

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. ELECTRICAL POWER ENGINEERING/ ELECTRICAL POWER SYSTEMS**  
**EFFECTIVE FROM ACADEMIC YEAR 2019- 20 ADMITTED BATCH**

**R19 COURSE STRUCTURE AND SYLLABUS**

**I Year I Semester**

Course Code	Course Title	L	T	P	Credits
Professional Core - I	Power System Analysis	3	0	0	3
Professional Core - II	Economic Operation of Power Systems	3	0	0	3
Professional Elective - I	1. HVDC Transmission 2. Renewable Energy Systems 3. Smart Grid Technologies 4. Modern Control Theory	3	0	0	3
Professional Elective - II	1. Electrical Power Distribution System 2. Reactive Power Compensation and Management 3. Mathematical Methods for Power Engineering 4. Hybrid Electric Vehicles	3	0	0	3
	Research Methodology and IPR	2	0	0	2
Lab - I	Power Systems Computation Lab-I	0	0	4	2
Lab - II	Advanced Power Systems Lab	0	0	4	2
Audit - I	Audit Course - I	2	0	0	0
	<b>Total</b>	<b>16</b>	<b>0</b>	<b>8</b>	<b>18</b>

**I Year II Semester**

Course Code	Course Title	L	T	P	Credits
Professional Core - III	Digital Protection of Power System	3	0	0	3
Professional Core - IV	Power System Dynamics	3	0	0	3
Professional Elective - III	1. Restructured Power Systems 2. EHV AC Transmission 3. Swarm Intelligence Techniques in Power Systems 4. Industrial Load Modelling and Control	3	0	0	3
Professional Elective - IV	1. AI Techniques in Power Systems 2. Power Quality 3. Power Apparatus Design 4. Power System Reliability and Planning	3	0	0	3
	Mini Project with Seminar	0	0	4	2
Lab - III	Power Systems Computation Lab-II	0	0	4	2
Lab - IV	Power System Protection Lab	0	0	4	2
Audit - II	Audit Course - II	2	0	0	0
	<b>Total</b>	<b>14</b>	<b>0</b>	<b>12</b>	<b>18</b>

**II Year I Semester**

Course Code	Course Title	L	T	P	Credits
Professional Elective - V	1. Power System Transients 2. Flexible AC Transmission Systems 3. Gas Insulated Systems 4. SCADA System and Applications	3	0	0	3
Open Elective	Open Elective	3	0	0	3
Dissertation	Dissertation Work Review - II	0	0	12	6
	<b>Total</b>	<b>6</b>	<b>0</b>	<b>12</b>	<b>12</b>

**II YEAR II - SEMESTER**

Course Code	Course Title	L	T	P	Credits
Dissertation	Dissertation Work Review - III	0	0	12	6
Dissertation	Dissertation Viva-Voce	0	0	28	14
	<b>Total</b>	<b>0</b>	<b>0</b>	<b>40</b>	<b>20</b>

**\*For Dissertation Work Review - I, Please refer 7.8 in R19 Academic Regulations.**

**Audit Course I & II:**

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**POWER SYSTEM ANALYSIS (Professional Core - I)**

**Prerequisite:** Computer Methods in Power Systems

**Course Objectives:** to prepare the students to

- Build the Nodal admittance and Nodal impedance matrices of a practical network.
- Study various methods of load flow.
- Analyse various types of faults in power system.
- Understand power system security concepts
- Understand state estimation and study simple algorithms for state estimation.

**Course Outcomes:** Students will be able to:

- To build/construct  $Y_{BUS}$  and  $Z_{BUS}$  of any practical network.
- calculate voltage phasors at all buses, given the data using various methods of load flow.
- calculate fault currents in each phase.
- Rank various contingencies according to their severity.
- Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps , CB status etc.

**UNIT-I: NETWORK MATRICES**

Introduction, per unit system, Bus Admittance Matrix, Network Solution, Network Reduction(Kron Reduction),  $Y_{BUS}$  structure and manipulation Bus Impedance matrix, Methods to determine columns of  $Z_{BUS}$ .

**UNIT-II: LOAD FLOW STUDIES**

Overview of Gauss-Siedel, Newton-Raphson load flow methods, fast decoupled method, convergence properties, sparsity techniques, handling Qmax violations in constant matrix, inclusion in frequency effects, AVR in load flow, handling of discrete variable in load flow.

