Department of Electrical and Electronics Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate, Doctoral, and Post Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become an internationally recognized centre of excellence in academics, research and technological services in the area of Electrical and Electronics Engineering and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently.
- Developing engineers with managerial attributes capable of applying appropriate technology with responsibility.
- Creation of congenial atmosphere and ample research facilities for undertaking quality research to achieve national and international recognition by faculty and students.
- To strive for internationally recognized publication of research papers, books and to obtain patent and copyrights.
- To provide excellent technological services to industry for the benefit of society.

Programme Educational Objectives (PEOs)

PEO 1: To acquire in-depth knowledge of complex Electrical Engineering problems especially in Power Systems to impart ability to discriminate, evaluate, analyze critically and synthesize knowledge pertaining to state of art and innovative research.

PEO 2: To solve complex power system problems with commensurate research methodologies as well as modern tools to evaluate a broad spectrum of feasible optimal solutions keeping in view socio- cultural and environmental factors.

PEO 3: To posses wisdom regarding group dynamics to efficaciously utilize opportunities for positive contribution to collaborative multidisciplinary engineering research and rational analysis to manage projects economically.

PEO 4: To communicate with engineering community and society at large adhering to relevant safety regulations as well as quality standards.

PEO 5: To inculcate the ability for life-long learning to acquire professional and intellectual integrity, ethics of scholarship and to reflect on individual action for corrective measures to prepare for leading edge position in industry, academia and research institutes.

Graduate Attributes (GAs)

GA 1: Scholarship of Knowledge

Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

GA 2: Critical Thinking

Analyse complex engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

GA 3: Problem Solving

Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

GA 4: Research Skill

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

GA 5: Usage of modern tools

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

GA 6: Collaborative and Multidisciplinary work

Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

GA 7: Project Management and Finance

Demonstrate knowledge and understanding of engineering and management principles and apply the same to one‘s own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

GA 8: Communication

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

GA 9: Life-long Learning

Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

GA 10: Ethical Practices and Social Responsibility

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

GA 11: Independent and Reflective Learning

Observe and examine critically the outcomes of one‘s actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

PROGRAM OUTCOMES (POs) for ME

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Recognise the need for continuous learning and will prepare oneself to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex power system problems.

PO5: Demonstrate knowledge of engineering and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

PO6: Possess knowledge and understanding to recognize opportunities and contribute to collaborative-multidisciplinary research, demonstrate a capacity for teamwork, decision-making based on open-mindedness and rational analysis in order to achieve common goals.

Course Structure & Syllabus

Postgraduate Programme
(Power Systems)

Department of Electrical & Electronics Engg.
Birla Institute of Technology
Mesra, Ranchi-835215

Course Structure

Program: Master of Engineering

(Power Systems)

Electrical & Electronics Engineering

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
Proposed Course Structure of ME (Electrical Engineering) Programme

Power Systems Specialization

I Semester

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 1103	Advanced Digital Signal Processing	3	-	-	3
2.	MEE 1101	Modern Control Theory	3	1	-	4
3.	MEE 1131	Advanced Power System Analysis	3	-	-	3
4.	MEE 1105	Optimization in Engineering Design (A***pplied Sciences Paper***)	3	-	-	3
5.		Elective I	3			3
6.	MEE 1104	Digital Signal Processing Laboratory	-	-	3	2
7.	MEE 1158	Control and Power Electronics Laboratory	-	-	3	2

Total Credit : 20

II Semester

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 2101	Soft Computing Techniques *	3	1	-	4
2.	MEE 2131	Power System Operation and Control	3	-	-	3
3.	MEE 2137	Power System Dynamics	3	-	-	3
4.		Appropriate Free Electives from other Departments	3	-	-	3
5.		Elective II	3	-	-	3
6.	MEE 2136	Power System Laboratory	-	-	3	2
7.	MEE 2142	Power System Simulation Lab.	-	-	3	2

Total Credit : 20

III Semester

Sr. No.	Subject	L	T	P	C
1.	MEE 3101 Thesis	-	-	-	15

IV Semester

Sr. No.	Subject	L	T	P	C
1.	MEE 3101 Thesis	-	-	-	20

Total Credits - 75

List of Elective -I

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 1133	EHV AC Power Transmission	3	-	-	3
2.	MEE 1135	Power System Planning and Reliability	3	-	-	3
3.	MEE 1139	Modern Power System Planning	3	-	-	3
4.	MEE 1121	HVDC Power Transmission	3	-	-	3

5.	MEE 1115	Power System Reliability	3	-	-	3

List of Elective - II

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 2139	Power System Deregulation	3	-	-	3
2.	MEE 2157	Renewable Sources of Electrical Energy	3	-	-	3
3.	MEE 2135	Advanced Power System Protection	3	-	-	3
4.	MEE 2159	Application of Power Electronics in Power System	3	-	-	3
5.	MEE 2115	Embedded System and Applications	3	-	-	3

Semester 1

Course code: MEE 1103

Course title: Advanced Digital Signal Processing

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students to:

1. Enumerate the basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner by employing different mathematical operations like folding, shifting, scaling, convolutions, Z-transform etc.;
2. determine transfer function, impulse response and comment on various properties like linearity, causality, stability of a system;
3. predict time and frequency response of discrete-time systems using various techniques like Z-transform**,** Hilbert transform**,** DFT, FFT;
4. design digital IIR and FIR filters using filter approximation theory, frequency transformation techniques, window techniques and finally construct different realization structures.

Syllabus:

Module - 1

Introduction: Discrete time systems, Discrete time signals, Analysis of discrete-time linear time invariant systems, Difference equation description.

Module - 2

Z-transform, Properties of Z-transform, Inverse of Z-transform, Chrip Z-ransform, Zury's test for stability, Digital filter structures: Direct form I & II, Cascade, Parallel and ladder realizations.

Module - 3

Frequency domain analysis, Discrete Fourier transform (DFT), Properties of DFT, Inverse DFT, Inter relationship with z-transform and Hilbert-transforms, Discrete Hilbert transform, FFT algorithms- Decimation in time and decimation in frequency.

Module – 4

Filter function approximation and transforms: Review of approximation of ideal analog filter response. IIR filter: Designs based on analog filter approximation impulse invariant, Bilinear transformation, Direct design of IIR filters, Time domain design techniques. Butterworth, Chebyshev type I & II, Elliptical filters.

Module - 5

Properties and design of FIR filters: Properties, Design techniques - window technique, Frequency sampling comparison of IIR and FIR filters.

