPress
4. Grid Converters for Photovoltaic and Wind Power Systems by R Teodorescu, M Liserre and P Rodriguez, Wiley- IEEE Press
5. Power Electronics: Circuits, Devices and Applications by H R Muhammad, Pearson

Name of the Course	Power and Energy System Simulation Lab		
Course Code	MEE-2004	Credits-1	L-0, T-0, P-4
Total Lectures	4 Hours/Week		
Semester End Examination	Max Marks:50	Min. Pass Marks: 20	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:

The question paper will consist of five Sections A, B, C, D & E. Section E will becompulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semesterend examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of thesemester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To provide power system-based problem-oriented knowledge, analyzing them in MATLAB framework.
- To address the concepts & approaches behind analysis of complex power system network using MATLAB.
- To formulate solutions of problems and implemented their algorithm in MATLAB.

List of Experiments

1. Using Lambda-iteration technique Economic load dispatch with/without losses of standard test systems using MATLAB
2. Implementation of unit commitment problems using lagrangian relaxation method and dynamic programming method usingMATLAB.
3. Implementation of Alfa- Lambda-iteration technique for hydro scheduling using MATLAB.
4. MATLAB modelling and analysis of automatic load frequency control of multi- area power systems.
5. Implementation of optimal power flow problem considering classical and meta-heuristic techniques using MATLAB.
6. MATLAB modelling of power electronic 3 phase, 6 pulse converters using PWM technique.
7. MATLAB modelling of power electronic chopper using any commutation technique.
8. Simulation study on Wind Energy Generator.
9. MATLAB modelling of solar PV boost converter using P&O MPPT technique.
10. Evaluation of active and reactive power & apparent energy flow between grid tied inverter, grid & load concept.
11. Simulation study on Intelligent Controllers for renewable energy systems.
12. Study of neural network graphical user interface tool in MATLAB.

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the power system problem and find the solution of the same.

CO2: Identify and achieve the programming task involved of a given problem such as OPF, economic load dispatch etc.

CO3: Do the analysis of various power system problems and find their solution using MATLAB.

Electives

List of Electives-I for M. Tech in Electrical Engineering (Power and Energy Systems)

S. No.	Subject Code	Course Title	L	T	P	Credit
1.	EL- 011	AI Techniques and Applications	4	0	0	4
2.	EL -012	Genetic Algorithm and Evolutionary Programming	4	0	0	4
3.	EL -013	Flexible AC Transmission System	4	0	0	4

List of Electives-II for M. Tech in Electrical Engineering (Power and Energy Systems)

S. No.	Subject Code	Course Title	L	T	P	Credit
1.	EL -021	Energy Policy Analysis	4	0	0	4
2.	EL -022	Energy Auditing & Management	4	0	0	4
3.	EL -023	Economics & Planning of Energy	4	0	0	4

*The candidate may choose any elective course from the list given above, in consultation with his/her thesis supervisor

Name of the Course	AI Techniques and Applications		
Course Code	**EL-011**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**
Instructions			
For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.			
For Candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.			

Course Objectives

- To impart knowledge about the application of artificial intelligence techniques in electrical engineering.
- To introduce the fundamental concepts relevant to fuzzy logic, artificial neural network, geneticalgorithm, Evolutionary techniques and Hybrid systems.
- This activity aims to get students thinking critically about what specialty makes humans intelligent, and how computer scientists are designing computers to act smartly or humanlike.

Section	COURSE CONTENTS
SECTION A	Artificial Intelligence: Definition, problem solving methods, searching techniques, knowledge representation, reasoning methods, predicate logic, predicate calculus, multi-value logic.
SECTION B	Fuzzy Logic: Concepts, fuzzy relations, membership functions, matrix representation, de-fuzzification methods. Artificial Neural Network: Introduction, multi-layer feed forward networks, back propagation algorithms, radial basis function and recurrent networks.
SECTION C	Evolutionary Techniques: Introduction and concepts of genetic algorithms and evolutionary programming. Hybrid Systems:
SECTION D	Introduction and Algorithms for Neuro-Fuzzy, Neuro-Genetic, Genetic-Fuzzy systems.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify different searching techniques, constraint satisfaction problem and example.

