1st Year 1st Semester								
Sl. No.	**Category**	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	CC1	MEPSC101	Research Methodology and IPR	2	0	0	2	2
2	CC2	MEPSC102	Advanced Power System Analysis	3	0	0	3	3
3	CC3	MEPSC103	High Voltage Transmission System	3	0	0	3	3
4	DSE1 DSE2 DSE3 DSE4	MEPSD101 MEPSD102 MEPSD103 MEPSD104	Elective – I	3	0	0	3	3
5	DSE5 DSE6 DSE7 DSE8	MEPSD105 MEPSD106 MEPSD107 MEPSD108	Elective – II	2	0	0	2	2
6	AUD1 AUD2 AUD3 AUD4 AUD5	AUDEE101 AUDEE102 AUDEE103 AUDEE104 AUDEE105	**Audit courses:** Disaster Management; Constitution of India; Personality Development through Life Enlightenment skills; Stress Management by Yoga; Sanskrit for Technical knowledge;	2	0	0	2	0
Total of Theory							15	13
B. PRACTICAL								
7	CC2	MEPSC192	Advanced Power System Analysis Lab-I	0	0	3	3	2
8	CC3	MEPSC193	High Voltage Transmission System Lab-II	0	0	3	3	2
9	SEC1	MEPSS181	Seminar I	0	0	2	2	1
Total of Practical							8	5
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional							23	18

1st Year 2nd Semester								
Sl. No.	**Category**	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	CC4	MEPSC204	Power System Operation and Control	3	0	0	3	3
2	CC5	MEPSC205	Power System Instrumentation	3	0	0	3	3
3	CC6	MEPSC206	Advanced Power System Protection	3	0	0	3	3
4	DSE9 DSE10 DSE11	MEPSD2090 MEPSD2010 MEPSD2011	Elective – III	2	0	0	2	2
5	DSE12 DSE13 DSE14	MEPSD2012 MEPSD2013 MEPSD2014	Elective - IV	2	0	0	2	2
6	AUD6	AUDPS206	**Audit Course** – any one subject from Elective III or Elective IV bucket	3	0	0	3	0
Total of Theory							16	13
B. PRACTICAL								
7	CC4	MEPSC294	Power System Operation and Control Lab;	0	0	3	3	3
8	CC5	MEPSC295	Power System Instrumentation;	0	0	3	3	3
9	SEC2	MEPSS282	Seminar II	0	0	2	2	1
Total of Practical							8	7
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional							24	20

2nd Year 3rd Semester								
Sl. No.	**Category**	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	AECC2	MEPSA302	Introduction to Management	3	0	0	3	3
2	DSE15 DSE16 DSE17	MEPSD3015 MEPSD3016 MEPSD3017	Elective V	3	1	0	3	3
Total of Theory							6	6
B. PRACTICAL								
3	SEC3	MEPSS83	Dissertation (Part I)	0	0	0	20	10
Total of Practical							20	10
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional							26	16

2nd Year 4th Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	SEC4	MEPSS484	Dissertation (Completion)	0	0	0	32	16
Total of Theory							32	16
B. PRACTICAL								
2								
Total of Practical								
C. SESSIONAL								
3								
Total of Theory, Practical and Sessional								

Total Credits: 18+18+16+16=68

Elective I

i) Power System Planning and Reliability
ii) Power System Apparatus
iii) Power Quality
iv) Advanced Power Electronics

Elective II

i) Optimization Techniques
ii) Digital Signal Processing
iii) Object Oriented Programming
iv) Soft computing technique

Elective III

i) Power System Transient
ii) Flexible A.C. Transmission System
iii) Advanced Electrical Drives

Elective IV

i) Advanced Control System
ii) Modeling and Simulation of dynamic systems
iii) Advanced Microprocessor and Microcontroller

Elective V

i) Non-conventional Energy
ii) Power System Harmonic

Course Name: Research Methodology and IPR Course	**Duration:** 6 Months
Course Code: MEEA101	**Contact:**
Semester: I	**Credit:** 2

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO1.
CO2.
CO3.

Course Content

Unit No	Module Name	Content	Hrs
I		Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	**4**
II		Effective literature studies approaches, analysis Plagiarism, Research ethics.	**4**
III		Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	**2**
IV		Research Planning and Sampling, Types of Research Methods and brief explanation of each method, Design of Experiments, Tools of Research, Collection and Analysis of Data, research Report.	**6**
V		Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases.	**6**
VI		New developments in IPR: Administration of Patent System. New developments in IPR, IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies.	**2**

Books/ Learning Resources:

1. Kothari C.R., "Research Methodology Methods and techniques", New Age International, 2004, ISBN: 9788122415223
2. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., "Management Research Methodology", Pearson Education India, 2009 Edition, ISBN:9788177585636
3. Levin, R.I. and Rubin, D.S., "Statistics for Management", 7th Edition, Pearson Education: New Delhi, ISBN-13: 978-8177585841
4. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students""
5. Ranjit Kumar, 2 nd Edition, "Research Methodology: A Step by Step Guide for beginners"
6. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
7. Mayall, "Industrial Design", McGraw Hill, 1992
8. Niebel, "Product Design", McGraw Hill, 1974
9. Asimov, "Introduction to Design", Prentice Hall, 1962

Course Name: Advanced Power System Analysis	**Duration:** 6 Months
Course Code: MEEC101	**Contact:** 3L
Semester: I	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO4.
CO5.
CO6.

Course Content

Unit No	Module Name	Content	Hrs
I	**Network matrix**	Physical interpretation of bus admittance and impedance matrices, introduction to admittance matrix formulation, formation of admittance matrix due to inclusion of regulating transformer, development of admittance matrix using singular transformation, modification of admittance matrix for branch addition/ deletion.	**8**
II	**Complex power flow**	Analytical formulation of complex power flow solution, Gauss-Seidal method of power flow, Newton Raphson method of power flow, algorithm for solving power flow problem using N-R method in rectangular form, algorithm for solving power flow problem using N-R method in polar form, fast decoupled load flow method.	**12**
III	**Power System Stability**	Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study.	**2**
IV	**Transient stability**	Assumptions for transient stability, derivation of swing equation, swing equation for synchronous machine connected to infinite bus, swing equation for a two machine system, solution of swing equation by Euler and Runge Kutta method, equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine. Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing , electric braking, voltage regulators, fast governor action, high speed excitation system.	**12**
V	**Voltage stability**	Definition and classification of voltage stability, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, expression	**6**

		for critical receiving end voltage and critical power angle at voltage stability limit for a two bus power system, PV and QV curves, L index for the assessment of voltage stability.	

Books/ Learning Resources:

1. Chakrabarti, M.L. Soni, P. V. Gupta, U. S. Bhatnagar "A text book on Power System Engineering", Dhanpat Rai and Co.
2. Power system Analysis by Hadi Saadat: Tata McGraw-Hill Publishing Company Limited.
3. Power system Analysis by Charles A. Gross: John Wiley & Sons.
4. Power system Analysis by John J. Grainger & William D. Stevenson, JR: Tata McGraw-Hill Edition.

Course Name: High Voltage Transmission System	**Duration:** 6 Months
Course Code: MEEC102	**Contact:** 3L
Semester: I	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO7.
CO8.
CO9.