Module - 6

Multirate digital signal processing, Introduction, Decimation by factor D, I sampling rate conversion by a rational factor I/D.

Module - 7

Introduction to continuous discrete and fast wavelet transforms. Families of Wavelets: orthogonal and bi-orthogonal wavelets, Daubechies' family of wavelets in detail.

Course Outcomes:

At the end of the course, student will be able to-

1. state sampling theorem and reproduce a discrete-time signal from an analog signal; acquire knowledge of multi rate digital signal processing, STFT and wavelets.
2. classify systems based on linearity, causality, shift-variance, stability criteria and represent transfer function of the selected system;
3. evaluate system response of a system using Z-transform, convolution methods, frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques;
4. design FIR and IIR filters used as electronic filter, digital filter, mechanical filter, distributed element filter, waveguide filter, crystal filter, optical filter, acoustic filter, etc.
5. construct (structure) and recommend environment-friendly filter for real- time applications.

Text Books:

1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications
2. Alan V. Oppenheim Ronald W. Schafer, Digital Signal Processing, PHI, India.
3. Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: An Introduction.

Reference Books:

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. Wavelate Transform, S. Rao.
3. Wavelate Analysis: "The scalable structure of Information" Springer 2008 – Howard L.Resinkoff, Raymond O. Wells.

Course code: MEE 1101

Course title: Modern Control Theory

Credits:	L	T	P	C
	3	1	0	4

Class schedule per week: 4 classes per week

Course Objectives:

1. To state students with concepts of state variables;
2. To extend comprehensive knowledge of mathematical modeling of physical system;
3. To illustrate basics of deigning a control problem;
4. To summarize them on theory of model control theory.

Syllabus:

1. **Introduction:**

   Systems, modelling, analysis and control, continuous-time and discrete-time.

2. **State Variable Descriptions:**

   Introduction, concept of state, state equations for dynamic systems, state diagrams.

3. **Physical Systems & State Assignments:**

   Linear continuous-time and discrete-time models; non-linear models; local linearization of non-linear-model.

4. **Solution of State Equations:**

   Existence and uniqueness of solution, linear time-invariant continuous-time state equations, linear discrete-time state equations.

5. **Controllability & Observability:**

   Concept of controllability & observability, controllability and observability tests for continuous -time systems, controllability and observability of discrete-time systems, canonical forms of state models.

6. **State models and input-output descriptions:**

   Input-output maps from state model and vice-versa, transfer matrix, output controllability, reducibility.

7. **Model Control**

Introduction, Effect of state feedback on controllability and observability, pole placement by state feedback; Full order observers, Reduced-order observers; deadbeat control by state feedback, deadbeat observers.

8. **Fractional Order Controller**

Fractional order calculus, Fractional order transfer function modelling, Frequency domain analysis of fractional order controller, Time domain analysis of time domain controller.

Course Outcomes:

At the end of the course, a student should be able to:

1. apply the different ways of modeling of physical system and read basics of the theory of fractional order controller;
2. recommend linearization of a nonlinear system;
3. summarize the controllability & observability conditions;
4. explain the functionality of Model Control;
5. formulate potential design techniques from analysis.

Books Recommended:

1. Digital Control & State Variable Methods – M. Gopal, Tata Macgraw Hill.
2. Modern Control System Theory by M. Gopal, New Age International(P) Ltd., 2nd edition.
3. Linear Systems by Thomas Kailath, Prentice-Hall Inc.,1980.
4. Modern Control Engg. by K. Ogata, Pearson, 5th edition

Course code: MEE1131

Course title: Advanced Power System Analysis

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

Objective of this course is to provide students with:

A. To define single-phase modeling of power system components.

B. To describe steady state operation of large-scale power systems and to solve the power flow problems using efficient numerical methods suitable for computer simulation.

C. To analyze power systems under abnormal conditions (short circuit) utilizing bus impedance matrix for short circuit analysis.

D. To analyze power system security using contingency analysis and assess the state estimation.

Syllabus:

Module - 1

Introduction - Modeling of power system component, Basic single-phase modelling, Generation, Transmission line, Transformers, Shunt elements.

Module - 2

Load Flow Analysis - Introduction, Nature of load flow equations, Newton Raphson method: Formulation for load buses and voltage controlled buses in rectangular and polar co-ordinates, Computational steps and flow chart, Computational Aspects of Large Scale System - Introduction, Sparsity oriented technique for reducing storage requirements, Factorization.

Module - 3

Decoupled load flow: Formulation, Fast decoupled load flow method, Continuation load flow technique, Series load flow technique.

Module - 4

Short Circuit Analysis - Introduction, Bus impedance matrix and its building algorithm through modifications, Fault calculation uses Zbus and its computational steps. Symmetrical and Unsymmetrical faults.

Module - 5

Contingency Analysis - Introduction to power system security, Factors affecting power system security, Analysis of single contingencies, Linear sensitivity factors, Analysis of multiple contingencies, Contingency ranking.

Module - 6

Static state Estimation : Introduction, weighted least square technique, Statistics, Errors and estimates.

Module - 7

Harmonic Analysis - Power Quality, Sources, Effects of Harmonics, Harmonic load flow analysis, Suppression of Harmonics.

Course Outcomes:

At the end of the course, student will be able to-

i. draw the impedance and reactance diagram and can explain different components modelling for load flow, short circuit, contingency analysis and harmonic analysis of power system.

ii. explain and solve load flow problems by different methods .

iii. identify and analyze the different abnormal (fault) conditions in power system utilizing efficient computer algorithm.

iv. explain different factors affecting the power system security for single and multiple contingencies.

v. explain different numerical methods for state estimation of power system.

Text Books

1. Power System Analysis - John J. Grainger, William D. Stevenson, Jr.
2. Power System Analysis - L. P. Singh

Reference Books

1. Electric Energy Systems Theory - An Introduction, O.L. Elgerd.
2. Computer Modelling of Electrical Power Systems - J. Arrillaga, N.R. Watson
3. Power System harmonic Analysis, J. Arrillage, B.C. Smith, et al.

Course code: MEE1105

Course title: Optimization in Engineering Design

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

Objective of this course is to provide students with :

1. Conceptualize the optimizations in engineering design and model the problem mathematically.
2. Understand various optimization methods and algorithms for solving optimization problems.
3. Develop substantial interest in research, for applying optimization techniques in problems of engineering and technology;
4. Analyze and apply mathematical results and numerical techniques for optimization of engineering problems, while being able to demonstrate solutions through computer programs.