CO2: Able to apply these techniques in different field, which involve perception, reasoning and learning.

CO3: Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.

Text Books:

1. Artificial Intelligence and Intelligent Systems by NP Padhy, Oxford University Press.
2. Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications by Rajasekaran S. and Pai G.A.V., PHI New Delhi.
3. Neural Fuzzy Systems by Lin C. and Lee G., Prentice Hall International Inc.
4. Genetic Algorithms in Search Optimization & Machine Learning by Goldberg D.E., Addition Wesley Co., New York.
5. Neural Networks & Fuzzy Systems A dynamical systems approach to machine intelligence by Kosko B, Prentice Hall of India.

Name of the Course	**Genetic Algorithms and Evolutionary Programming**		
Course Code	**EL-012**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:

The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To impart knowledge about related with Genetic algorithm and Evolutionary programming.
- To introduce the fundamental concepts relevant to GA operators, creation of offspring etc.
- To enable the students to understand the factors related with application and fundamental of GA and EP.

SECTION	COURSE CONTENTS
SECTION A	Introduction, Basic concepts and definitions, artificial intelligence, genetic algorithms (GAs), evolutionary programming (EP), Genetic algorithm, Coding, fitness function, Calculation of the number of bit required for a variable, GAs operators, crossover and mutation, roulette wheel method for selection process, cumulative probabilities
SECTION B	Basic flow chart, GAs for optimization detail steps, Similarities between GAs and traditional methods, Differences between GAs and traditional methods, Evolutionary programming, Initialization, Creation of offspring, Competition and selection
SECTION C	Gaussian random numbers, standard deviation, Difference between GAs and EP, basic algorithm, step by step procedure of evolutionary programming for optimization.
SECTION D	Applications of GAs for economic power dispatch and optimal power flow, applications of EP for economic power dispatches and optimal powersflow.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify various concepts of Genetic algorithm and Evolutionary programming.

CO2: Describe important concepts related with optimization with GA and EP.

CO3: Apply principal to explain various problems related with problems described in CO2.

CO4: Assess the results obtained by solving above problems.

Text Books:

1. Genetic Algorithms, Data Structures and Evolution Programs by Z. Michalewicz, Berlin: Springer-Verlag.
2. Genetic Algorithms in search, Optimization and Machine Learning by D.E. Goldberg, Addison-Wesley.
3. Genetic Algorithms for VLSI Design, Layout & Test Automation by Pinaki Mazumder and Elizabeth M. Rudnick, Prentice Hall PTR.

Name of the Course	**Flexible AC Transmission System**		
Course Code	**EL-013**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:

The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To learn the concept of power flow control through various power electronic controllers including state of art FACTS controllers, operational aspects, capabilities and their integration in power flow analysis.
- To learn the effectiveness of Filters in distribution system for harmonic mitigation etc.
- Application of FACTS controllers as case studies in the Power System