**UNIT-III: FAULT CALCULATIONS**

Symmetrical faults-Fault calculations using  $Z_{BUS}$  - Fault calculations using  $Z_{BUS}$  equivalent circuits, Selection of circuit breakers, symmetrical components, unsymmetrical faults - Problems on various types of faults.

**UNIT-IV: CONTINGENCY ANALYSIS**

Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking

**UNIT-V: STATE ESTIMATION**

Sources of errors in measurements, Virtual and Pseudo measurements, Observability concepts, Tracking state Estimation, Weighted Least Square method, Bad Data detection and estimation.

**TEXT BOOKS:**

1. J.J. Grainger & W.D.Stevenson, "Power system analysis ", McGraw Hill ,2003.
2. A. R. Bergen & Vijay Vittal , "Power System Analysis" ,Pearson , 2000.

**REFERENCES:**

1. L.P. Singh , "Advanced Power System Analysis and Dynamics", New Age International, 2006.
2. G.L. Kusic, "Computer aided power system analysis" ,Prentice Hall India, 1986.

3. A.J. Wood, " Power generation, operation and control" , John Wiley, 1994.
4. P.M. Anderson, "Faulted power system analysis" , IEEE Press , 1995.
5. NPTEL Course, A. K. Sinha, Power System Analysis,  
<https://www.youtube.com/playlist?list=PL36A60B630E8C7B56>
6. Pradeep Yemula, Power System Practice, online course  
[https://www.youtube.com/playlist?list=PL-uxPiMI0\\_6GWFPGXqVapb1yjVAZs9YGz](https://www.youtube.com/playlist?list=PL-uxPiMI0_6GWFPGXqVapb1yjVAZs9YGz)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**ECONOMIC OPERATION OF POWER SYSTEMS (Professional Core - II)**

**Prerequisite:** Electrical Power Systems

**Course Objectives:** Students will be able to:

- understand economic load scheduling problem and unit commitment problem.
- understand hydro-thermal scheduling problem.
- understand load frequency control (LFC)
- understand the optimal power flow (OPF) problem.

**Course Outcomes:** the student will be able to

- distinguish between economic load dispatch and unit commitment problem
- solve economic load scheduling (with and without network losses) and unit commitment problem
- solve hydro-thermal scheduling problem
- analyze the single area and two area systems for frequency deviation
- solve the OPF problem using ac and dc load flow methods.

**UNIT-I: ECONOMIC LOAD SCHEDULING**

Characteristics of Steam Turbine, Variations in steam unit characteristics, Economic dispatch with piecewise linear cost functions, Lambda Iterative method, LP method, Economic dispatch under composite generation production cost function, Base point and Participation factors, Thermal system Dispatching with Network losses.

**UNIT-II: UNIT COMMITMENT**

Unit Commitment – Definition – Constraints in Unit Commitment–Unit Commitment solution methods – Priority–List Methods – Dynamic Programming Solution.

**UNIT-III: HYDRO THERMAL SCHEDULING**

Characteristics of Hydroelectric units, Introduction to Hydrothermal coordination, Long-Range and Short-Range Hydro-Scheduling, Hydroelectric plant models, Hydrothermal scheduling with storage limitations, Dynamic programming solution to hydrothermal scheduling.

**UNIT-IV: LOAD FREQUENCY CONTROL**

Control of generation – models of power system elements – single area and two area block diagrams – generation control with PID controllers – implementation of Automatic Generation control (AGC) – AGC features.

**UNIT-V: OPTIMAL POWER FLOW**

Introduction to Optimal power flow problem, OPF calculations combining economic dispatch and power flow, OPF using DC power flow, Algorithms for solution of the ACOPF, Optimal Reactive Power Dispatch.