Syllabus:

Module – 1

INTRODUCTION

Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.

Module - 2

ONE-DIMENSIONAL SEARCH METHODS

Optimality Criteria, Bracketing methods: Exhaustive search methods, Region – Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.

Module - 3

Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's (Steepest descent) method and Newton's method.

Module - 4

LINEAR PROGRAMMING

Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications.

Module - 5

MULTIVARIABLE OPTIMIZATION ALGORITHM

Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method.

Module - 6

CONSTRAINED OPTIMIZATION ALGORITHM

Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.

Module - 7

ADVANCED OPTIMIZATION TECHNIQUES

Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, advanced GAs, Differences between GAs and traditional methods.Simulated annealing method, working principles. Particle swarm optimization method, working principles.

Course Outcomes:

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

1. Have a basic understanding of traditional and non-traditional optimization algorithms.
2. Formulate engineering design problems as mathematical optimization problems.
3. Use mathematical software for the solution of engineering problems.
4. Differentiate the various optimization concepts and equivalently apply them to engineering problems.
5. Evaluate pros and cons for different optimization techniques.

Referred Books:

1. Optimization for Engineering Design - Kalyanmoy Deb.
2. Optimization Theory and Applications - S.S. Rao.
3. Analytical Decision Making in Engineering Design - Siddal.
4. Linear Programming – G. Hadle.

Elective-I:

Course code: MEE1133

Course title: EHV AC Power Transmission

Credits:	L	T	P	C
	3	0	0	3

Class schedule per week: 3 classes per week

Syllabus:

Module - 1

General Background & State of art of EHV AC Transmission Technology Bundled conductors, Maxwell's Coefficients, Inductance and capacitance matrices

Module - 2

Surface Voltage gradient on bundled conductors, Mangoldt's formula, Gradient factors.

Module - 3

Corona Effects: Power Loss, Audible noise, BI & TVI.

Module - 4

Ground level electrostatic field of EHV Lines

Module - 5

Power-frequency over voltages & Voltage Control, Series & Shunt Compensation.

Module - 6

Static Var Compensator: Introduction, Principles of operation, Types of SVC, Introduction to

FACTS.

Module - 7

Switching over-voltages in EHV Systems.

Books recommended:

1. R.D. Begamudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Ltd., 1986.
2. S.Rao, EHV AC and HVDC Transmission Engineering & Practice, Khanna Publishers, Delhi, 1990.

Course code: MEE1135

Course title: Power System Planning and Reliability

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students:

A. Explain the basic modelling of power system components for reliability evaluation and planning

B. Describe the methodologies to solve power system generation system reliability calculation and generation planning

C. Apply fundamentals of reliability analysis to power systems and demonstrate the calculation of basic reliability indices

D. Describe load forecasting models for short-term and long-term power system planning

Syllabus:

Module - 1

Introduction : Hierarchy of modern power system planning, Brief description about short term and long term planning.

Introduction to Reliability Engineering: Definition of reliability, Probabilistic reliability, Repairable and non-repairable items, the pattern of failures with time (non-repairable and repairable items).

Module - 2

Generation expansion planning: fundamentals, Economic analysis, planning including maintenance scheduling.

Module - 3

Network expansion planning: Introduction, Heuristic methods, Mathematical optimization methods.

Module - 4

Reliability Mathematics : The general reliability function, The exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

Module - 5

Static Generating Capacity Reliability Evaluation: Introduction, Capacity outage probability tables, Loss of load probability (LOLP) method, Loss of energy probability (LOLE) method, Frequency and duration approach.

Module - 6

Spinning Generating Capacity Reliability Evaluation: Introduction, Spinning capacity evaluation, Derated capacity levels.

Module - 7

Transmission System Reliability Evaluation: Average interruption rate method, the frequency and duration approach, Stormy and normal weather effects, The Markov processes approach, System studies.

Course Outcomes:

After the completion of this course, students will be able to:

1. Acquire the knowledge of basic reliability concepts and planning aspects.
2. Apply the different techniques for analysing the reliability of generation and transmission systems.
3. Develop an n-state Markov Model for any kind of stochastic system.
4. Select suitable technology options for generation and transmission planning problems using cost benefit analysis.
5. Apply the knowledge of reliability and planning concepts to the practical and real time systems.

TEXT BOOKS:

1. Power System Reliability Evaluation - R. Billinton, Gordon and Breach Science Publishers, New York.

2. Modern Power System Planning, X, Wang and J.R. McDonald, McGraw-Hill Book Company.

3. Reliability Modeling in Electric Power Systems, J. Endrenyi, John Wiley & Sons, New York.

REFERENCE BOOKS:

1. Practical Reliability Engineering, Patrick D.T. O'Connor, John Wiley & Sons, (Asia) PTE Ltd., Singapore.

2. Reliability of Engineering Systems - Principles and Analysis, I. Ryabinin, MIR Publishers, Moscow.

Course code: MEE1139

Course title: Modern Power System Planning

Credit:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Syllabus:

Module - 1
Introduction: Hierarchy of modern power system planning, Brief description about short term and long term planning.

Module - 2
Load Forecasting: Classification and characteristics of loads, Forecasting methodology (extrapolation and correlation), Energy forecasting, Peak demand forecasting, Non-weather sensitive forecast (NWSF), Weather-sensitive forecast (WSF), Total forecast, Annual and monthly peak demand forecast.

Module - 3
Power System Reliability Calculation: Mathematical basics for reliability calculation, Power system component reliability models, Reliability of power generation system.

Module - 4
Power System Probabilistic Production Simulation: Fundamentals of production simulation, Cumulant method in probabilistic production simulation, Equivalent energy function method, Simulation of hydroelectric generating units and pump-storage units.

Module - 5
Maintenance Scheduling of Generating Units in a Power System: Introduction, Levelized reserve method, Levelized risk method, Maintenance scheduling using soft computing techniques.

Module - 6
Generation Expansion Planning: Fundamental economic analysis, Generation planning optimized according to generating unit categories (WASP), Generation planning optimized according to power plants (JASP).

Module - 7
Network Planning: Introduction, Heuristic methods of network planning, Network planning by mathematical optimization, Fast static security contingency analysis, Probabilistic load flow calculation.