SECTION	COURSE CONTENTS
SECTION A	FACTS concepts and General system considerations: Introduction to power semiconductor devices, Diode, GTO, MOSFET, IGBT, MOS Controlled Thyristor, Transmission interconnection, power flow in ac system, power flow and dynamic stability considerations, Basic of FACTS controllers, shunt, series, combined and other controllers, FACTS technology, HVDC or FACTS.
SECTION B	Voltage Source Converters: Basic concepts, single phase full wave bridge converter operation, three phase full wave bridge converter, sequence of valve conduction process in each phase leg, transformer connections for 12 pulse operation, three level voltage sourced converter, PWM converter. Self and Line Commutated Current Sourced Converters: Basic concepts, three phase full wave diode rectifier, thyristor-based converter, Rectifier and inverter operation valve voltage and commutation failure, Current sourced versus voltage sourced converters.
SECTION C	Harmonics and Filters: Harmonics on ac side and dc side of converter, characteristics and uncharacteristic harmonics, troubles caused by harmonics, harmonic filters. FACTS Devices: Introduction: objectives of shunt compensation, methods of controllable Var Generation, static Var Compensators, SVC and STATCOM, Static series compensators, TSSC, TCSC and SSC.
SECTION D	Combined Compensators: Introduction, Unified power flow controller (UPFC), conventional power control capabilities, real and reactive power flow control, comparison of UPFC to series compensators, control structure, dynamic performance. Interline power flow controller basic operating principles, control structure, application considerations. Application Examples: Case studies of standard power systems with FACTS.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Modelling concepts of commonly used FACTS controllers will be understood.

CO2: How FACTS controllers improve power flow in system and their incorporation in the system shall be clear.

CO3: To understand how FACTS controllers, enhance the power system stability.

CO4: Student will learn how FACTS devices improve power system operation and damp the system oscillations.

CO5: Application of harmonics filters for harmonic mitigation shall be understood.

Text Books:

1. Understanding FACTS concepts and Technology of Flexible AC Transmission system by N.G. Hingorni and L. Ayugyi, standard Publication New Delhi.
2. Facts Controllers in Power Transmission and Distribution by K. R. Padiyar, New Age International Publishers
3. Thyristor-Based FACTS Controllers for Electrical Transmission Systems by Mohan Mathur and Rajiv K. Verma, Wiley Student Edition
4. Flexible AC Transmission Systems: Modelling and Control by Zhang, X. P., Rehtanz, C. and Pal, B., Springer
5. Research papers related to FACTS in power system

Name of the Course	**Energy Policy Analysis**		
Course Code	**EL-021**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**4 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:

The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To impart knowledge on Energy Policy.
- To impart knowledge on Energy-Economy-Environment interaction.
- To impart knowledge on Energy Policy Instruments.

SECTION	COURSE CONTENTS
SECTION A	**Energy Policy:** Energy policies in the country, Tariffs and subsidies, Energy utility interface, Private sector participation in power generation, State role and fiscal policy, Energy and development, National energy plan, International treaties, Role of modeling in energy policy analysis. **Energy Demand and Supply:** Energy database, Energy balances, Flow diagrams, Energy demand analysis, Trend analysis, Econometric models
SECTION B	Elasticities approach, Input-output models, Simulation / process models, Energy supply analysis, Costs of exploration and economics of utilization of depletable and renewable resources, Scarcity rent, International energy supply **Energy Policy Instruments:** Pricing, Regulation, Incentives, Subsidies, Framework for policy analysis, Stakeholders, Criteria for energy access, Security, Sustainability, Development.
SECTION C	Case studies of a few energy policies– successes and failures, Free riders and rebound effect, Reference energy system, End use analysis
SECTION D	**Modelling**: Energy, S-shaped logistic curves, Examples of accelerated diffusion, Factors affecting diffusion, Economy wide impacts, Input-output models, Optimization models

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Students will be able to draft a policy document.

CO2: Students will be able to understand Energy Policy Instruments.

CO3. Students will be able to carry out project on Energy Policy analysis.

Text Books:

1. Energy Policy Analysis and Modelling by Mohan Munasinghe and Peter Meier, Cambridge University Press.
2. Energy Systems Analysis for Developing Countries by P Meier, Springer.
3. Energy Policies of the World by Gerand J. Mangone, Elsevier.
4. Energy Policy Analysis: A Conceptual Framework by M S Hamilton, CRCPress.
5. Introduction to Energy Analysis by K Blok and Evert Nieuwlaar, Routledge.