Course Content

Unit No	Module Name	Content	Hrs
I		High voltage transmission line trends and preliminary aspects of standard transmission voltages. Comparison between HVAC and HVDC transmission, planning for HVDC transmission, links, properties of HVDC thyristor valves, components of HVDC transmission system.	**4**
II	**HVDC converters**	6 pulse converter circuits and working principle, converter bridge characteristics, working principle and characteristics of a twelve pulse converter with two & three valve conduction mode, three valve conduction mode and three and four valve conduction mode.	**10**
III	**Calculation of line resistance and inductances**	Resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductors lines and multi-conductor lines, Maxwell's coefficient matrix.	**8**

IV	**Line capacitance calculation**	Capacitance of two conductor line and capacitance of multi conductor lines, potential coefficient for bundled conductor lines, sequence inductance and capacitances.	**6**
V	**Corona**	Corona in EHV lines- corona loss formulates- Audio noise due to corona, its generation, characteristics and limits measurement of audio noise.	**4**
VI		Introduction of Electric Field calculation, Uniqueness theorem, Field calculation by finite difference method with equal and unequal nodal distance in 2-D and 3D system.	**8**

Books/ Learning Resources:

1. Rakosh Das Begamudre,'Extra high voltage ac transmission engineering' New Age International Publisher.
2. Padiyar K. R. 'HVDC transmission systems' Wiley.
3. Arrilaga, J. 'High voltage direct current transmission' Peter Pereginver Ltd, London

Course Name: Power System Planning and Reliability	**Duration:** 6 Months
Course Code: MEPSD101	**Contact:** 3L
Semester: I	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO10.
CO11.
CO12.

Course Content

Unit No	Module Name	Content	Hrs
I	**Load Forecasting**	Load Forecasting Categories-Long term, Medium term, short term, very short term Applications of Load Forecasting, Factors Affecting Load Patterns Medium and long term load forecasting methods-end use models, econometric models, statistical model based learning. Short Term Load Forecasting (STLF): Applications of Load Forecasting, methods - similar day approach, regression methods, time series, ANN, Expert systems, Fuzzy logic based method, support vector machines ANN architecture for STLF, Seasonal ANN, Adaptive Weight, Multiple-Day	

		Forecast, STLF Using MATLAB'S ANN Toolbox, Training and Test Data, Stopping Criteria for Training Process, sensitivity analysis.	
II	**Power System Reliability**	Basic Notions of Power System Reliability- sub systems, reliability indices, outage classification, value of reliability tools, Concepts and methodologies, power system structure, Reliability based planning in power systems, Effect of failures on power system, Planning criteria, Risk analysis in power system planning, multi-state systems.	
III	**Basic Tools and Techniques**	Random processes methods & Markov models, Computation of power system reliability measures by using Markov reward models, Evaluation of reliability indices, Universal Generating Function (UGF) Method, Monte Carlo simulation.	
IV	**Reliability of Generation Systems**	Capacity outage calculations, reliability indices using the loss of load probability method, unit commitment and operating constraints, optimal reserve management, single and multi-stage expansion.	
V	**Reliability Assessment for Elements of Transmission and Transformation Systems**	Reliability indices of substations based on the overload capability of the transformers, evaluation and analysis of substation configurations, Reliability analysis of protection systems for high voltage transmission lines.	

Books/ Learning Resources:

1. Markey operations in electric power systems Forecasting, Scheduling, and Risk Management, Shahidehpour M, Yamin H, Li z, John Wlley & sons
2. Reliability evaluation of power systems, Billinton R, Allan R (1996) Plenum Press New York
3. Computational Methods in Power system Reliability, D. Elmakias, Springer-Verlag

Course Name: Power System Apparatus	**Duration:** 6 Months
Course Code: MEPSD101	**Contact:** 3L
Semester: I	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO13.
CO14.
CO15.

Course Content

Unit No	Module Name	Content	Hrs
I	**Circuit Breaker**	Introduction, Operating Principle, Detail study on VCB and SF6 Circuit breaker, Ratings, Selection. Surge Arrester & Surge Absorber. Insulation Co-ordination, BIL.	**6**
II	**FACTS**	Concepts and general system consideration: Opportunities for FACTS. Basic types of FACTS controllers. Brief description and definition of FACTS controllers. Shunt connected controllers. Series Connected controllers. Combined Shunt and Series connected controllers.	**8**
III	**Static Shunt Compensators**	Objectives of Shunt Compensations. Midpoints voltage regulation for line segmentation. Improvements of transient stability, Methods of controllable VAR generation. Variable impedance type static VAR generation, TCR and TSR, FC-TCR (Fixed Capacitor, Thyristor Controlled Reactor), Hybrid VAR Generators. Static VAR Compensator (SVC & STATCOM). Transfer Function and Dynamic Performance. Power Oscillation, Damping. Transient Stability.	**12**
IV	**Static Series Compensators**	GCSC, TSSC, TCSC and SSSC: Basic Operating Control Schemes for GCSC, TSSC and TCSC.	**6**
V	**Static Voltage and Phase Angle Regulators**	TCVR and TCPAR. Unified power flow controllers.	**4**

Books/ Learning Resources:

1. Understanding FACTS by Narain G. Hingorani & Laszlo Gyugyi: IEEE Press.
2. Power System Switchgear & Protection by Sunil S. Rao.

Reference Books:

Course Name: Power Quality	**Duration:** 6 Months
Course Code: MEPSD103	**Contact:** 3L
Semester: I	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO16.
CO17.
CO18.

Course Content

Unit No	Module Name	Content	Hrs
I	**Electric power quality phenomena**	Impacts of power quality problems on end users, Power quality standards, power quality monitoring.	
II	**Power quality disturbances**	Transients, short duration voltage variations ,long duration voltage variations, voltage imbalance, wave-form distortions, voltage fluctuations, power frequency variations, power acceptability curves.	
III	**Power quality problems**	Poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage.	
IV	**Transients**	Origin and classification- capacitor switching transient-lighting-load switching-impact on users-protection- mitigation.	
V	**Harmonics**	Harmonic distortion standards, power system quantities under non sinusoidal conditions-harmonic indices-source of harmonics-system response characteristics-effects of harmonic distortion on power system apparatus –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response- Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.	
VI	**Power quality conditioners**	Shunt and series compensators, Dstatcom-dynamic voltage restorer, unified power quality conditioners.	

Books/ Learning Resources:

1. Ghosh Arindam and Ledwich Gerard, 'Power quality enhancement using custom power devices' Springer.
2. Arrillaga J., Watson N. R. and Chen S., 'Power System Quality Assessment' Wiley.
3. Caramia P, Carpinelli G and Verde P, 'Power quality indices in liberalized markets' – Wiley
4. Angelo Baggini 'Handbook of Power Quality' – Wiley.

Course Name: Advanced Power Electronics	**Duration:** 6 Months
Course Code: MEPSD104	**Contact:** 3L
Semester: I	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO19.
CO20.
CO21.

Course Content

Unit No	Module Name	Content	Hrs
I	**Uncontrolled and Controlled Rectifiers**	Single-Phase and Three-Phase Uncontrolled rectifiers. Phase controlled Rectifiers: Principle of operation of single phase and three phase semi-controlled, full controlled converters with R, R-L and RLE loads. Effects of source inductance on the performance of converters. Performance parameters of converters, Dual converters, Solution of problems.	
II	**Inverters**	Principle of operation of single phase inverter, 120º and 180° conduction mode of operation of three phase inverter, performance parameters of inverters, PWM techniques, Sinusoidal PWM, modified Sinusoidal PWM - multiple PWM Voltage and harmonic Control, introduction to Space vector modulation method, Series resonant inverter-Current Sources Inverter.	
III	**FACTS & Compensators**	Introduction, Principles of shunt and series compensation, TCR, TCS, SVC, TSSC, TCSC, UFC, comparison, Matrix converters: Basic principles and analysis, applications.	
IV	**DC-DC Converters**	Principle of operation, control strategies, Step up and Step down choppers, Buck, Boost, Buck - Boost and Cuk Converters, Full bridge dc-dc converter, Flyback converter, Concept of Resonant Switching.	