Books Recommended:

1. Modern Power System Planning, X, Wang and J.R. McDonald, McGraw-Hill Book Company.
2. Power System Planning, R.L. Sullivan, McGraw-Hill International Book Company

Course code: MEE1121

Course title: HVDC Power Transmission

Credit:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students to:

1. Identify the significance of HVDC System
2. Understanding the AC/DC conversion and its components
3. Interpretation of reactive power harmonics in HVDC system , its effect and filtering
4. Infer and categorize AC/DC system, know the operation, control and protection for HVDC system

Syllabus:

Module - 1

Introduction to HVDC transmission: Comparison with EHV AC power transmission, HVDC system configuration and components.

Module - 2

Principles of AC/DC conversion: Converter connections, Wave forms, Relevant Equations, Reactive Power requirements

Module - 3

Harmonics and Filters : Waveforms of a-c bus currents in Star/Star, Star/delta & 12-phase converters and their Fourier -series representations, Non-characteristic harmonics, Harmful Effects of Harmonics, DC side harmonics, Filters and detuning, Cost considerations of filters.

Module - 4

HVDC system control : CC and CEA controls, Static characteristics of converters, Combined characteristics of rectifier and inverter, Power reversal, Asynchronous & synchronous HVDC links, Frequency Control of A.C. system, Stabilisation & damping of A.C. networks, CP Control

Module - 5

HVDC circuit Breakers and Protection: Response to dc and ac system faults, DC line fault, AC system fault, Converter fault.

Module - 6

HVDC systems elements: Converter transformers, D.C. smoothing reactors, Thyristor valves etc., Earth electrodes & earth return

Module - 7

HVDC links and classification: Monopolar links, Bipolar links, Homopolar links. HVDC-AC interactions: SCR, Problems with low ESCR system, Solutions to problems associated with weak system.

Course Outcomes:

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

1. To list significance/ importance/ advantages of HVDC systems over EHVAC systems, types and application of HVDC system
2. To explain different converters and inverters for converting AC to DC & DC to AC conversion
3. To interpret the reactive power, harmonics in HVDC system , its effect and filtering
4. To infer AC/DC system interaction and know the operation and control of HVDC System
5. To categorize AC/DC system and apply protection for HVDC system

Books recommended:

1. HVDC Power Transmission Systems by K. Padiyar, Wiley Eastern Ltd.

2. Direct Current Transmission by E.W.Kimbark, Wiley InterScience-New-York

3. HVDC Transmission by J.Arillaga, Peter Peregrinus Ltd; London U.K.,1983

4. Power Transmission by Direct Current by E.Uhlman, Springer Verlag, BerlinHelberg, 1985.

Course code: MEE1115

Course title: Power System reliability

Credit:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Syllabus:

Module - 1

Introduction to Reliability Engineering: Definition of reliability, Probabilistic reliability, Repairable and non-repairable items, the pattern of failures with time (non-repairable and repairable items).

Module - 2

Reliability Mathematics : The general reliability function, The exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

Module - 3

Static Generating Capacity Reliability Evaluation: Introduction, Capacity outage probability tables, Loss of load probability (LOLP) method, Loss of energy probability(LOLE) method, Frequency and duration approach.

Module - 4

Spinning Generating Capacity Reliability Evaluation: Introduction, Spinning capacity evaluation, Derated capacity levels.

Module - 5

Transmission System Reliability Evaluation: Average interruption rate method, the frequency and duration approach, Stormy and normal weather effects, The Markov processes approach, System studies.

Module - 6

Composite System Reliability Evaluation Considering Interconnection: Service quality criterion, Conditional probability approach, Two-plant single load and two load systems. The probability array for two interconnected systems, Loss of load approach, Interconnection benefits.

Module - 7

Direct Current Transmission System Reliability Evaluation: System models of failure, Loss of load approach, Frequency and duration approach, Spare -valve assessment, multiple bridge equivalents.

Text Books:

1. Power System Reliability Evaluations - R. Billinton, Gordon and Breach Science Publishers, New York.
2. Reliability Modeling in Electric Power Systems, J. Endrenyi, John Wiley & Sons, New York.

Reference Books

1. Practical Reliability Engineering, Patrick D.T. O'Connor, John Wiley & Sons, (Asia) Pte Ltd., Singapore.
2. Reliability of Engineering Systems - Principles and Analysis, I. Ryabinin, MIR Publishers, Moscow.

Course code: MEE1104

Course title: Digital Signal Processing Lab

Credit:	**L**	**T**	**P**	**C**
	0	0	3	2

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students to:

1. Enumerate the basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner through different mathematical operations like folding, shifting, scaling, convolutions, etc. using MATLAB; also gain Knowledge of TMS kit, digital image filter.
2. Construct different realization structures.
3. Determine transfer function and predict frequency response of discrete-time systems by applying various techniques like Z-transform, DFT and FFT using MATLAB
4. Design and compose digital IIR and FIR filters using filter approximation theory, frequency transformation techniques, window techniques in MATLAB environment.

List of Experiments:

1. **Name: Introduction to MATLAB.**
   Aim: An introduction to MATLAB.

2. **Name: Generation and representation of different types of signal.**
   Aim: To perform generation of different signals in MATLAB.

3. **Name: The Z-Transform and Inverse Z-Transform.**
   Aim: To write a program to find z-transform of given signal.

4. **Name: The Cross-correlation, Auto-correlation between two sequences. Also, Circular convolution between two periodic sequence.**
   Aim : To perform cross-correlation, auto-correlation and circular convolution of two sequence.

5. **Name:- Discrete Fourier transform and Inverse- Discrete Fourier transform**
   Aim: To write an MATLAB program to find discrete Fourier transform and Inverse-discrete Fourier transform.

6. **Name: DFT by DIT-FFT and DIF-FFT method.**
   Aim: To perform DFT by DIT-FFT and DIF-FFT methods in MATLAB.

7. **Name: The low pass, high-pass, band-pass and band-stop filter using Butterworth approximation.**
   Aim : To write a MATLAB program for low pass , high pass and band pass filter using Butterworth approximation.

8. **Name: Familiarization with TMS-320C6713 DSP starter Kit.**
   Aim : To perform a descriptive and practical study for hardware of TMS- 320C6713 DSP starter Kit.

9. **Name: Correlation of two discrete time signal**
   Aim : . To write a MATLAB program to perform correlation of two discrete time signal.

10. **Name: Linear convolution of two sequence using circular matrix method.**
    Aim : To write a MATLAB program to perform Linear convolution of two sequence using circular matrix method.

11. **Name: The Radix-2 DIT FFT algorithm.**
    Aim : To perform Radix-2 DIT FFT algorithm of 8-point sequence in MATLAB.