<table>
<tr><td>Name of the Course</td><td colspan="3">Energy Auditing & Management</td></tr>
<tr><td>Course Code</td><td>EL-022</td><td>Credits-4</td><td>L-4, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">4 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.</td></tr>
<tr><td colspan="4">Course Objectives
• To impart knowledge in the domain of energy conservation andmanagement.
• This activity aims to get students thinking critically about assessing the energy efficiency of an entity/ establishment.
• To bring out Energy Conservation Potential and Business opportunities across different user segments</td></tr>
</table>

SECTION	COURSE CONTENTS
SECTION A	Understanding, analysis and application of electrical energy management-measurement and accounting techniques- consumption patterns- conservation methods-application in industrial cases. System approach and End use approach to efficient use of Electricity; Electricity tariff types
SECTION B	Energy auditing: Types and objectives-audit instruments-ECO assessment and Economic methods-specific energy analysis-Minimum energy paths- consumption models-Case study. Electric motors-Energy efficient controls and starting efficiency- Motor Efficiency and Load Analysis- Energy efficient / high efficient Motors-Case study
SECTION C	Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing - Optimal operation and Storage
SECTION D	Reactive Power management- Capacitor Sizing-Degree of Compensation-Capacitor Losses-Location-Placement-Maintenance, case study. Peak Demand controls-Methodologies-Types of Industrial Loads-Optimal Load scheduling-case study. Lighting-Energy efficient light sources-Energy conservation in Lighting Schemes

Course Outcomes

CO1: Obtain the knowledge about energy conservation act, policy, regulations and business practices.

CO2: Analyse different energy systems from a supply and demand perspective.

CO3: Recognize opportunities for rational use of energy in industrial application.

CO4: Apply knowledge of Energy Conservation Opportunities in a range of contexts.

CO5: Identify and develop innovative energy efficiency solutions and demand management strategies for future.

Text Books:

1. Handbook on Energy Audit and Environment Management by Y P Abbi and Shashank Jain, TERI.
2. Handbook of Energy Audits Albert Thumann by William J. Younger, Terry Niehus
3. Industrial Energy Management: Principles and Applications by Giovanni Petrecca, The Kluwer international series- 207.
4. Guide to Electric Load Management by Anthony J. Pansini, Kenneth D. Smalling, Pennwell Pub.
5. Energy-Efficient Electric Motors and Their Applications by Howard E. Jordan, Plenum PubCorp.
6. Energy Management Handbook by Turner, Wayne C., Lilburn, The FairmontPress.
7. Handbook of Energy Audits by Albert Thumann, Fairmont Pr.
8. Recommended Practice for Energy Conservation and cost-effective planning in Industrial facilities IEEE Bronze Book, USA.

Name of the Course	Economics & Planning of Energy System		
Course Code	EL-023	Credits-4	L-4, T-0, P-0
Total Lectures	4 Hours/Week		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculator is allowed.

Course Objectives

- To enable students, undertake financial feasibility evaluation studies of energy technologies.
- To impart knowledge about the techniques used in energyplanning

SECTION	COURSE CONTENTS
SECTION A	**Economics of Energy System:** Relevance of financial and economic feasibility, Evaluation of energy technologies and systems, Basics of engineering economics, Financial evaluation of energy technologies, Social cost benefit analysis, Energy demand analysis and forecasting, Economics of energy conservation and renewable energy technologies, Energy supply assessment and evaluation, Energy demand – supply balancing, Energy models, Carbon credits and trading opportunities, Case studies on financial and economic feasibility evaluation of renewable energy systems.
SECTION B	**Energy Planning:** Policy and Planning implications of energy-environment interaction, Energy investment planning and project formulation, Energy Pricing, Clean development mechanism, Generation system capacity adequacy planning, Probabilistic models of generating unit outage performance and system load, Evaluation of loss of load and loss of energy indices
SECTION C	Probabilistic production costing, Reliability analysis, Software for energy planning, Technology transfer and its financing, Energy policy related acts and regulations, Interconnected systems, Multi-area reliability analysis, Power pool operation and energy exchange contracts.
SECTION D	**Energy Forecasting**: Sector-wise peak demand and energy forecasting by trend and econometric projection methods, Optimal generation expansion planning, Formulation of least cost optimization problems, Problems involving all type of costs, Minimum assured reliability constraints, Optimization techniques for solution by linear, Nonlinear and dynamic programming approaches.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Students will be able to apply the knowledge of the subject in financial estimation of renewable energy system.