Books/ Learning Resources:

1. M. H. Rashid, “Power Electronics: Circuits, Device and Applications”, 2nd Ed. 1993, Prentice-Hall, Inc.
2. N. Mohan, T. M. Undeland, and W. P. Robbins, “Power Electronics: Converters, Application and Design”, 3rd. Ed., John Wiley, 2003
3. A. M. Trzynadlowski, “Introduction to Modern Power Electronics” John Wiley, 1998

Course Name: Optimization Techniques	**Duration:** 6 Months
Course Code: MEPSD105	**Contact:** 2L
Semester: I	**Credit:** 2

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO22.
CO23.
CO24.

Course Content

Unit No	Module Name	Content	Hrs
I	**Fundamentals of Optimization Techniques**	Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-Classical Optimization techniques (Lamda Iteration method, Linear programming, Quadratic programming).	
II	**Lamda iteration method**	Brief introduction to lamda iteration method, formulate the Lagrange function, Lamda iteration method to solve Optimal dispatch problem.	
III	**Quadratic programming**	Introduction to quadratic programming, Working principle, sequential programming, Linear constrained optimization problem, Karush-Kuhn-Tucker conditions and its application to solve various problems, Interior point.	
IV	**Linear programming**	Examples of linear programming problem, The Simplex Method I, Fundamental theorem of linear programming, Weak and strong duality theorems, Integer programming, Network flow, develop a linear programming model from problem description.	
V	**Genetic Algorithm**	Introduction to genetic Algorithm, working principle, Principles of Genetic Algorithm-Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation fitness function. GA operators; Similarities and differences between GA and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm.	
VI	**Particle Swarm Optimization**	Fundamental principle-Velocity Updating-Advanced operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial	
VII	**Differential Evolution**	Fundamental principle, developing DE based	

		solution techniques for OPF problems with single and multiple objectives and comparing the performance and computational effectiveness of DE with other evolutionary and conventional techniques.	
VIII	**Application of population based optimization techniques in power systems**	Algorithms and flow chart of various optimization techniques for solving economic load dispatch and hydro-thermal scheduling problem.	

Books/ Learning Resources:

1. S.S.Rao, Engineering Optimization, 3rd Edition, New Age International (P) Ltd.
2. Genetic Algorithm – D.E.Goldberg
3. Principle of soft computing by S.N.Sivanandam & S.N. Deepa
4. Soft computing Technique and its application in electrical Engineering by Chaturvedi,
5. Optimization on Power system Operation by Jizhong Zhu Wiley-IEEE Press.
6. An Introduction to Optimization, 3rd Edition by K.P. Chong, Stanislaw H. Zak.

Course Name: Soft Computing Techniques	**Duration:** 6 Months
Course Code: MEPSD106	**Contact:** 2L
Semester: I	**Credit:** 2

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO25.
CO26.
CO27.

Course Content

Unit No	Module Name	Content	Hrs
I		Introduction to Soft Computing, components of soft computing, traditional computing and drawbacks, advantages of soft computing techniques.	**2**
II		Introduction to fuzzy logic: definition, general idea and importance in practical life. Fuzzy set theory: concept of fuzzy set, membership functions, comparison of fuzzy set and classic al set. Operations on fuzzy sets, properties of standard operations, T norm and S norm, Extension	**24**

		principle and application. Height of fuzzy set, core of fuzzy set, support of fuzzy set, normal fuzzy set, normalization of fuzzy set, level set, α cut and strong α cut of fuzzy set, concentration and dilation of fuzzy sets, fuzzy singleton, crossover points. Fuzzy relation: fundamentals of fuzzy relations, operations on fuzzy relations, composition of fuzzy relations, fuzzy reasoning, fuzzy relation inferences, compositional rule of inference, fuzzification. Fuzzy methods in control theory: Introduction to fuzzy logic controller, types of fuzzy logic controllers, basic structure of fuzzy knowledge based controllers, defuzzification methods, applications of fuzzy logic control.	
III		Introduction to artificial neural networks, artificial neuron model, types of activation functions. Learning in neural networks, feed forward and feedback neural networks, backpropagation training algorithm, Hopfield network, Boltzman machine. Self-organizing map, learning vector quantization algorithm.	**10**
IV		Basic concept of genetic algorithm, comparison of GA and traditional techniques, objective function and fitness function, crossover, mutation, GA search, applications of GA.	**6**

Books/ Learning Resources:

1. Klir, G.J. & Yuan,B.- Fuzzy sets and Fuzzy logic, theory and applications, Prentice Hall of India Private Limited.
2. M. Ganesh - Introduction to fuzzy sets and fuzzy logic, PHI.
3. N. P. Padhy – Artificial intelligence and intelligent systems, Oxford.
4. Timothy J. Ross – Fuzzy logic with engineering applications, Wiley.
5. Nie and Linkens,- Fuzzy Neural Control-Principles, Algorithms and Application, PHI
6. J.S.R. Jang, C.T. Sun, E. Mizutani - Neuro-fuzzy and soft computing, PHI.
7. Kosco, B.-Neural Networks and Fuzzy System.PH
8. Haykin- Neural Network; A Comprehensive Foundation, PHI
9. Rajasekaran and Pai – Neural Networks , Fuzzy Logic and Genetic algorithms: Synthesis and Application, PHI.
10. Goldberg- Genetic Algorithms, Pearson.

Course Name: Digital Signal Processing	**Duration:** 6 Months
Course Code: MEPSD106	**Contact:** 2L
Semester: I	**Credit:** 2

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO28.
CO29.
CO30.

Course Content

Unit No	Module Name	Content	Hrs
I	**Description of Signals and Systems**	Types of signals and their characteristics, types of systems and their behavior.	
II	**Discrete-time description of signals**	Discrete-time sequences, their frequency domain behaviour, comparison with analog signals, convolution of two sequences, sampling a continuous function to generate a sequence, reconstruction of continuous-time signals from discrete-time sequences.	
III	**Discrete-time description of systems**	Unit-sample response of a system, Time-invariant systems, Superposition principle for linear systems, Stability criterion for discrete-time systems, Causality criterion for discrete-time systems.	
IV	**Discrete-time Fourier transform**	Definition of Fourier transform (FT), important properties of FT, properties of FT for real- valued sequences, use of FT in signal processing, FT of special sequences, the inverse FT, FT of the product two discrete -time sequences.	
V	**Discrete Fourier Transform**	The definition of the Discrete Fourier Transform (DFT), efficient computation of DFT, properties of the DFT.	
VI	**Digital filter**	Definition and anatomy of a digital filter, frequency domain description of signals and systems, replacing analog filters with digital filters, filter categories: IIR and FIR, recursive and non-recursive.	
VII	**Optimal and adaptive filters**	Wiener filtering technique, adaptive filters and their applications.	
VIII	**Spectrum estimation and analysis**	Principles, Periodogram method, Blackman – Turkey method, fast correlation method. Autoregressive spectrum estimation.	
IX	**Wavelet Transforms**	Fourier Transform and its limitations, Short Time Fourier Transform, introduction of Continuous	

		Wavelet Transform, Discretization of the Continuous Wavelet Transform (DWT).	