12. **Name : Image Processing.**
    Aim: 1.To write a program to remove Salt & paper type noise from a given image
    2. To change the color of specific part of given image
    3. Write a program to remove Gaussian noise from given image

Course Outcomes:

At the end of the course, student will be able to-

1. Convert analog signal into digital signals and vice-versa, generation of different signals and basic knowledge of TMS kit.
2. Examine system response using Z-transform, convolution methods and interpret transfer function of the selected system;
3. Evaluate frequency response of the systems using frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques and visualization using MATLAB;
4. Design FIR and IIR filters.
5. Recommend environment-friendly filter for different real- time applications such as optical filter design, acoustic filter design etc.

Text Books:

1. Digital signal processing and applications with C6713 and C6416 DSK by Rulph Chassaing, Wiley publication.
2. Real-Time digital signal processing based on the TMS320C6000 by Nasser Kehtarnavaz, ELSEVIER publication.

Reference Books:

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. Wavelate Transform, S. Rao.
3. Wavelate Analysis: “The scalable structure of Information” Springer 2008 – Howard L. Resinkoff, Raymond O. Wells

Course code: MEE1158

Course title: Control and Power Electronics Laboratory

Credit:	**L**	**T**	**P**	**C**
	0	0	3	2

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students to:

1. To impart basic concept of various control system components of converter and inverter operation.
2. To provide skills for application of appropriate tools in order to solve various technical problems.
3. To encourage students to undertake technical projects of multi disciplinary nature.
4. To provide knowledge current state of art in the field of power electronics and control system in order to motivate students to take up research activities.

List of Experiments:

Control System Experiments

1. To study and implementation of ON-OFF temperature controller.
2. To obtain the step response of first and second order RLC series circuit and determine the value of R and L for a given value of C through time response specification.
3. To study the characteristics of synchros, potentiometers and servomotors.
4. Determine the characteristics of LOW PASS and HIGH PASS filters by experimental sine sweep and Lissajous figures draw on CRO.
5. Controller design for stabilization of inverted pendulum.
6. To study the performance characteristics of a LVDT.

Power Electronics Experiments

1. Perform an experiment on a single phase fully controlled SCR rectifier and find its voltage ripple.
2. Conduct an experiment on a synchronous motor in order to draw it V-Curve.
3. Do a suitable test on a given IGBT to draw its output and transfer characteristics.

4. Execute test on a resonant pulse SCR chopper in order to study its performance.
5. Execute an experiment on a two identical DC machine to find out its over all efficiency.
6. Execute an experiment on a step up chopper using MOSFET in order to observe its performance and plot waveforms.

Course Outcomes:

At the end of the course, student will be able to-

1. Explain basic operating principle of various control system components, converters and inverters.
2. Analyze the performance parameter of various controllers, converters in the application of control of electric drives.
3. Select appropriate tools for design and up gradation work to solve complex engineering problem
4. Undertake design projects involving inter disciplinary nature in the domain of control system and power electronics.
5. Provide capability to work in a team consisting of members from different areas of expertise and pursue research in order to find new innovative solution for various social and economic problems using technical rationale.

Text Books:

1. M.H. Rashid,“Power Electronics: Circuits, Device and Applications”,2nd Ed.n, PHI, New Jersey, 1993.
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
3. M. D. Singh, K. B. Khanchandani, “Power Electronics”, 2ndEdn., Tata McGraw-Hill, 2007.
4. M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH. (T2)

Reference Books:

1. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, 1st Edn., Prentice Hall,2001.
2. B. K. Bose, “Modern Power Electronics & AC Drives” , 1st Edn., Prentice Hall, 2001.
3. L. Umanand, “Power Electronics: Essentials & Applications”, 1stEdn. Wiley India Private Limited, 2009.
4. M. Gopal, "Digital Control & State Variable Method", TMH.

Semester: 2

Course code: MEE 2101

Course title: Soft Computing Techniques

Credits:	**L**	**T**	**P**	**C**
	3	1	0	4

Class schedule per week: 4 classes per week

Course Objectives:

The course objective is to provide students with an ability to:

1. Conceptualize neural networks and its learning methods.
2. Infer the basics of genetic algorithms and their applications in optimization and planning.
3. Interpret the ideas of fuzzy sets, fuzzy logic and fuzzy inference system.
4. Categorize the tools and techniques available for soft computing, while employing them according to practical requirements of an engineering design.

Syllabus

Module - I

Introduction: Background, uncertainty and imprecision, statistics and random processes, uncertainty in Information. Fuzzy sets and membership, chance versus ambiguity, fuzzy control from an industrial perspective, Knowledge based systems for process control, knowledge based controllers, knowledge representation in knowledge based controllers.

Module – II

Mathematics of Fuzzy Control : Classical sets, Fuzzy sets, Properties of fuzzy sets, operations on fuzzy sets. Classical relations and fuzzy relations - cartesian product, crisp relation, Fuzzy relations, Tolerance and Equivalence Relations, Fuzzy tolerance and equivalence relations, operation on fuzzy relations, The extension principle.

Module - III

Membership Function: Features of membership functions, standard forms and boundaries, Fuzzyification, Membership value assignment. Fuzzy-to-Crisp conversions: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations. Defuzzification Methods

Module – IV

Introduction: Structure and foundation of Single Neuron, Neural Net Architectures, Neural Learning Application, Evaluation of Networks, Implementation. Supervised Learning - Single Layer Networks, Perceptions, Linear saparability, Perception, Training algorithms, Guarantee of success, Modifications.

Module – V

Multilayer Networks - Multilevel discrimination, preliminaries, backpropagation algorithm, setting the parameter values, Accelerating the learning process, Applications, RBF Network.

Module - VI

Unsupervised learnings - Winner take all networks, learning vector quantizers, ART, Topologically organised networks.

Associative Models - Non-iterative procedures for Association, Hopfield networks,

Module - VII

Discussion of Neural Networks and Fuzzy Logic Application in areas of Power Electronics and motor control.

Course Outcomes:

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

1. Identify the soft computing techniques and their roles in building intelligent machines.
2. Recognize an appropriate soft computing methodology for an engineering problem.3.
3. Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems.
4. Apply neural network and genetic algorithms to combinatorial optimization problems;
5. Classify neural networks to pattern classification and regression problems and evaluvate its imparts while being able to demonstrate solutions through computer programs.

Text Books:

1. Fuzzy logic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.
2. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice- Hall of India Private Limited.
3. Neural Networks: A Comprehensive Foundation – Siman Haykin, IEEE, Press, MacMillan, N.Y. 1994.