CO2: Students will be able to carry out estimation of energy requirement using energy forecasting methods.

CO3: Students will be able to estimate energy pricing.

Text Books:

1. Reliability Evaluation of Power Systems by R. Billinton & R.N. Allan, PlenumPress.
2. Energy Planning and Policy by Maxime Kleinpeter, Wiley.
3. Financial Evaluation of Renewable Energy Technologies by T C Kandpal and H P Garg, Macmillan India Ltd.
4. Contemporary Engineering Economics by C S Park, PHI.
5. Energy Planning by Ashok V. Desai (Editor), Wiley Eastern Ltd.

Admission & Eligibility Criteria for M. Tech Admissions

1. The admission process and eligibility criteria for the Master of Technology (M. Tech.) in Electrical Engineering program shall be in accordance with the norms prescribed by the All India Council for Technical Education (AICTE), which are as follows:

   - B.Tech./B.E./AMIE in Electrical Engineering/ Electrical & Electronics Engineering/ Electrical & Instrumentation Engineering/Electrical & Power Engineering Electrical Devices & Power Systems Electrical Engineering Industrial Control/ Electrical Instrumentation & Control Engineering, Electrical Power System/ Instrumentation/ Instrumentation Engineering/ Instrumentations & Control Engineering.

2. The admission to the M.Tech. program shall be based on the merit of valid GATE score and left out seats will be filled on the basis of the merit of qualifying exam.

   OR

   University may conduct entrance examination for deciding the merit, in case the number of applications received are more than 100.

3. The total number of student intake shall be 18, plus supernumerary seats as per HPU norms.

4. The entrance test will be based on Multiple Choice Questions (MCQ) with a total of 100 marks, each question carrying one mark. There will be no negative marking.

Course Duration

The M. Tech. programmes in UIT shall be of two (02) year duration, spread over four (04) semesters and shall be run-on Full-Time basis. It may be extended to a maximum duration of 5 years with approval from the appropriate authority.

The details of semester wise course outlines and syllabi are available on UIT website.

Departmental Master Program Committee (DMPC) under Faculty of Engineering and Technology

Each academic Department shall have a Departmental Master Programme Committee (DMPC) for dealing with academic matters (admission process: counseling, presentation/thesis evaluation, etc.) pertaining to Master's Degree Programme.

Constitution of DMPC

Any faculty member holding an Engineering degree may be appointed as a member of the DMPC. The DMPC shall have the following constitution:

1.	Chairperson, DMPC	HoD
2.	Convener, DMPC	To be nominated by the Head of the Department (HoD)
3.	***Additional Members**	
	1. One Professor, if available (otherwise Associate/Assistant Professor with PhD)	Member
	2. One Associate Professor, if available (otherwise Assistant Professor with PhD)	Member
	3. One Assistant Professor	Member
	4. One Professor/ Associate Professor/Assistant Professor from another r Department (To be nominated by the HoD, in consultation with the Departmental)	Member

**In case there is not a sufficient faculty member in a particular Department/Centre, Director may nominate faculty holding an Engineering degree from other Departments/Centres of the university.*

5. The student may choose to have a co-supervisor, subject to the approval of the DMPC.

6. The final evaluation of the M.Tech. Thesis shall be conducted through a public defense, open to all, wherein the candidate shall present and defend their research work before a panel of examiners. In the event that the candidate's performance is deemed unsatisfactory, He/She shall be required to reappear for a subsequent defense, subsequent to incorporating the necessary revisions and improvements, until the evaluation process is successfullycompleted.