**TEXT BOOKS:**

1. Olle I. Elgerd, "Electric Energy Systems Theory an Introduction", TMH, 2<sup>nd</sup> Edition, 1983
2. J.J. Grainger &W.D.Stevenson, "Power system analysis ", McGraw Hill ,2003

**REFERENCES:**

1. Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé-Power Generation, Operation and Control-Wiley-Interscience (2013)
2. NPTEL Course, Prof. S. N. Singh, Power System Operation and Control, <https://www.youtube.com/playlist?list=PL4BFB13CCDB954BCF>

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**HVDC TRANSMISSION (Professional Elective - I)**

**Prerequisite:** Power Systems and Power Electronics

**Course Objectives:**

- to prepare the students to understand the state-of-the-art of HVDC technology.
- to enable the students to model and analyse HVDC systems

**Course Outcomes:** Students will be able to:

- understand the state-of-the-art of HVDC technology.
- model and analyse the HVDC system for inter-area power flow regulation.
- analyze the converter and dc grid faults and adopt methods to mitigate them.
- analyse the HVDC converter reactive power requirements and address the issues.

**UNIT-I: GENERAL ASPECTS OF DC TRANSMISSION**

Evolution of HVDC transmission, Comparison of HVDC and HVAC systems, Types of DC links, Components of a HVDC system, Valve characteristics, Properties of converter circuits, assumptions, single phase and Three-phase Converters, Pulse number, choice of best circuit for HVDC converters.

**UNIT-II: ANALYSIS OF BRIDGE CONVERTER**

Analysis of simple rectifier circuits, Required features of rectification circuits for HVDC transmission.

**Analysis of HVDC converter:** Different modes of converter operation, Output voltage waveforms and DC voltage in rectification, Output voltage waveforms and DC in inverter operation, Thyristor/Valve voltages. Equivalent electrical circuit.

**UNIT-III: DC LINK CONTROL**

Grid control, basic means of control, power reversal, limitations of manual control, Constant current versus Constant Voltage, Desired features of control.

**Actual control characteristics:** Constant-minimum-ignition-angle control, Constant-current control, Constant-extinction-angle control. Stability of control, tap-changer control, Power control and current limits, frequency control.

**UNIT-IV: CONVERTER FAULTS & PROTECTION**

Converter mal-operations, Commutation failure, Starting and shutting down the converter bridge, Converter protection.

**UNIT-V: REACTIVE POWER MANAGEMENT**

Smoothing reactor and DC Lines, Reactive power requirements, Harmonic analysis, Filter design

**TEXT BOOKS:**

1. J. Arrillaga, "High Voltage Direct Transmission", Peter Peregrinus Ltd. London, 1983.
2. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 3<sup>rd</sup> Edition, 2015.

**REFERENCES:**

1. High Voltage Direct Current Transmission, NPTEL Lectures by Prof. S. N. Singh, <https://www.youtube.com/playlist?list=PL4B78E9972172086A>

2. E. W. Kimbark, "Direct Current Transmission", Vol. I, Wiley Interscience, 1971.
3. Erich Uhlmann, "Power Transmission by Direct Current", B.S. Publications, 2004.
4. SN Singh, "*Electric Power Generation, Transmission and Distribution*", PHI, New Delhi 2nd edition, 2008.
5. V. Kamaraju, "HVDC Transmission" Tata McGraw-Hill Education Pvt Ltd, New delhi, 2011.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**RENEWABLE ENERGY SYSTEMS (Professional Elective - I)**

**Prerequisite:** Power Systems and Electrical Machines

**Course Objectives:** to prepare the students to

- learn various renewable energy sources
- gain understanding of integrated operation of renewable energy sources
- understand power electronics interface with the grid

**Course Outcomes:** Students will be able to

- Knowledge about renewable energy
- Understand the working of distributed generation system in autonomous/grid connected modes

**UNIT- I: SOLAR ENERGY SYSTEMS:**

Introduction – solar radiation - solar thermal energy conversion - Flat plate collector - concentric collectors- solar pond - central receiver system- solar pumping - Solar photovoltaic systems - characteristics of PV cell- Photo voltaic modules - Types of Photo voltaic systems.

**UNIT-II: WIND ENERGY AND BIO GAS:**

Basics of wind energy - classification of turbines - wind characteristics - energy extraction - Betz limit - Modes of wind power generation- Bio Mass energy conversion - Anaerobic Digestion - Aerobic Digestion - Gasification-Bio Gas Plants.

