Common Syllabus for M. Tech. EE in Power Systems
West Bengal University of Technology
1st semester

Theory

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Code</th>
<th>Paper</th>
<th>Contact periods per week</th>
<th>Total Contact hours</th>
<th>Credit</th>
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<tbody>
<tr>
<td>1.</td>
<td>EMM-101</td>
<td>Advanced Engineering Mathematics</td>
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<td>PSM-101</td>
<td>Advanced Power System Analysis</td>
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<td>PSM-102</td>
<td>High Voltage Transmission System</td>
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Practical/Sessional

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2nd Semester

Theory

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<td>Power System Operation and Control</td>
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Practical/Sessional

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#### Practical/Sessional

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### 4th Semester

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**Elective I**
- i) Power System Planning and Reliability - PSM 103 (a)
- ii) Power System Apparatus - PSM 103 (b)
- iii) Power Quality - PSM 103 (c)

**Elective II**
- i) Optimization Techniques - PSM 104 (a)
- ii) Soft Computing Technique - PSM 104 (b)
- iii) Digital Signal Processing - PSM 104 (c)
- iv) Object Oriented Programming - PSM 104 (d)

**Elective III**
- i) Power System Transient – PSM 204 (a)
- ii) Flexible A.C. Transmission System - PSM 204 (b)
- iii) Advanced Electrical Drives - PSM 204 (c)

**Elective IV**
- i) Advanced Control System - PSM 205 (a)
- ii) Modeling and Simulation of dynamic systems - PSM 205 (b)
- iii) Advanced Microprocessor and Microcontroller – PSM 205 (c)

**Elective V**
- i) Non-conventional Energy - PSM 301 (a)
- ii) Power System Harmonics - PSM 301 (b)
- iii) Energy Management and Audit – PSM 301 (c)
Advanced Engineering Mathematics

EMM 101

Contact: 3L+1T
Credit: 4

Unit I: Complex Variables
Review of complex variables, Conformal mapping & transformations, Function of complex variables, Pole and singularity, Integration with respect to complex argument, Residues and basic theorems on residues.

Unit II: Numerical Analysis
Introduction, Interpolation formulae, Difference equation, Roots of equations, Solution of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE, Introduction to stability, Matrix eigen value and eigen vector problems.

Unit III: Optimization Technique
Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Elements of calculus variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

Unit IV: Linear Algebra
Vector space, Linear dependence of vectors, basis, linear transformations, inner product space, rank and inverse of a matrix, solution of algebraic equations, consistency conditions, Eigen values and eigen vectors, Hermitian and Skew Hermitian matrices.

Books:

Advanced Power System Analysis

PSM-101

Contact: 3L+1T
Credit: 4

Unit 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.
Unit II


Unit III

**Power System Stability:** Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study.

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.

Voltage stability: Definition and classification of voltage stability, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, expression 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

**High Voltage Transmission System**

PSM-102

Contact: 4L
Credit: 4

**Unit 1:** 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.

**Unit 2:** 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.

**Unit 3:** 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.

**Unit 4:** Line capacitance calculation: capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficient for bundled conductor lines, sequence inductance and capacitances.
Unit 5: Corona: Corona in EHV lines- corona loss formulate- Audio noise due to corona, its generation, characteristics and limits measurement of audio noise. 4

Unit 6: 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: 1. Rakosh Das Begamudre, ‘Extra high voltage ac transmission engineering’ New Age International Publisher.
3. Arrilaga, J. ‘High voltage direct current transmission’ Peter Pereginver Ltd, London

Power System Planning and Reliability
PSM 103(a)

Contact: 4L
Credit: 4

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

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.


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.

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.

References:
1. Markey operations in electric power systems Forecasting, Scheduling, and Risk Management, Shahidehpour M, Yamin H, Li z, John Wlley & sons

Power System Apparatus
PSM 103(b)

Contact: 4L
Credit: 4


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

**Static Series Compensators:** GCSC, TSSC, TCSC and SSSC: Basic Operating Control Schemes for GCSC, TSSC and TCSC.  

**Static Voltage and Phase Angle Regulators:** TCVR and TCPAR.  

**Unified power flow controllers**  

**Reference:**  

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**Power Quality**  

**PSM 103 (e)**  

**Contact:** 4L  

**Credit:** 4  

**Electric power quality phenomena:** - Impacts of power quality problems on end users, Power quality standards, power quality monitoring.  