Books/ Learning Resources:

1.
2.

Course Name: Object Oriented Programming	**Duration:** 6 Months
Course Code: MEPSD107	**Contact:** 2L
Semester: I	**Credit:** 2

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO31.
CO32.
CO33.

Course Content

Unit No	Module Name	Content	Hrs
I	**Objective oriented programming paradigm**	Introduction – reusability – security – object oriented programming fundamentals –abstraction - encapsulation-derivation –object oriented languages and packages.	**5**
II	**Classes and objects**	Introduction to C++ - procedural oriented approach to C++ - data types – control structures – problem solving - standard input and output streams – C++ enhancements – function prototypes - defaults reference variables – constants – classes – constructors – destructors – constraint objects – member objects and the functions.	**15**
III	**Advanced features**	Dynamic memory allocation pointers – new and delete operators – classes with pointers – copy constructor – static member– friend classes – friend functions– operator overloading.	**10**
IV	**Polymorphism and inheritance**	Function overloading – connection classes – derived classes – class conservation – protected members – virtual functions – dynamic binding – abstract classes – multiple inheritances – templates error handling.	**10**
V	**Case studies**	Overview of typical object oriented systems– case studies – application to electrical engineering.	**5**

Books/ Learning Resources:

1. Stanley B. Lipman , C++ primer, Addison Wesley, 1989
2. Bertrand Meyar, Object softwere construction, Prentice Hall, 1988
3. K.R. Dittrich et al , On object oriented data base system , Springer Verlag , 1991

Course Name: Power System Operation and Control	**Duration:** 6 Months
Course Code: MEPSC204	**Contact:** 3L
Semester: II	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO34.
CO35.
CO36.

Course Content

Unit No	Module Name	Content	Hrs
I	**Optimal Generation Scheduling**	Power flow scheduling using economic load dispatch, power flow scheduling using Lagrange multiplier method, penalty factor, scheduling with network losses, hydrothermal coordination with and without losses, cascaded and pump storage plant scheduling, unit commitment, unit commitment solution methods, introduction to optimal power flow solution using Newton Raphson method.	**12**
II	**Automatic Generation Control**	Types of alternator exciters, automatic voltage regulators for generator excitation control, static and dynamic performance of AVR loop, automatic load frequency control, primary automatic load frequency control loop, secondary automatic load frequency control loop, extension of automatic load frequency control loop to multi area systems, tie line power flow model.	**12**
III	**Power System Security**	Security analysis, security assessment, contingency analysis, algorithm to determine system security following contingency analysis procedure, security assessment using ac power flow model, security analysis using concept of performance index.	**6**
IV	**State Estimation and load forecasting**	Methods of state estimation – least square and weighted least square estimation, bad data detection and suppression of bad data, load forecasting, load forecasting techniques – methods of extrapolation and correlation, estimation of average and trend terms of deterministic part of load – limitation of the method, prediction of deterministic load, generalized load modeling, estimation of periodic components, estimation of stochastic part of load – time series approach.	**12**

Books/ Learning Resources:

1. Power System Analysis, Operation and Control, Abhijit Chakrabarti and Sunita Halder PHI.
2. Power Generation Operation and Control, Allen J. Wood, Bruce F. Woolenburg

Course Name: Power System Instrumentation	**Duration:** 6 Months
Course Code: MEPSC205	**Contact:** 3L
Semester: II	**Credit:** 3

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO37.
CO38.
CO39.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction**	Power generating Station – Thermal, Hydel, Nuclear, Wind – Their functional characteristics as processes, Components of power Grid – interdependency between different blocks, Review of Mechanical, Electrical, Electronics, Thermal, Optical, Pneumatic, fluidics.	**6**
II	**Thermal Power Generation**	Coal handling plant – coal feed rate measurement, determination of calorific value. Water treatment Boiler – Feed water, pressure, temperature, steam flow rate, flue gas analysis, optical pyrometer Turbine – Speed, shaft eccentricity, temperature Condenser – pressure, temperature Generator – Speed, hydrogen leakage Control and protection systems of a thermal power plant. Thermal power generation from nuclear reactor. Ash handling and pollution control.	**14**
III	**Hydel Power Plant**	Types - flow rate, Water pressure	**2**
IV	**Wind Power**	Principles – synchronization with grids	**1**
V	**Transformer**	Transformer oil, hot spot, moisture detection,	**2**
VI	**Transmission Lines**	Fibre optics meter for high voltage and high current measurement, Transmission line sag	**2**

		measurement using triangulation technique.	
VII	**Tariff**	Objective, Available based tariff, Digital energy meter, Remote terminal unit (RTU)	**3**
VIII	**Local Dispatch Centre**	Data handling – Processing, Logging, Acquisition, Accounting, Display and Storage, SCADA, Techniques of Data acquisition at Central Load Dispatch Centres for coordinated control of the grid.	**6**
IX	**IS specification**	Introduction, Application and Relevancy of IS specification in perspective of power system instrumentation.	**2**

Books/ Learning Resources:

1. Modern Power Station Practice – Vol: C, Vol: D, Pergamon Press
2. Principles of Industrial Instrumentation - D Patranabish, TMH, New Delhi
3. Industrial Instrumentation Control and Automation – S Mukhopadhyay, S.Sen, A. Deb – Jaico Publishing House, Mumbai.
4. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co. Philadelphia

Course Name: Advanced Power System Protection	**Duration:** 6 Months
Course Code: EMPSC206	**Contact:** 3L
Semester: II	**Credit:** 4

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO40.
CO41.
CO42.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction**	Protective Relays; Basic requirements and type of protection, reviews of relay characteristics and operating equations, protective CTs, PTs, , phase and amplitude comparator, classification of Electromagnetic relays, Plug Setting Multiplier and Time Multiplier setting, Universal Torque Equation, Non Directional Relay, Directional relay, Distant relay, Differential relay.	**8**

II	**Protection of Alternators**	Protection against Stator fault (Phase to Phase and Phase to Ground), Balanced earth fault protection, Stator inter turn protection, Unbalanced loading of Alternator, Prime Mover failure, Overvoltage protection, Overloading (or over current) Protection, Restricted Earth fault and standby earth fault protection, Rotor Fault Protection.	**4**
III	**Protection of Transformer**	Overcurrent and unrestricted Earth fault protection, Different CT connections, Balanced (Restricted) earth fault protection, Harmonic restraint, Frame leakage protection.	**3**
IV	**Bus bar, Feeder, Transmission line Protection**	Bus bar Protection: Circulating Current Protection, Frame Leakage Protection. Feeder protection: Time Graded protection, Differential Protection. Transmission Line Protection: Introduction to distance relay, Simple Impedance relay, Reactance relay, Mho relays, comparison of distance relay – Choice between Impedance, Reactance and Mho relay, High speed Impedance relay, setting of distance relays. Pilot Relaying Schemes: Wire Pilot Protection, Carrier Current Protection.	**10**
V	**Static Relay Introduction**	Basic construction of static relays, advantages and disadvantages of Static Relay, different types of static relays (static overcurrent, static time overcurrent, static instantaneous overcurrent, directional static overcurrent, static differential and static distance relay) comparators and associated elements, system switching and transient effects	**6**
VI	**Protection of High Voltage Capacitor Bank**	Including consideration of inrush current, over current and over voltage, and differential protection scheme.	**2**
VII	**Protection Of large Motors**	Differential protection, Earth fault Protection, Thermal overload protection, Starting and Stalling currents and effect of negative Sequence current.	**3**
VIII	**Digital Relay**	Introduction, protection philosophy, basic hardware and protection schemes, protection algorithms, microprocessor based digital relaying.	**4**

Text Books:

1. A. Chakrabarti,M.L. Soni, P. V. Gupta, U. S. Bhatnagar “A text book on Power System Engineering”, Dhanpat Rai and Co.
2. Paithankar.Y.G and Bhide.S.R, “Fundamentals of Power System Protection”, Prentice-Hall of India.
3. Badri Ram and Vishwakarma.D.N, “Power System Protection and Switchgear”, Tata McGraw-Hill Publishing Company, 2002.
4. Arun K. Phadke, James. S. Thorp, “Computer relaying for Power system”, John Wiley and sons, New York, 1998.