**UNIT-III: OCEAN ENERGY CONVERSION:**

Tidal Energy generation - characteristics of Tides - Power generation schemes - Components in Tidal power plant- Wave Energy - Principle of wave energy plant - Wave energy conversion machines - Ocean Thermal Energy conversion - Principle - cycles of operation - Types of OTEC plants - Applications

**UNIT-IV: GEO-THERMAL ENERGY AND FUEL CELLS:**

**HYBRID ENERGY SYSTEMS:**

Geothermal Energy - Structure of Earth's interior - Geothermal fields, gradient, resources - Geothermal power generation - Fuel cells – Introduction - Principle of operation - Types of **FUEL CELLS** - State of art fuel cells-energy output of a fuel cell - operating characteristics of fuel cells - thermal efficiency - Need for Hybrid systems - Types of Hybrid systems.

**UNIT-V: ENERGY SYSTEMS AND GRIDS**

Introduction, Energy systems, Distribution technologies, Energy storage for grid electricity, Social and environmental aspects of energy supply and storage.

Electricity grids(networks), DC grids, Special challenges and opportunities for renewable electricity, Power Electronic Interface with the Grid

**TEXT BOOKS:**

1. D.P.Kothari, K.C.Singal, R.Ranjan, "Renewable Energy Resources and emerging technologies"- PHI 2/e 2011.
2. John Twidell and Tony Weir, "Renewable Energy Resources" - 2<sup>nd</sup> edition, CRC Press.
3. Rakosh Das Begamudre, "Energy conversion systems"- New Age International Publishers, New Delhi - 2000.
4. "Renewable Energy Resources" by John Twidell and Tony Weir, 2<sup>nd</sup> Edition, Fspan & Co.

**REFERENCES:**

1. "Understanding Renewable Energy Systems", by Volker Quaschnig, 2005, UK.
2. "Renewable Energy Systems-Advanced Conversion, Technologies & Applications" by Faner Lin Luo Honer Ye, CRC press, Taylor & Francis group.
3. NPTEL Course on Non-Conventional Energy Sources,  
[https://www.youtube.com/playlist?list=PL3QMEfkoIRFbGhXveCE7RFDBgY0\\_gRxkh](https://www.youtube.com/playlist?list=PL3QMEfkoIRFbGhXveCE7RFDBgY0_gRxkh)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**SMART GRID TECHNOLOGIES (Professional Elective - I)**

**Prerequisite:** Power Systems

**Course Objectives:** to prepare the students to

- Understand concept of smart grid and its advantages over conventional grid
- Know smart metering techniques
- Learn wide area measurement techniques
- Understand the problems associated with integration of distributed generation & its solution through smart grid.

**Course Outcomes:** Students will be able to

- Distinguish between conventional grid and smart grid
- Apply smart metering concepts to industrial and commercial installations
- Formulate solutions in the areas of smart substations, distributed generation and wide area measurements
- Develop smart grid solutions using modern communication technologies

**UNIT-I: INTRODUCTION TO SMART GRID**

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid

**UNIT-II: SMART METERS**

Introduction to Smart Meters, Real Time Pricing, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Smart Appliances, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation, Wide Area Measurement System (WAMS), Phasor Measurement Unit (PMU)

**UNIT-III: INFORMATION AND STORAGE SYSTEMS**

Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, Pumped Hydro, Compressed Air Energy Storage, fuel-cells

**UNIT-IV: MICROGRID**

Concept of microgrid, need & applications of microgrid, formation of micro-grid, Issues of interconnection, protection & control of microgrid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, micro-turbines, Captive power plants, Integration of renewable energy sources

**UNIT-V: POWER QUALITY**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, power quality conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. and communication protocols in grid.

**TEXT BOOKS:**

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2011

2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press , 2009

**REFERENCES:**

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications", Wiley 2012
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions " CRC Press
3. A.G.Phadke, "Synchronized Phasor Measurement and their Applications", Springer
4. S. Chowdhury, S. P. Chowdhury, and P. Crossley, "Microgrids and active distribution networks", IET, 2009, <http://uni-site.ir/khuelec/wp-content/uploads/Microgrids-and-Active-Distribution-Networks.pdf>
5. Prof. N. P. Padhy and Prof. Premalatha Jena, NPTEL course – Introduction to Smart Grid [https://www.youtube.com/playlist?list=PLLy\\_2iUCG87D59-Bc8Jqfqt43LvPC0KgC](https://www.youtube.com/playlist?list=PLLy_2iUCG87D59-Bc8Jqfqt43LvPC0KgC)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. I Year I Sem. (EPE/EPS)**

**MODERN CONTROL THEORY (Professional Elective - I)**

**Prerequisite:** Linear Control Systems

**Course Objectives:**

- To explain the concepts of basics and modern control system for the real time analysis and design of control systems.
- To explain the concepts of state variables analysis.
- To study and analyze non linear systems.
- To analyze the concept of stability for nonlinear systems and their categorization.
- To apply the comprehensive knowledge of optimal theory for Control Systems.