**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.  

**Power quality problems:** poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage.  

**Transients:** Origin and classification- capacitor switching transient-lighting-load switching-impact on users-protection-mitigation.  

**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.  

**Power quality conditioners:** Shunt and series compensators, Dstatcom-dynamic voltage restorer, unified power quality conditioners.  

**Book**  
Optimization Techniques

PSM-104 (a)

Contact: 4L
Credit: 4

Unit I
Fundamentals of optimization techniques: Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-Classical Optimization techniques (Lambda Iteration method, Linear programming, Quadratic programming).

Unit II
Lambda iteration method: Brief introduction to lambda iteration method, formulate the Lagrange function, Lambda iteration method to solve Optimal dispatch problem.

Unit 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 method, lagrangian duality.

Unit 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.

Unit 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.

Unit 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

Unit 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,

Unit 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.

Reference:
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,
Soft Computing Techniques

PSM 104 (b)

Contact: 4L
Credit: 4

Module 1
Introduction to Soft Computing, components of soft computing, traditional computing and drawbacks, advantages of soft computing techniques. 2

Module 2
Introduction to fuzzy logic: definition, general idea and importance in practical life. 2
Fuzzy set theory: concept of fuzzy set, membership functions, comparison of fuzzy set and classical set. 6
Operations on fuzzy sets, properties of standard operations, T norm and S norm, Extension principle and application. 4
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. 2
Fuzzy relation: fundamentals of fuzzy relations, operations on fuzzy relations, composition of fuzzy relations, fuzzy reasoning, fuzzy relation inferences, compositional rule of inference, fuzzification. 6
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. 4

Module 3
Introduction to artificial neural networks, artificial neuron model, types of activation functions. 4
Learning in neural networks, feed forward and feedback neural networks, backpropagation training algorithm, Hopfield network, Boltzman machine. 4
Self organizing map, learning vector quantization algorithm. 2

Module 4
Basic concept of genetic algorithm, comparison of GA and traditional techniques, objective function and fitness function, crossover, mutation, GA search, applications of GA. 6

Total 42

Reference book:
2. M. Ganesh - Introduction to fuzzy sets and fuzzy logic, PHI.
5. Nie and Linkens,- Fuzzy Neural Control-Principles, Algorithms and Application, PHI
Digital Signal Processing

PSM-104 (c)

Description of Signals and Systems: Types of signals and their characteristics, types of systems and their behavior.

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.


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.

Discrete Fourier Transform: The definition of the Discrete Fourier Transform (DFT), efficient computation of DFT, properties of the DFT.

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.

Optimal and adaptive filters: Wiener filtering technique, adaptive filters and their applications.


Object Oriented Programming

PSM-104 (d)


Case studies: Overview of typical object oriented systems – case studies – application to electrical engineering.

Reference:
1. Stanley B. Lipman, C++ primer, Addison Wesley, 1989
2. Bertrand Meyar, Object software construction, Prentice Hall, 1988

Power System Operation and Control

PSM-201


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.


Books:
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

Power System Instrumentation

PSM–202

Contact: 3L+1T
Credit: 4
**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

**Thermal Power Generation:**

(a) Coal handling plant – coal feed rate measurement, determination of calorific value.
(b) Water treatment
(c) Boiler – Feed water, pressure, temperature, steam flow rate, flue gas analysis, optical pyrometer
(d) Turbine – Speed, shaft eccentricity, temperature
(e) Condenser – pressure, temperature
(f) Generator – Speed, hydrogen leakage
(g) Control and protection systems of a thermal power plant.
(h) Thermal power generation from nuclear reactor.
(i) Ash handling and pollution control  
14

**Hydel Power Plant:** Types - flow rate, Water pressure  
2

**Wind Power:** Principles – synchronization with grids  
1

**Transformer:** Transformer oil, hot spot, moisture detection,  
2

**Transmission Lines:** Fibre optics meter for high voltage and high current measurement, Transmission line sag measurement using triangulation technique.  
2

**Tariff:** Objective, Available based tariff, Digital energy meter, Remote terminal unit (RTU)  
3

**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

**Computer Control of Power Plant:**  

**IS specification:** Introduction, Application and Relevancy of IS specification in perspective of power system instrumentation.  
2

**Reference:**

2. Principles of Industrial Instrumentation - D Patranabish, TMH, New Delhi

**Advanced Power System Protection**

PSM-203

Contact: 4L

11
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.