Reference:

1. Power System Protection, PM Anderson, IEEE Press Book
2. Protective Relays Application and Guide, GEC Measurements
3. Jones D., " Analysis and protection of electrical power systems", Pitman Publishing, 1971.
4. "Power system reference manual, Ray rolls protection", Orient press, 1982.
5. Stanley H., Horowitz (ED), "Protective relaying for power system", IEEE press, 1980.

Course Name: Power System Transients	**Duration:** 6 Months
Course Code: MEPSD209	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO43.
CO44.
CO45.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction and survey**	Review of various types of power system transients – effect of transients on power systems – relevance of the study and computation of power system transients.	**5**
II	**Lighting surges**	Electrification of thunderclouds – lightning current surges – lightning current parameters and their values – stroke to tower and midspan – induced lightning surges.	**10**
III	**Switching surges**	Closing and reclosing of lines – load rejection – fault initiation – fault clearing – short line faults – Ferro – resonance – isolator switching surges – temporary over voltages – surge on an integrated system – switching – harmonics.	**10**
IV	**Computation of transient in conversion equipment**	Travelling wave method – Beweley's Lattice diagram – analysis in time and frequency domain – Eigen value approach – Z-transform – EMTP software.	**10**
V	**Insulation coordination**	Over voltage protective devices – shielding wires, rods gaps and surge diverters, principles of insulation coordination-recent advancements in insulation coordination– design of EHV system.	**10**

Reference:

1. Allan Greenwood, Electrical transients in Power Systems, Wiley Interscience, New York, 1971.
2. Klaus Ragaller, Surges in High Voltage Networks, Plenum Press, New York, 1980.
3. Diesendrof W., Over Voltages On High Voltage Systems, Renselaer Bookstore, Troy New York, 1971.
4. Peterson H.A., transients in power systems, Dover Publications, New York, 1963.
5. Rakosh Das Begamudre, Extra High VoltageAC Transmission Engineering, Wiley Estern Itd, New Delhi, 1990.
6. www.abb.com
7. www.microtran.com

Course Name: Flexible AC Transmission System	**Duration:** 6 Months
Course Code: MEPSD2010	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO46.
CO47.
CO48.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction**	FACTS – a toolkit, basic concepts of static VAR compensator, Resonance Damper, thyristor-controlled series capacitor, static condenser, phase angle regulator and other controllers.	**9**
II	**Series compensation schemes**	Sub-synchronous resonance, torsional interaction, torsional torque, compensation of conventional, ASC, NGH damping schemes, modelling and control of thyristor-controlled series compensators.	**9**
III	**Unified power flow control**	Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller. Phasor Monitoring Units; Power System Control using Synchro phasors.	**9**
IV	**Design of facts controllers**	Approximate multi-model decomposition, variable structure FACTS controllers for power system transient stability, non-linear variable-structure	**9**

		control, variable structure series capacitor control and variable structure resistor control.	
V	**Static var compensation**	Basic concepts, thyristor controlled reactor(TCR), Thyristor Switched Reactor(TSR), Thyristor Switched capacitor(TSC), saturated reactor(SR), fixed capacitor(FC).	**9**

Reference:

1. Narin G. Hingorani, Flexible AC transmission, IEEE Spectrum, April 1993, pp40-45.
2. Narin G. Hingorani, High Power Electronics and flexible Ac Transmission systems, IEEE High Power Engineering Review, 1998.
3. Narin G. Hingorani, Power Electronics in Electric Utilities: Role of Power Electronics in future power systems, Proc. of IEEE, IEEE, Vol.-76, No.-4, April 1988.
4. Einar V Larsen, Juan J. Sanchez-Gasca, Joe H. Chow, Concepts for design of FACTS Controllers to damp Power Swings, IEEE Trans on Power Systems, Vol.-10, No.-2, May 1995.
5. Gyugyi L., Unified Power Flow Control Concept For Flexible Ac Transmission, IEEE Proc-C Vol.-139, No.-4 July 1992.

Course Name: Advanced Electrical Drives	**Duration:** 6 Months
Course Code: MEPSD2011	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO49.
CO50.
CO51.

Course Content

Unit No	Module Name	Content	Hrs
I	**Power devices and Motor Drive**	An introduction to modern electrical drives, Power devices and their switching, Electric machines, Power converters, controllers and load	
II	**Reference frame theory and transformation**	Three phase transformation, abc-axis to dq-axis transformation, space vector and transformation	
III	**Modelling and Control of DC Machines**	Electromechanical modelling, state-space modelling Block diagram and transfer function, Control of separately excited dc motor drives for Inner current	

		loop and speed control design	
IV	**Speed control of Induction motor (IM) drives**	V/f control, dq0 model and state space model of three phase IM, Vector control of IM, Direct torque control (DTC) of induction motor drives, Comparison of DTC and Vector control	
V	**Brushless DC motor drives and an introduction to Microcontroller based control of electrical drives**	Brushless DC motor drives, Introduction of Microcontroller and DSP based control of electrical drives and some industrial applications	

Reference:

1. B.K. Bose: Modern Power Electronics and AC Drives, 1st Edition, Pearson, 2002
2. Bin-Wu: High-power Converters and AC Drives, IEEE Press, John Wiley & Sons, 2006
3. R. Krishanan: Electric Motor Drives Mode

Course Name: Advanced Control System	**Duration:** 6 Months
Course Code: MEPSC2011	**Contact:** 3L
Semester: II	**Credit:** 4

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO52.
CO53.
CO54.

Course Content

Unit No	Module Name	Content	Hrs
I	**Overview of Control Systems**	LTI Motion Control System; Temperature & Voltage Regulators; Modeling of Servo -motors, Hydraulic & pneumatic actuators. Computation of Relative stability using Bode plot and Nyquist method. Hierachical Control Of Power System; System Control; Load scheduler and Optimiser; Real Reactive power Flow Control; AVR and Turbine Speed governor set points.	**6**
II	**Control System Performance**	Improvement of System Performance through Compensation; Design of lag; Lead and Lag load Compensators; PI, PD & PID control; PID Controller Design and tuning; Disturbance	**6**

		rejection; System Uncertainty and performance Robustness.	
III	**Analysis in state space**	State model for SISO & MIMO Systems; State Diagram; Solution of state equation; State Transformations; Jacobian Linearization Technique; Stability; Controllability & Observability; Perspective on State -Space design; Full-State Feedback Design of continuous time control system; Full Order observer System.	**6**
IV	**Digital Control system**	Configuration of Digital Control System; Supervisory Control; Direct digital control; Single - Loop Digital controllers; Sampling Process; Sampling theorem; Data reconstruction; Digital transfer function & System response; Stability Tests ; Mapping between s-plane & z-plane; Bilinear transformation; Error constants; Pole assignment design based on full state feedback; Compensator design in w-plane using Bode plot.	**10**
V	**Non-linear System**	Common non-linearities; Methods of Analysis; Linearization; Phase Plane method; Describing function Analysis; Limit Cycles; Relay with dead-zone and hysteresis; Stability analysis by Lyapunov's methods.	**6**
VI	**Optimal Control**	Characteristics of optimal control problems; Linear optimal Control with quadratic performance index; Selection of performance measure; State and Output regulators; Optimal state regulator problem with matrix Ricatti equation.	**6**