Reference Books:

1. Elements of Artificial Neural Networks – Kishan Mehrotra, Chilakuri K. Mohan, Sanjay Ranka (Penram International Publishing (India)

Course code: MEE 2131

Course title: Power System Operation and Control

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

1. To learn about different states in power system and transition between the states following the dynamic changes happened in power system.

2.To understand the nature of frequency change in Isolated and integrated system and thereby the control strategy for Generator.

3.To learn different methods for economic operation of the power plant by fuel saving , scheduling of thermal and hydel units.

4.To provide the introductory concept on power system deregulation and its effect on power system operation.

Syllabus:

Module - 1

Introduction - Operating States, Preventive and Emergency control, Indian Electricity Grid Code, Co-ordination between different agencies in India.

Module - 2

Load Frequency Control - Introduction, Types of speed governing system and modelling, Mechanical, Electro-hydraulic, Digital electro-hydraulic governing system, Turbine modelling, Generator-load modelling, Steady-state and dynamic response of ALFC loop, the secondary ALFC loop, Integral control.

Module - 3

Multi-control-Area System - Introduction, Pool operation, Two-area system, Modelling the tie line, Static and dynamic response of two area system, Tie-line bias control, State space representation of two-area system, Generation allocation, Modern implementation of AGC scheme, Effect of GRC and speed governor dead-based on AGC.

Module -4

Excitation System - Introduction, Elements of an excitation system, Types of excitation system, Digital excitation system, modelling.

Module - 5

Optimum Operating Strategies - Introduction, Generation mix, Characteristic of steam and Hydro-electric units, Optimum economic dispatch - neglecting Loss and with transmission loss, Computational steps, Derivation of loss formula, Calculation from Jacobian matrix equation, Economic dispatch for Hydro-thermal plants, Short-term Hydro-thermal scheduling, Hydro-thermal co-ordination, Reactive power scheduling.

Module - 6

Unit Commitment - Introduction, Constraints in unit commitment, Thermal unit constraints, Hydro-constraints, Unit commitment solution method - Priority list method, Dynamic programming solution.

Module - 7

Power System Restructuring : introduction, Regulation vs. Deregulation, Competitive Market for Generation, The Advantages of Competitive Generation, Electric Supply Industry Structure Under Deregulation in India. Restructuring Models.

Course Outcomes:

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

1. To realize and understand the different operating condition and methods and technologies involved in control action according to different operating states of power system.

2. To utilize the knowledge of mathematics, physics , control system, and network analysis to evaluate the frequency change and calculate the primary and secondary parameter for Automatic generation control .

3.To solve the economic generation scheduling using different solution techniques.

4.To understand the operation of power market and different methodologies to settle the market.

Text Books:

1. Electric Energy Systems Theory an Introduction - Olle I. Elgerd
2. Power Generation Operation and Control - A.J. Wood, B.F. Wollenberg

Reference Books:

1. Power System Deregulation by Loi Lei Lai
2. Power System Stability and Control - P. Kundur

Course code: MEE 2137

Course title: Power System Dynamics

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

The course objective is to provide students with:

1. To know the basic classification of power system stability
2. To understand the concept of dynamic model of synchronous machine excitation system and load
3. To investigate the concept of small signal stability and transient stability
4. To impart the analysis of voltage stability

Syllabus:

Module - 1

Introduction to Power System Stability problem: Stability classification - Small signal & Transient stability, Rotor angle & Voltage stability, Hierarchy of controls in a Power System.

Module - 2

Synchronous machine modelling: Basic equations, dqo transformation, equations of motion, generator operated as part of large power grid.

Module - 3

Excitation System: Requirements of excitation system, Elements of excitation system, Types of excitation system, Modelling of excitation system.

Module - 4

Power system loads: Static load models, Dynamic load models.

Module - 5

Small Signal (Steady State) Stability: Linearization, State matrix, modal analysis technique.

Module - 6

Transient Stability Studies: Network performance equations, alternate solution techniques - Runga Kutta & Trapezoidal, Methods of enhancement of transient stability.

Module - 7

Voltage Stability: Basic concepts related to voltage stability and voltage, Classification, Aspects of voltage stability analysis, Modelling requirements.

Course Outcomes:

At the end of the course, student will be able to-

i. Describe the dynamic model of single and multi machine system
ii. Examine the small signal stability of single and multi machine system
iii. Evaluate the transient stability of electrical system
iv. Investigate the sensitivity analysis and asses the voltage stability
v. Identify reasons for failure of stability of electrical network.

Books Recommended:

1. Power System Stability and Control, P. Kundur.
2. Electric Energy System Theory – O.I. Elgerd
3. Power System Dynamics – K.R.Padiyar

Elective II:

Course code: MEE 2139

Course title: Power System Deregulation

Credits:	L	T	P	C
	3	0	0	3

Class schedule per week: 3 classes per week

.

Course Objectives:

Objective of this course is to provide students to:

i. define power system restructuring and distinguish between regulation and deregulation of electric supply industry.
ii. explain and relate different power system restructuring models.
iii. identify and analyze the different electricity trading mechanism.
iv. analyze and demonstrate different types of congestion management
v. explain and validate economic operations of restructured power system.

Syllabus:

Module- 1

Power System Restructuring: introduction, Regulation vs. Deregulation, Competitive Market for Generation, The Advantages of Competitive Generation, Electric Supply Industry Structure under Deregulation in India

Module- 2

Restructuring Models: Introduction, Monopoly, Single Purchasing Agent Model, Wholesale Competition Model, Pool Model, Bilateral, Different Independent System Operator Model.

Module- 3

International Experiences: Introduction, North American Deregulation Process: California State, Canada, England and Wales, China

Module- 4

Competitive Wholesale Electricity Markets: Introduction, Bidding, Market Clearing and Pricing, Central Auction, Unit Commitment Based Auction Model, Market Power and Mitigation

Module- 5

Transmission Pricing: Introduction, cost components of Transmission system, pricing of transmission services, location based marginal costing.

Module- 6

Congestion Management: Introduction, Different ways of congestion management, impact on marginal price, congestion pricing, Inter-zonal and intra zonai congestion management.

Module- 7

Power system Analysis and operation in deregulated environment: Load Flow, OPF, Profit Based Unit commitment, and Automatic Generation Control in Deregulated environment.

Course Outcomes :

After completion of the course, the learners will be able to:

i. define power system restructuring and distinguish between regulation and deregulation of electric supply industry.
ii. explain and relate different power system restructuring models.
iii. identify and analyze the different electricity trading mechanism.
iv. analyze and demonstrate different types of congestion management
v. explain and validate economic operations of restructured power system.