**Course Outcomes:** Upon completion of this course, students should be able to:

- terms of basic and modern control system for the real time analysis and design of control systems.
- To perform state variables analysis for any real time system.
- Apply the concept of optimal control to any system.
- Able to examine a system for its stability, controllability and observability.
- Implement basic principles and techniques in designing linear control systems.
- Formulate and solve deterministic optimal control problems in terms of performance indices.
- Apply knowledge of control theory for practical implementations in engineering and network analysis.

**UNIT I: Mathematical Preliminaries and State Variable Analysis:**

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear systems – The concept of state – State space model of Dynamic systems – Time invariance and Linearity – Non uniqueness of state model – State diagrams for Continuous-Time State models - Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and it's properties. Complete solution of state space model due to zero input and due to zero state.

**UNIT II: Controllability and Observability:**

General concept of controllability – Controllability tests, different state transformations such as diagonalization, Jordan canonical forms and Controllability canonical forms for Continuous-Time Invariant Systems – General concept of Observability – Observability tests for Continuous-Time Invariant Systems – Observability of different State transformation forms.

**State Feedback Controllers and Observers:**

State feedback controller design through Pole Assignment, using Ackkermans formula– State observers: Full order and Reduced order observers.

**UNIT III: Non-Linear Systems:**

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc; Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

**UNIT IV: Stability Analysis:**

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasoviski's method.

UNIT V: Calculus of Variations:

--- optimal control

**TEXT BOOKS :**

1. M.Gopal, Modern Control System Theory, New Age International - 1984
2. Ogata. K, Modern Control Engineering, Prentice Hall - 1997

**REFERENCES:**

1. N K Sinha, Control Systems, New Age International – 3<sup>rd</sup> edition.
2. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**ELECTRICAL POWER DISTRIBUTION SYSTEM (Professional Elective - II)**

**Prerequisite:** Power Systems

**Course Objectives:** to prepare the students to

- Learn about load forecasting
- Understand power distribution system reconfiguration and restoration
- Learn control and communication systems
- Understand distribution automation

**Course Outcomes:** Students will be able to

- understand power distribution system
- explore distribution automation and its application in practice
- learn control and communication systems
- apply optimization techniques for distribution systems
- carryout distribution energy management

**UNIT-I: LOAD FORECASTING**

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting.

**UNIT-II: DISTRIBUTION AUTOMATION**

Advantages of Distribution Management System (DMS) Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction

**UNIT-III: CONTROL AND COMMUNICATION**

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation. SCADA: Introduction, Block Diagram, SCADA Applied To Distribution Automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA

**UNIT-IV: OPTIMALITY PRINCIPLES**

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring

**UNIT-V: ENERGY MANAGEMENT**

Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution. Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation

**TEXT BOOKS:**

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi

**REFERENCES:**

1. Turan Gonen, "Electric Power Distribution Engineering", 3rd Edition CRC Press,
2. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
3. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press
4. NPTEL course, Electrical Distribution System Analysis,  
[https://www.youtube.com/playlist?list=PLLy\\_2iUCG87DxrqJr3dBhSruMiRHK0rNr](https://www.youtube.com/playlist?list=PLLy_2iUCG87DxrqJr3dBhSruMiRHK0rNr)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**REACTIVE POWER COMPENSATION AND MANAGEMENT (Professional Elective - II)**

**Prerequisite:** Power Systems

**Course Objectives:**

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management.

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads
- Observe various compensation methods in transmission lines
- Construct model for reactive power coordination
- Distinguish demand side reactive power management & user side reactive power management

**UNIT- I: LOAD COMPENSATION**

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

**UNIT- II: STEADY-STATE AND TRANSIENT REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM**

Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples.