Reference Books:

1. Ogata, k – modern control engineering, p.h learning.
2. Kuo, b.c – automatic control systems, prentic hall.
3. Roy chowdhury, d – modern control engineering, prentic hall.
4. Nagrath i.j, gopal m – control system engineering, new age publishing.
5. Gopal, m – digital control and state variable methods, tata mcgraw -hill.
6. Kuo, b.c. – digital control system, oxford university press.
7. Franklin f, powell j.d, emami naeini, a- feedback control of dynamic systems, addision weslay publication.
8. Peter dorato – robast control.
9. Gibson, j.e. – non-linear system, mcgraw hill. "Power system reference manual, Ray rolls protection", Orient press, 1982.

Course Name: Modelling and Simulation of Dynamic Systems	**Duration:** 6 Months
Course Code: MEPSD2013	**Contact:** 3L
Semester: II	**Credit:** 4

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO55.
CO56.
CO57.

Course Content

Unit No	Module Name	Content	Hrs
I		Introduction, State space representation of systems of different kind. Simulation of the state model. Describing equations and different kinds of models. Eigen values and vectors, Similarity X' formation, invariants. Stability, controllability, observability, Leverrier's algorithm. Linearization of nonlinear systems.	**8**
II		Theorem on feedback control, pole placement controller. Full order and reduced order observer design. Theory of industrial regulation, feed forward control. Application - motor speed control with disturbance rejection.	**4**
III		Heat flow in one-dimension, finite element method. Modelling and simulation through bond graphs. Qualitative reasoning: M & S with Incomplete Knowledge.	**3**
IV		Sensor modelling: Lumped parameter and distributed parameter models, thick and thin film models. Numerical modelling techniques, model equations, application of Finite Element method. Different effects on modelling - temperature, radiation, mechanical, chemical, magnetic, electrical (e.g. capacitive, resistive, piezo -resistive, frequency, etc.). Examples of modelling: micro-modelling of photodiodes, magnetic, capacitive, mechanical sensors.	**10**

Reference Books:

1. D M Wiberg State Space and Linear Systems Schaum's Outline Series McGraw Hill 1971
2. W B J Zimmerman Process Modelling and Simulation with Finite Element Methods Univ. of Sheffield UK 2004

3. Amalendu Mukherjee and Ranjit Karmakar Modelling and Simulation of Engineering Systems through Bond Graphs Narosa New Delhi 1999
4. Benjamin Kuiper Qualitative reasoning: Modelling and Simulation with Incomplete Knowledge MIT Press Cambridge Mass 1994
5. Thomas Kailath Linear Systems Prentice Hall 1980
6. Robert D. Strum and Donald E. Kirk Contemporary Linear Systems Using MATLAB Thomson Learning1999
7. M Gopal Modern Control System Theory Wiley Eastern 1984
8. M Gopal Digital Control Engineering Wiley Eastern 1988
9. K Ogata Modern Control Engineering 4th edition Prentice Hall 2002
10. B C Kuo Automatic Control Systems 7th Edition Prentice Hall 1995.
11. Patranabis, D.- Sensors and Transducers. 2nd edition, PHI, New Delhi.
12. Learning MATLAB and Simulink Mathworks
13. Grandke, T. and Ko, W.H. (ed) - Sensors: Fundamentals and General Aspects. Vol I of Sensors: A Comprehensive Survey. VCH, Germany, 1989

Course Name: Advanced Microprocessor and Microcontroller	**Duration:** 6 Months
Course Code: MEPSD2014	**Contact:** 2L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO58.
CO59.
CO60.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction**	Review of Intel 8085 and 8086 – Architecture and Organization.	**2**
II	**Components and functions**	Execution Unit, Bus Interface Unit, Registers, Minimum and Maximum Mode of Operation, Bus Arbiter, Interrupt Structure, Interrupt Vector Table, I/O Ports, Experimental identification of Ports and Pins.	**10**
III	**Peripheral devices**	PPI 8255, Mode 0, Mode 1, Mode 2 and BSR Mode. Interrupt Controller, DMA Controller, ADC, DAC	**5**

IV	**Development of waveforms**	Square, Triangular, Ramp, Staircase, Sinewave.	**3**
V	**Relays**	Microprocessor based Electromagnetic Relays, IDMT, Differential Relay.	**4**
VI	**Instrumentation & protection (smart grid)**	Microprocessor based Voltage, Current, Power and Speed measurement, Frequency Monitoring, Overvoltage, Undervoltage, Overcurrent and Undercurrent protection, Speed Control of Motors, Traffic Light Controller, Washing Machine Controller.	**12**
VII	**Microcontroller**	Architecture, Organization and Programming Techniques.	**4**

Reference:

1. A. K. Mukhopadhyay - Microprocessor, Microcontroller and their Applications, Narosa Publishing / Alpha Publication, Oxford University
2. A. K. Mukhopadhyay – Microprocessor based Laboratory experiments and Projects, I. K. International
3. Microprocessor and Microcontroller - Gaonkar
4. Anokh Singh, A. K. Chhabra - Fundamentals of Microprocessors and its Applications, S. Chand Publishers.

Course Name: Non-conventional Energy	**Duration:** 6 Months
Course Code: MEPSD3015	**Contact: 2**L
Semester: III	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO61.
CO62.
CO63.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction to solar energy**	Recent trends in energy consumption – World energy scenario – Energy sources and their availability – Need to develop new energy technologies – Solar radiation and measurement – Solar cells and their characteristics– Electrical storage with batteries – Production and transfer of solar energy – Sun-Earth angles – Availability and	

		limitations of solar energy – Measuring techniques and estimation of solar radiation – Solar thermal collectors – General description and characteristics – Flat plate collectors –Short term and long-term collector performance – Solar concentrators – Design, analysis and performance evaluation. – Analysis of PV systems.	
II	**Wind energy conversion system:**	Basic principle of wind energy conversion – nature of wind – Wind survey in India Site selection considerations– Power in the wind –components of a wind energy conversion system -Types of wind power conversion systems – Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis Performance of Induction Generators for WECS – Classification of WECS.	
III	**Bio-mass energy**	Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc. Concept of Bio-energy: Photosynthesis process, Biomass resources Bio based chemicals and materials Thermo-chemical Conversion: Pyrolysis, Combustion, Gasification, Liquification. Bio-Chemical Conversion: Aerobic and Anaerobic conversion, Fermentation etc. Bio-fuels: Types of Bio-fuels, Bio fuel applications, Ethanol as a fuel for I.C. engines, Importance of biogas technology, Different Types of Biogas Plants. Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas. Removal of CO2 and H2O, Bio-hydrogen production.	
IV	**Geothermal, tide and wave energy**	Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.	
V	**Power conditioning converters**	DC Power conditioning converters – Maximum Power point tracking algorithms – AC power conditioners – Line commutated inverters – synchronized operation with grid supply – Harmonic problem	

Text Books/ Reference:

1. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific & Technical, ISBN- 0-582-03184, 1990.
2. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003

3. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
4. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Printice Hall, 2000.
5. Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by David Linden and Thomas.
6. B. Reddy, McGraw Hill Book Company, N.Y. 2002
7. Rai G.D., "Non – Conventional Energy Sources", Khanna Publishers, 1993.
8. Rai G.D., "Solar Energy Utilisation", Khanna Publishers, 1993.
9. Gary L. Johnson, "Wind Energy Systems", Prentice Hall Inc., 1985.