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.

Protection of Transformer: Overcurrent and unrestricted Earth fault protection, Different CT connections, Balanced (Restricted) earth fault protection, Harmonic restraint, Frame leakage protection.

Bus bar, Feeder, Transmission line Protection:
- Feeder protection: Time Graded protection, Differential Protection.

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.

Protection of High Voltage Capacitor Bank: Including consideration of inrush current, over current and over voltage, and differential protection scheme.

Protection Of large Motors: Differential protection, Earth fault Protection, Thermal overload protection, Starting and Stalling currents and effect of negative Sequence current.

Digital Relay: Introduction, protection philosophy, basic hardware and protection schemes, protection algorithms, microprocessor based digital relaying.
Text Books:

Reference:
2. Protective Relays Application and Guide, GEC Measurements

Power System Transients
PSM-204(a)

Contact: 4L
Credit: 4

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.


Insulation coordination: Over voltage protective devices – shielding wires, rods gaps and surge diverters, principles of insulation co ordination-recent advancements in insulation co ordination – design of EHV system.

References:
Flexible AC Transmission System
PSM-204(b)

Contact: 4L
Credit: 4

Introduction: FACTS – a toolkit, basic concepts of static VAR compensator, Resonance Damper, thyristor controlled series capacitor, static condenser, phase angle regulator and other controllers.

Series compensation schemes: Sub-synchronous resonance, torsional interaction, torsional torque, compensation of conventional, ASC, NGH damping schemes, modeling and control of thyristor controlled series compensators.


Design of facts controllers: Approximate multi-model decomposition, variable structure FACTS controllers for power system transient stability, non-linear variable-structure control, variable structure series capacitor control and variable structure resistor control.

Static var compensation: Basic concepts, thyristor controlled reactor(TCR), Thyristor Switched Reactor(TSR), Thyristor Switched capacitor(TSC), saturated reactor(SR), fixed capacitor(FC).

References:

Advanced Electrical Drives
PSM-204(c)

Contact: 4L
Credit: 4

Power devices and Motor Drive: An introduction to modern electrical drives, Power devices and their switching , Electric machines, Power converters, controllers and load
**Reference frame theory and transformation:** Three phase transformation, abc-axis to dq-axis transformation, space vector and transformation

**Modeling 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

**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

**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 Books:**

3. R. Krishanan: Electric Motor Drives Mode

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**Advanced Control System**  
**PSM-205 (a)**

**Contact:** 4L  
**Credit:** 4

**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. Hierarchical Control Of Power System; System Control; Load scheduler and Optimiser; Real Reactive power Flow Control; AVR and Turbine Speed governor set points.

6

**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 rejection; System Uncertainty and performance Robustness.

6

**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

**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
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.

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.

Reference books:
2. Kuo, b.c – automatic control systems, 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.
7. Franklin f, powell j.d, emami naeini, a- feedback control of dynamic systems, addision wesley publication.
8. Peter dorato – robust control.
9. Gibson, j.e. – non-linear system, mcgraw –hill.

Modeling and Simulation of Dynamic Systems

PSM-205(b)

Contact: 4L
Credit: 4


Module 4: Sensor modeling: Lumped parameter and distributed parameter models, Thick and thin film models. Numerical modeling techniques, model equations, application of Finite Element method. Different effects on modeling - temperature, radiation, mechanical, chemical, magnetic, electrical (e.g. capacitive, resistive, piezo-resistive, frequency, etc.). Examples of modeling: micro-modeling of photodiodes, magnetic, capacitive, mechanical sensors.