Characteristic time periods – passive shunt compensation – static compensations - series capacitor compensation – compensation using synchronous condensers – examples

**UNIT- III: REACTIVE POWER COORDINATION**

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences

**UNIT- IV DISTRIBUTION SIDE REACTIVE POWER MANAGEMENT:**

Load patterns, basic methods load shaping, power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels

System losses, loss reduction methods, economics planning, capacitor placement, retrofitting of capacitor banks

**UNIT- V: USER SIDE REACTIVE POWER MANAGEMENT**

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

**Reactive power management in electric traction systems and arc furnaces:**

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

**TEXT BOOKS:**

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982.
2. Reactive power Management by D.M.Tagare, Tata McGraw Hill, 2004.

**REFERENCES:**

1. [Wolfgang Hofmann](#), [Jurgen Schlabbach](#), [Wolfgang Just](#) "Reactive Power Compensation: A Practical Guide, April, 2012, Wiley publication.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**MATHEMATICAL METHODS FOR POWER ENGINEERING (Professional Elective - II)**

**Prerequisite:** Mathematics

**Course Objectives:** to prepare the students to

- understand the relevance of mathematical methods to solve engineering problems.
- understand how to apply these methods for a given engineering problem.

**Course Outcomes:** Students will be able to

- understand vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators
- learn about linear programming problems and understand the simplex method for solving linear programming problems in various fields of science and technology
- acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems
- understand the concept of random variables, functions of random variable and their probability distribution
- understand stochastic processes and their classification

**UNIT- I:**

Vector spaces, Linear transformations, Matrix representation of linear transformation, Eigen values and Eigen vectors of linear operator

**UNIT- II:**

Linear Programming Problems, Simplex Method, Duality, Non Linear Programming problems

**UNIT- III:**

Unconstrained Problems, Search methods, Constrained Problems

**UNIT- IV:**

Lagrange method, Kuhn-Tucker conditions, Random Variables, Marginal and Conditional distributions, Elements of stochastic processes

**UNIT- V:**

Mathematical methods applied to Power Engineering, examples – economic load dispatch, optimal power flow, unit commitment

**TEXT BOOKS:**

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004

**REFERENCES:**

1. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002
2. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994
3. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002
4. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley, 2000

5. Hillier F S and Liebermann G J, "Introduction to Operations Research", 7th Edition, McGraw Hill, 2001
6. Simmons D M, "Non Linear Programming for Operations Research", PHI, 1975
7. MIT online course, Prof. Gilbert Strang, Linear Algebra,  
<https://www.youtube.com/playlist?list=PL49CF3715CB9EF31D>
8. Matpower, Free open-source tools for electric power system simulation and optimization,  
<https://matpower.org/>

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**HYBRID ELECTRIC VEHICLES (Professional Elective - II)**

**Prerequisite:** Power Systems, Electrical Machines and Power Electronics

**Course Objectives:** to prepare the students to

- understand upcoming technology of hybrid system
- understand different aspects of drives application
- learn the electric Traction

**Course Outcomes:** Students will be able to

- Acquire fundamental concepts and principles of hybrid electric vehicles (HEV)
- Design and analyse HEVs
- Apply electric drives in vehicles / traction
- Understand energy management in HEVs

**UNIT-I: INTRODUCTION TO HYBRID ELECTRIC VEHICLES (HEV)**

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, Mathematical models to describe vehicle performance

**UNIT-II: HYBRID TRACTION**

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

**UNIT-III: CONTROL OF MOTORS FOR HEV**

Introduction to electric components used in hybrid and electric Vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives configuration and control of Permanent Magnet Motor drives Configuration and control of Switch Reluctance, Motor drives, drive system efficiency

**UNIT-IV: DESIGN OF HEV**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems

**UNIT-V: ENERGY MANAGEMENT IN HEV**

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

**TEXT BOOKS:**

1. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters"

**REFERENCES:**

1. NPTEL Course on Electric Vehicles, <https://www.youtube.com/playlist?list=PLIYm0-AHZdZRLYSyIFinxkspWmcgNvbtI>

2. Iqbal Hussein, *Electric and Hybrid Vehicles: Design fundamentals*, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2004.
4. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**RESEARCH METHODOLOGY AND IPR**

**Prerequisite:** None

**Course Objectives:**

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

**Course Outcomes:** At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**UNIT- 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

**UNIT- II:**

Effective literature studies approaches, analysis, Plagiarism, Research ethics

**UNIT- 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

**UNIT- IV:**

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, Patenting under PCT.