Course Name: Power System Harmonics	**Duration:** 6 Months
Course Code: MEPSD3016	**Contact: 2**L
Semester: III	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO64.
CO65.
CO66.

Course Content

Unit No	Module Name	Content	Hrs
I	**Harmonic Analysis**	Representation of harmonics, Fourier series and Coefficients, odd, even and half wave symmetry, phase sequence. Measures of harmonic distortion: voltage and current distortion factors, active and reactive power, apparent power, distortion power, power factor, current and voltage crest factors. Power in passive elements: power in a pure resistance, power in a pure inductance and power in a pure capacitance. Series and parallel resonance.	**12**
II	**Harmonic Sources**	Types of harmonic sources, Harmonic in transformers, normal excitation characteristics, determination of current waveshape in transformers, inrush current harmonics in transformers, Harmonic in rotating machines: mmf distribution of ac windings, slot harmonics, voltage harmonics produced by synchronous machines,	**10**

		rotor saliency effects, voltage harmonics produced by induction motors. Distortion caused by arcing devices: Electric arc furnaces and discharge type lighting. Distortion caused by dc power supplies.	
III	**Effects of Harmonic Distortion in Power Systems**	Thermal losses in harmonic environment: Copper losses, iron losses, dielectric losses. Harmonic amplification in capacitor banks. Effects of harmonics in transformers. Effects of harmonics in rotating machines: induced emf, chorded windings, distributed winding, winding factor. Harmonic interference with power system protection: harmonic problems during fault conditions. Effects of harmonics on consumer equipment. Interference with Communications.	**8**
IV	**Limits of Harmonic Distortion**	Voltage harmonic distortion limits: IEEE limits, IEC limits EN limits and NORSOK limit. Current harmonic distortion limits: IEEE limits IEC limits and NORSOK limits.	**2**
V	**Elimination of Power System Harmonics**	Passive filters: Tuned filters and damped filters. Active filters: Series and parallel connection of active filters. Role of power converters, transformers, rotating machines and capacitor banks in reduction of harmonics. Harmonic filter design: Series tuned filters and second order damped filters.	**8**

Reference Books:

1. "Power System Harmonics" by J. Arrillaga and N. R. Watson, Wiley
2. "Power Systems Harmonics" by George J. Wakileh, Springer

Course Name: Energy Management & Audit	**Duration:** 6 Months
Course Code: MEPSD2017	**Contact:** 3L
Semester: III	**Credit:** 4

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO67.
CO68.
CO69.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction**	Energy Scenario – global, sub continental and Indian, Energy economy relation, Future energy demand and supply scenario, Integrated energy planning with particular reference to Industrial Sector in India, Captive power units and others – demand v/s supply.	**8**
II	**Types of Energy**	Physical Aspects of Energy: Classification of energy – Hydel, Thermal, Nuclear, Wind, & from Waste Products. Efficiency and effectiveness of energy utilization in Industry. Energy and energy analysis. Renewable le and non- renewable energy, Conventional and unconventional energy.	**4**
III	**Energy Demand Management**	Energy utilization, Instrumentation and data analysis, Financial aspects of energy management, Energy management as a separate function and its place in plant management hierarchy. Energy Planning, Energy Staffing, Energy Organization, Energy Requirement. Energy Costing, Energy Budgeting, Energy Monitoring, Energy Consciousness, Energy Conversions, Energy Efficient Equipment, Energy Management Professionals, Environment Pollution due to Energy Use, Components of Pollution, Harmful Effects of Pollution, Measures taken to combat Pollution.	**6**
IV	**Energy Audit and Energy Saving**	Energy Audit and analysis, Energy load measurements, System evaluation and simulation, Energy saving techniques and guidelines: Administrative control, Proper Measurement and monitoring system, Process control, proper planning & scheduling, Increasing capacity utilization, Improving equipment control, waste heat recovery, Change of energy source. Upgradation of Technology. Change of product specifications, Use of High efficiency equipment, Design modification for better efficiency, Improved periodic maintenance;	**6**
V	**Energy Control Centers**	Remote Telemetry; Remote Terminal Units; IEC TC 57 (870 -5-1) Protocol Standard; Data Acquisition Procedure; Data Handling and Organization; Real Time Database; Alarm and Events; Disturbance Processing; Fault Locating Technology; Real Time Display; MIMIC Boards; Supervisory Remote Control; Load Dispatch Control Centers; Distribution Control Centers; Time Keeping Systems;	**10**

VI	**Integration of Distributed and Renewable Energy Systems to Power Grids**	DC-to-AC Converters; AC-to-AC Converters; DC-to-DC Converters; Plug-In Hybrid Electric Vehicles; Energy Storage Technologies; Microgrids;	**6**
VII	**Legal Provisions**	The Prevention and Control of Pollution Act, 1974, The Energy Conservation Act, 2001, The Environmental Protection Act, 1986. The Electricity Act, 2003. National Electricity Policy. Rural Electrification.	**4**

Reference Books:

1. Paul W., O'callaghan; "Energy Management", McGraw Hill Book Company
2. Steve Doty, Wayne C. Turner; "Energy Management Handbook", Fairmont Press Inc., GA 30047
3. Barny L. Capehart, Wainey C. Turner, William J. Kennedy; "Guide to Energy Management", Fairmont Press Inc., GA 30047
4. Handbook of Energy Engineering, Albert Thumann & Paul Mehta, The Fairmont Press, INC. NPC energy audit manual and reports
5. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council
6. www.bee.org

Audit Course

DIMA5116	Disaster Management
INCO5117	Constitution of India
PDLS5118	Personality Development through Life Enlightenment Skills
YOGA5119	Stress Management by Yoga
SANS5120	Sanskrit for Technical Knowledge

Course Name: Disaster Management	**Duration:** 6 Months
Course Code: CSEN5116	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2. Critically evaluate disaster risk reduction and humanitarian response policy and

practice from multiple perspectives.

CO3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Content

Unit No	Module Name	Content	Hrs
I	**Introduction on Disaster**	• Disaster: Definition; Types of Disaster • Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc. • Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail and Road), Structural failures (Building and Bridge), War and Terrorism etc. • Differences, Nature and Magnitude • Factors Contributing to Disaster Impact and Severity - Repercussions of various types of Disasters Economic Damage; Loss of Human and Animal Life; Destruction of Ecosystem; Outbreaks of Disease and Epidemics; War and Conflict • Natural Disaster-prone areas in INDIA - Areas prone to; Earthquake; Floods and Droughts; Landslides and Avalanches; Cyclonic and Coastal Hazards such as Tsunami; • Lessons Learnt from Recent Disasters Introduction to Disaster Management • What is Disaster Management • Different Phases of Disasters • Disaster Management Cycles • Disaster Management Components -Hazard Analysis; Vulnerability Analysis; Prevention and Mitigation; • Preparedness; Prediction and Warning; Response; Recovery; • Disaster Management Act, 2005 • National Disaster Management Structure • Organizations involved in Disaster Management	**6**
II	**Overview on Hazard Analysis and Vulnerability Analysis Disaster Preparedness**	• Disaster Risk Assessment People's Participation in Risk Assessment • Disaster Risk Reduction • Preparedness Plans • Community preparedness: Emergency Exercises/ Trainings/Mock Drills	**6**