Text Books

1. Power System Deregulation by Loi Lei Lai

2. Course material on "Operation and Management in Restructured Environment"-Edited by Dr. S.N. Singh, IIT, Kanpur

Reference Book

1. Understanding Electric Utilities and Deregulation by L. Philipson, N.L. Willis.

Course code: MEE 2135

Course title: Advanced Power System Protection

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students:

A. To understand the concepts of static overcurrent, static differential and static distance relays
B. To design and work with the concepts of numerical relaying.
C. To describe the necessity for the protection of alternators, transformers, transmission lines and feeder bus bars from overvoltages and other health hazards.
D. To understand the concepts of relay coordination and protection of substation

Syllabus

Module – I: Review

Methods of discrimination, derivation of relaying quantities, components of protection, specifications for CT & PT for protection and metering, principal types of electromechanical relays, Insulation co-ordination.

Module – II : Static Relays

Basic circuits, components, Transient over voltages and interference, power supplies, output and indicating circuits, application and characteristics.

Module – III: Protection Signalling

Communication media and components, signalling problem and performance requirements, methods of signalling, Using frequency based DSP techniques such as wavelet transform.

Module – IV: Numeric Protection

Introduction, block diagram of numeric relay, Numeric over current protection, Numerical transformer differential protection, Numerical distance protection of transmission lines.

Module – V: Protection Schemes

Phase and earth faults, unit protection of feeders, distance protection, parallel and multi-ended feeders, Autoreclosing, busbar protection.

Module – VI:

Transformer and transformer feeder, Generator and Generator transformer protection, intertripping.

Module – VII:

Substation protection system and relay co-ordination

Course Outcomes:

After the completion of this course, students will be able to:

1. Describe the construction of static relay and identify the advantages of static relay over electromagnetic relay.
2. Identify various types of relaying schemes used for different apparatus protection
3. Analyze the concepts of relay coordination
4. Explore the benefits derived from numerical relaying
5. Explain the necessity of protection in modern power system

TEXT BOOKS & REFERENCE BOOK:

1. Protective Relays: Theory and Practice - AR Van C. Warrington.
2. Protective Relays Application Guide, GEC measurements.
3. Automatic Protection of A.C. Circuits by GW stubbings
4. Carrier Communication Over Power Lines by HK Poolszeck
5. Radio Engineering by FE Terman
6. Power System Protection Vol.I, II, III Peter Peregrinus

Course code: MEE 2115

Course title: Embedded Systems & Applications

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

The course objective is to provide students with an ability to:

1. comprehend the basic functions, structure, concept and definition of embedded systems;
2. interpret ATMEGA8 microcontroller, FPGA & CPLD, TMS320C6713 processors in the development of embedded systems;
3. correlate different serial interfacing protocols(SPI,TWI,I2C,USART);
4. understand interfacing of different peripherals (ADC, DAC, LCD, motors).
.

Syllabus:

MODULE – I

Introduction: Embedded Systems Overview, Processor technology- General purpose processors (Software), Single purpose processors (Hardware), Application- Specific processors; IC Technology- Full-custom/VLSI, Semicustom ASIC (Gate Array and standard cell), PLD, etc.

MODULE – II

Basic Concepts of Computer Architecture: Concepts, Memory, Input/Output, DMA, Parallel and Distributed computers, Embedded Computer Architecture, etc.

MODULE – III

Embedded Processors & Systems: Atmel AVR ATMEGA 8 Micro-controller: Introduction, Major features, Architecture, Application and programming. Timers/Counters, ADC, USART, SPI, TWI, Vectored Interrupts.

MODULE – IV

FPGA: Xilinx XC3S400 FPGA Architecture, XC9572 CPLD Architecture, VHDL Programming (VHDL Synthesis)

MODULE – V

dsp-based controllers: Texas Instrument's TMS320C6713 DSP processor: Introduction, Major features, Architecture, Application and programming.

MODULE – VI & VII

Peripherals and Interfacing: Adding Peripherals and Interfacing- Serial Peripherals and Interfacing- Serial Peripheral Interface (SPI), Inter Integrated Circuit (I^2C), Adding a Real-Time Clock with I^2C, Adding a Small Display with I^2C; Serial Ports - UARTs, RS-232C & RS-422, Infrared Communication, USB, Networks- RS-485, Controller Area Network (CAN), Ethernet, Analog Sensors - Interfacing External ADC, Temperature Sensor, Light Sensor, Accelerometer, Pressure Sensors, Magnetic - Field Sensor, DAC, PWM; Embedded System Applications - Motor Control, and Switching Big Loads.

Course Outcomes:

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

1. visualize the basic elements and functions of ATMEGA8 and FPGA/CPLD in building an embedded system;
2. work with modern hardware/software tools(Xilinx project navigator for synthesis of VHDL codes) for building prototypes of embedded systems;
3. interface various sensors, ADC, DAC, LCD, stepper motors with FPGA/CPLD and ATMEGA8;
4. employ various bus protocols like SPI,TWI,I2C for interfacing peripherals;
5. apply design methodologies for embedded systems, while appreciating the considerations for embedded systems design: specification, technological choice, development process, technical, economic, environmental and manufacturing constraints, reliability, security and safety, power and performance

Text Books:

1. Catsoulis, John, "Designing Embedded Hardware", First/Second Edition, Shroff Publishers & Distributors Pvt. Ltd., New Delhi, India.
2. Vahid, Frank and Givargis, Tony, "Embedded System Design - A Unified hardware/Software Introduction", John Wiley & Sons, (Asia) Pvt Ltd., Replika Press Pvt., Delhi - 110040.
3. Douglas Perry, “VHDL Programming by Example”, TMH publication
4. J. Bhaskar, “A VHDL Primer”, Pearson Education
5. Mazidi & Mazidi, "AVR Microcontrollers", Pearson Education
6. Rulph Chassaing, “Digital Signal Processing and Applications with C6713 and C6416 DSK”, John Wiley and Sons publication.

Reference Books:

1. Stuart R. Ball, “Embedded Microprocessor Systems, Real World Design”, Second Edition, Newnes publication.
2. Nasser Kehtarnavaz, “Real Time Digital Signal Processing based on the TMS320C6000”, Elsevier publication.

Course Code : MEE 2157

Course Title : Renewable Sources of Electrical Energy

Credits:	**L**	**T**	**P**	**C**
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

1. To educate students about different sources of energy (conventional, non-conventional, renewable etc.)
2. To give an exposure of solar energy, wind energy, biomass and small hydro energy generation.
3. To impart knowledge about the storage of electrical energy.
4. To train the students for integration of renewable electrical energy sources to the electrical grid.