Reference Books:
2. W B J Zimmerman Process Modeling and Simulation with Finite Element Methods Univ. of Sheffield UK 2004
3. Amalendu Mukherjee and Ranjit Karmakar Modeling and Simulation of Engineering Systems through Bond Graphs Narosa New Delhi 1999
5. Thomas Kailath Linear Systems Prentice Hall 1980
6. Robert D. Strum and Donald E. Kirk Contemporary Linear Systems Using Matlab Thomson Learning 1999
Advanced Microprocessor and Microcontroller  
PSM 205 - (d)  

Contact: 4L 
Credit: 4 

Introduction: Review of Intel 8085 and 8086 – Architecture and Organization  
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.  
Peripheral devices: PPI 8255, Mode 0, Mode 1, Mode 2 and BSR Mode. Interrupt Controller, DMA Controller, ADC, DAC.  
Development of waveforms: Square, Triangular, Ramp, Staircase, Sinewave.  
Relays: Microprocessor based Electromagnetic Relays, IDMT, Differential Relay.  
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.  

References:  
2. A. K. Mukhopadhyay – Microprocessor based Laboratory experiments and Projects, I. K. International  
3. Microprocessor and Microcontroller - Gaonkar  

EMM 301 - Basics of Pedagogy and Academic Management  
(4 0 0)  
4 credits  

Module 1  
12

Class room management - Effective Classroom Communication - Classroom Motivation principles and techniques - Techniques of Class room management.

Student evaluation - Principles of evaluation - Tools and techniques of evaluation - Statistical analysis of evaluation process.

Student feedback - Tools and techniques - Evaluation of teacher performance

Module 2.  
Research methodology and tools - Definition of research and research methodology - objectives and types research - criteria of a good research.

Data collection – primary data (questionnaire, interview, etc.) and secondary data (case study, journals, etc.) – sampling - census and sample survey - need for sampling - characteristics of a good sample - criteria of selecting sampling procedure - different types of sample design

Data analysis - frequency distribution - measures of central tendency - correlation and regression (concepts only)

Research proposal - selection of topic - literature survey - development of hypothesis - hypothesis testing (concepts only)

Report writing - Interpretation and report writing – techniques of interpretation - significance of report writing - different steps in report writing and format for report writing.

Plagiarism in research.

Module 3.  
Intellectual Property Right and Patent Laws in India

What is intellectual property - importance of IPR. Patent -types of patents - patentable inventions - what is not patentable - application and registration of patents - who can apply - rights and duties of patentee - infringement and remedies.

Copyright - coverage provided by copyright - Transfer of copyright - Infringement of copyright

Trademark - Well-known trademarks and associated trademarks - Service marks - Certification Trademarks.

R & D activities in educational institutes – IPR and patent issues.

Module 4.  
Academic Institution Management - Organisation - Types- structure-Institution as an organisation

Institutional process - objectives - purpose - responsibilities
Management - functions - skills - motivational theories - communication - types - nature - importance - channel richness - how to increase effectiveness of organisational communication. Transparency in academic institutions.

Quality-concept-deciphering quality aspect of different products, services as also that of educational system and institutions

Quality improvement in institutional activities - identification of potential areas

Washington Accords – goal – salient features - implications

Customer – different classes - orientation – satisfaction of stake holders

Basics of project management - concept - types - life cycle - phases - feasibility - viability - cost benefit analysis – PERT and CPM – SWOT Analysis - dimensions of educational projects – case studies

Text Books

3. Cooper J.M,( Ed) - Classroom Teaching Practice, D.C.Heath and Co
4. Romiszwoski A J - Designing Instructional Systems, Kogan Page
6. Kulkarni M V - Research Methodology, EPH
12. Chary S N – Production and Operations Management, TMH

Reference Books

5. Heywood J - Pitfalls and Planning in Student Teaching, Kogan Page
9. Cohen L and Manion L - A Guide to Teaching Practice, Methuen & Co
10. Romiszwoski A J - Producing Instructional Systems, Kogan Page
14. Trochim W M K – Research Methods, Biztantra
17. Gopal Krishnaand Ramamoorthy - Text Book of Project Management; McMillan

Non conventional Energy

PSM 301 - (a)

Contact: 4L
Credit: 4


Text/References:

Power System Harmonics

PSM 301 - (b)

1. 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.
2. **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, 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.


5. **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.

**Reference Books:**
1. “Power System Harmonics” by J. Arrillaga and N. R. Watson, Wiley
2. “Power Systems Harmonics” by George J. Wakileh, Springer

**Energy Management & Audit**

PSM 301 - (c)

**Contact:** 4L  
**Credit:** 4  

**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.


**Demand Side Management:**  
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 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;

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;


Reference Books:
5. NPC energy audit manual and reports
7. www.bee.org