		Disaster Prediction and Warning • Activities - Tracking of disaster; Warning mechanisms; Organizational response; Public education; Communication; Evacuation planning • Current tools and models used for prediction and early Warnings of disaster - Application of Remote Sensing; Data From Meteorological and other agencies; Smartphone/ Web based Apps for Disaster Preparedness and Early Warning used in different parts of Globe	
III	**Disaster Response**	• Crisis Management: The Four Emotional Stages of Disaster - Heroic Phase; Honeymoon Phase; Disillusionment Phase; Reconstruction Phase • Need for Coordinated Disaster Response - Search, Rescue, Evacuation, Medical Response and Logistic Management; Psychological Response and Management (Trauma, Stress, Rumor and Panic) • Role of Government, International and NGO Bodies **Post-disaster Situation Awareness** • Need for Situation Awareness in Post Disaster scenario • Challenges in communication of situational data from affected areas • Need for community-driven disaster management for reliable situation awareness • Crowd-sourcing of situational data: Issues and challenges **Post-disaster Damage and Need Assessment** • Current Trends and Practices – RAPID Damage and Need Assessment • SPHERE standards in Disaster Response • ICT based techniques for Post-disaster damage and need assessment **Rehabilitation, Reconstructions and Recovery** • Reconstruction and Rehabilitation as a Means of Development. • Post Disaster effects and Remedial Measures • Creation of Long-term Job Opportunities and • Livelihood Options • Disaster Resistant House Construction • Sanitation and Hygiene • Education and Awareness • Dealing with Victims‟ Psychology • Long-term Counter Disaster Planning	**10**

IV	**Disaster Mitigation**	• Meaning, Concept and Strategies of Disaster Mitigation • Emerging Trends in Mitigation • Structural Mitigation and Non-Structural Mitigation • Programs of Disaster Mitigation In India	**6**

Reference:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.
2. Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep and Deep Publication Pvt. Ltd., New Delhi.

Course Name: Constitution of India	**Duration:** 6 Months
Course Code: INCO5117	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals" constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

Course Outcome: On successful completion of the course, student will be able to

CO1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO4. Discuss the passage of the Hindu Code Bill of 1956.

Course Content

Unit No	Module Name	Content	Hrs
I		• History of Making of the Indian Constitution: History, Drafting Committee, (Composition and Working) • Philosophy of the Indian Constitution: Preamble, Salient Features	**8**
II		• Contours of Constitutional Rights and Duties: Fundamental Rights, Right to Equality, Right to Freedom, right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.	**4**
III		• Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions	**4**
IV		• Local Administration: District"s Administration head: Role and Importance; Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation; Pachayati raj: Introduction, PRI: ZilaPachayat; Elected officials and their roles; CEO ZilaPachayat: Position and role; Block level: Organizational Hierarchy (Different departments); Village level: Role of Elected and Appointed officials, Importance of grass root democracy • Election Commission: Election Commission: Role and Functioning; Chief Election Commissioner and Election Commissioners; State Election Commission: Role and Functioning; Institute and Bodies for the welfare of SC/ST/OBC and women.	**8**

Reference:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Name: Personality Development through Life Enlightenment Skills	**Duration:** 6 Months
Course Code: PDLS5118	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

CO2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

CO3. Study of Neetishatakam will help in developing versatile personality of students.

Course Content

Unit No	Module Name	Content	Hrs
I	**Neetisatakam-Holistic development of personality**	• Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride and heroism) • Verses- 26,28,63,65 (virtue)	**6**
II	**Approach to day-to-day work and duties**	• Verses- 52,53,59 (dont‟s) • Verses- 71,73,75,78 (do‟s) • Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,	**6**
III	**Statements of basic knowledge**	• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, • Chapter 18-Verses 45, 46, 48. • Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18	**6**
IV	**Personality of Role model**	• Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	**6**

Reference:

1. “Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication 2. Department), Kolkata
2. Bhartrihari‟s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Name: Stress Management by Yoga	**Duration:** 6 Months
Course Code: YOGA5119	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcome: On successful completion of the course, student will be able to

CO1. Develop healthy mind in a healthy body thus improving social health also

CO2. Improve efficiency

Course Content

Unit No	Module Name	Content	Hrs
I		• Definitions of Eight parts of yoga. (Ashtanga)	**6**
II		• Yam and Niyam, Do's and Don'ts in life. • Ahinsa, satya, astheya, bramhacharya and aparigraha • Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	**6**
III	**Asan and Pranayam**	• Various yog poses and their benefits for mind and body	**6**
IV		• Regularization of breathing techniques and its effects-Types of pranayam	**6**

Reference:

1. "Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

Course Name: Sanskrit for Technical Knowledge	**Duration:** 6 Months
Course Code: SANS5120	**Contact: 2**L
Semester: II	**Credit: 2**

Prerequisites:

Course Objective: The purpose of this course is to provide…

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science and other subjects
4. Enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the
6. Huge knowledge from ancient literature

Course Outcome: On successful completion of the course, student will be able to

CO1. Understanding basic Sanskrit language
CO2. Ancient Sanskrit literature about science and technology can be understood
CO3. Being a logical language will help to develop logic in students

Course Content

Unit No	Module Name	Content	Hrs
I		• Alphabets in Sanskrit, • Past/Present/Future Tense,	**6**
II		• Simple Sentences • Order	**6**
III		• Introduction of roots • Technical information about Sanskrit Literature	**6**
IV		• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	**6**

Reference:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India"s Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Name: Industrial Management	**Duration:** 6 Months
Course Code: MBA43144	**Contact:** 3L
Semester: II	**Credit: 3**

Prerequisites:

Course Objective: The purpose of this course is to provide…

Course Outcome: On successful completion of the course, student will be able to

CO4.
CO5.
CO6.

Course Content

Unit No	Module Name	Content	Hrs
I	**Industrial Management**	Introduction: concept, development, application and scope of industrial management. Productivity: definition, measurement, productivity index, types of production system, industrial ownership.	**8**
II	**Management Function**	Principles of Management – Time and motion study, work simplification – process charts and flow diagrams, Production Planning. Inventory Control: Inventory, Cost, Deterministic Models, Introduction to supply chain management.	**10**
III	**Quality Control**	Process control, SQC, Control charts, Single, Double and Sequential Sampling, Introduction to TQM.	**6**
IV		Fundamentals of Materials Management; Material cycle; Forecasting; Material Classification-need and usage, Single and Multidimensional classifications; Materials Codification-Usage, Codification types.	**8**
V		Production Planning and Materials Requirements, Materials Procurement; Tendering; Types of Tenders, Storage and warehousing concepts, Receipt, Warehouse type, Layout, issue of materials and updation of records; Manpower and equipment.	**8**
VI		Project Management concept, Project Feasibility Studies, Project Identification, Market and Demand Analysis, Technical Analysis, Project Scheduling with PERT/CPM, Project Cost Estimate, Financial Appraisal of Single Project, Financial Appraisal of Multiple Projects, Project Cost Control (PERT/Cost).	**7**

Text Books:

1. Arnold, Chapman: Introduction to Materials Management: Pearson, 5th edition, 2008.

Reference:

1. Gopalkrishnan & Sundarsan: Material Management: An Integrated Approach, Prentice Hall of India Private Limited, New Delhi, 2003
2. Industrial Engineering and Management by OP Khanna, Dhanpat Rai Publications, Delhi.
3. Industrial Management by VK Sharma, OP Harkut.