Syllabus:

Module – I

Energy Scenario: Classification of Energy Sources, Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. Worldwide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts. Global environmental concern, Kyoto Protocol, Concept of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF). Factors favoring and against renewable energy sources, IRP

Module – II

Solar Energy: Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications. Photo voltaic (PV) technology: Present status, - solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components , sizing and economics. Peak power operation, Solar tracking system, Standalone and grid interactive systems.

Module – III

Wind Energy: Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation.

Module – IV

Biomass Energy System: Biomass – various resources, energy contents, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Cofiring, Generation from municipal solid waste, Issues in harnessing these sources.

Module – V

Hydro energy: Feasibility of small, mini and micro hydel plants scheme layout economics. Tidal and wave energy, Geothermal and Ocean-thermal energy conversion (OTEC) systems – schemes, feasibility and viability.

Module – VI

Energy storage and hybrid system configurations: Energy storage: Battery – types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Fly wheel- energy relations, components, benefits over battery. Fuel Cell energy storage systems. Ultra Capacitors.

Module – VII

Grid Integration: Grid integration with the system: Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling.

Course Outcomes: Student will be able to:

1. gain knowledge of different renewable sources and storage method of electrical energy
2. perform experiments to measure characteristics of photovoltaic cell
3. design renewable / non conventional source of energy
4. design circuits for generation of maximum power from solar energy
5. integrate renewable sources to the electrical grid.

Text Books:

1. Renewable energy technologies - R. Ramesh, Narosa Publication.
2. Energy Technology – S. Rao, Parulkar
3. Non-conventional Energy Systems – Mittal, Wheelers Publication.

Reference Books:

1. Wind and solar systems by Mukund Patel, CRC Press.
2. Solar Photovoltaics for terrestrials, Tapan Bhattacharya.
3. Wind Energy Technology – Njenkins, John Wiley & Sons
4. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern.
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill.
6. Solar Energy – S. Bandopadhay, Universal Publishing.
7. Guide book for National Certification Examination for EM/EA – Book 1

Course Code : MEE 2136

Course Title : Power System Laboratory

Credits:	**L**	**T**	**P**	**C**
	3	0	0	2

Class schedule per week: 3 classes per week

LIST OF EXPERIMENTS:

EXPERIMENT : 01
AIM: Power factor control for an inductive load

EXPERIMENT: 02
AIM: Power system fault analysis using DC network analyzer.

EXPERIMENT: 03
AIM: Determination of ABCD parameters and voltage profile for an artificial transmission line of 600 km.

EXPERIMENT: 04
AIM: Determination of over current relay characteristic (IDMT characteristics) using relay test setup.

EXPERIMENT: 05
AIM: To control the receiving end voltage in Transmission line by a microcomputer controlled static VAR compensator.

EXPERIMENT: 06
AIM: Measurement of negative and zero sequence reactance of an alternator.

EXPERIMENT-07
AIM: - To determine the phase sequence of 3-phase supply using RC method and 2 bulb method.

EXPERIMENT: 08
AIM: To obtain Ferro Resonance characteristics of a single phase transformer at no load.

EXPERIMENT: 09
AIM: Determination of Zero sequence impedance and reactance of a transformer.

EXPERIMENT: 10
AIM: Earth resistance measurement by Earth Tester

Course Outcomes:

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

I. To outline theoretical knowledge and estimate practical outcomes.

II. To interpret the possible practical values of different experiments and individual parameters measured
III. Apply and Analyze the techniques, skills and modern engineering tools necessary for engineering practice
IV. Conclude by justifying the output of the experimental output with theoretical and practical outputs respectively and take corrective measures as necessary
V. Ability to compile the experimental data, prepare write-ups.

Text Books:

- Electric Power System – C. L. Wadhwa, 6th edition, 2013, New Age International Publishing.

Reference Books:

- Electric Energy Systems Theory - An Introduction – O. I. Elgerd, 27th reprint, 2007, TMH.
- Power System Engineering – A. Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar, 4th edition, 2008, Dhalpat Rai & Co.

Course Code : MEE 2142

Course Title : Power System Simulation Lab.

Credits:	**L**	**T**	**P**	**C**
	3	0	0	2

Class schedule per week: 3 classes per week

Course Objectives:

A. enable the students to apply different equations used in load flow analysis and thereby applying the analysis for line overloading removal and voltage improvements, rating selection of protection devices for different types of short-circuits;

B. expose the students about the necessity of economic operation power systems through cost efficient power dispatch;

C. develop classical and numerical solution techniques for understanding angle stability;

D. teach the students about the ways of representation of power system network and thereby simulate different situations occurred in the network.

LIST OF EXPERIMENTS:

1. Simulation of IEEE 14 and IEEE 30 bus system.
2. Study and analysis of the load flow result for IEEE 14 and 30 Bus systems.
3. Variation of voltage magnitude and angle with variation of real and reactive power at any load bus.
4. Comparison between Gauss Siedal and Newton Raphson method for load flow analysis.
5. Study of line performance at different conditions and placement of Reactive VAR compensators as per requirement.
6. To examine the effect of line outage of IEEE 30 bus system and to reduce the overloading by generation re-scheduling.
7. Economic Load Dispatch of Generators neglecting transmission loss.
8. Economic Load Dispatch of Generators considering Transmission loss.
9. Study of symmetrical and unsymmetrical fault analysis and to observe the result by creating faults at different buses.
10. Power System Stability analysis.

Course Outcomes:

After the completion of this course, students will be able to:

1. understand the purposes and importance of different analysis taught in power system classes through simulating the network and disturbances;

2. develop mathematically different contigent cases and situations occurred from different disturbances and thereafter the consequences arised from each case;
3. suggest the solutions for every case;
4. compare different methods to solve load flow problems;
5. comprehend and write technical observations referring the results for each case.

Text Books:

- Power System Analysis – Hadi Saadat, Tata McGraw-Hill Edition, 2002.
- Electric Power System – C. L. Wadhwa, 6th edition, 2013, New Age International Publishing.

Reference Books:

- Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, 4th edition, 2014, Tata-McGraw Hill.
- Electric Energy Systems Theory - An Introduction – O. I. Elgerd, 27th reprint, 2007, TMH.
- Power System Engineering – A. Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar, 4th edition, 2008, Dhalpat Rai & Co.