**UNIT- V:**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**TEXT BOOKS:**

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".

**REFERENCES:**

1. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall , "Industrial Design", McGraw Hill, 1992.
4. Niebel , "Product Design", McGraw Hill, 1974.
5. Asimov , "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**POWER SYSTEMS COMPUTATION LAB - I (Lab - 1)**

**Prerequisite:** power systems

**Course Objectives:** Students will be able to:

- Construction of Y-bus, z-bus for a n-bus system.
- Analyze various Load flow studies .
- Steady state, transient stability analysis.
- Economic load dispatch problem.
- Unitcommitment problem.
- State estimation of power system.

**Course Outcomes:** Students will be able to:

- Construct Y-bus and Z-bus
- Compare the different load flow methods
- Analyze the different stability analysis of variety of power systems
- Understood Economic load dispatch and Unitcommitment problems.
- Understood State estimation of power system.

**List of Experiments**

1. Develop Program for  $Y_{BUS}$  formation by direct inspection method.
2. Develop Program for  $Y_{BUS}$  formation by Singular Transformation method.
3. Develop Program for G-S Load Flow Algorithm.
4. Develop Program for N-R Load Flow Algorithm in Polar Coordinates.
5. Develop Program for FDLF Algorithm.
6. Develop Program for DC load Flow Algorithm.
7. Develop Program for  $Z_{BUS}$  Building Algorithm.
8. Develop Program for Short Circuit Analysis using  $Z_{BUS}$  Algorithm.
9. Develop Program for Transient Stability Analysis for Single Machine connected to Infinite Bus
10. Develop Program for Economic Load Dispatch Problem using Lambda Iterative Method.
11. Develop Program for Unit Commitment Problem using Forward Dynamic Programming Method.
12. Develop Program for State Estimation of Power System.

**Note:** From the above list minimum 10 experiments are to be conducted using suitable software.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year I Sem. (EPE/EPS)**

**ADVANCED POWER SYSTEMS LAB (Lab - 2)**

**Prerequisite:**power systems and FACTS

**Course Objectives:** Students will be able to:

- Determine transmission line parameters
- Determine transmission line regulation and efficiency
- Determine various fault calculations
- Perform load and line compensation

**Course Outcomes:** Students will be able to:

- Calculate transmission line parameters
- Calculate transmission line regulation and efficiency
- Calculate various fault parameters
- Compare system parameters with and without compensation

**List of Experiments**

1. Determination of Line Parameters R, L and C.
2. Determination of T/L efficiency and Regulation for a given load.
3. Analysis of Ferranti effect on Transmission Lines under light loadings.
4. Determination of ABCD parameters of a given Transmission Line Network.
5. Fault Analysis:
  - I. Single Line to Ground fault (L-G).
  - II. Line to Line fault (L-L).
  - III. Double Line to Ground fault (L-L-G).
  - IV. Triple Line to Ground fault (L-L-L-G).
6. Analysis of Uncompensated lines and their voltage profiles.
7. Shunt compensation of Transmission lines (Capacitor/Reactors)
8. Load Compensation analysis
9. Line Compensation using FACTS devices.
10. Analysis of Transmission lines under Surge Impedance Loading.
11. Determination of Sequence impedance of Transmission Line and SIL analysis.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**DIGITAL PROTECTION OF POWER SYSTEM (Professional Core - III)**

**Prerequisite:** Power System Protection

**Course Objectives:** to prepare the students to:

- Study numerical relays.
- Develop mathematical approach towards protection.
- Study algorithms for numerical protection.

**Course Outcomes:** Students will be able to:

- understand the importance of Digital Relays.
- apply mathematical approach towards protection.
- develop various protection algorithms.

**UNIT-I: Mathematical Background to Digital Protection**

Overview of static relays, Transmission line protection, Transformer protection, Need for Digital protection. Performance and operational characteristics of Digital protection, Basic structure of Digital relays, Finite difference techniques, Interpolation formulas, Numerical differentiation, Curve fitting and smoothing, Fourier analysis, Walsh function analysis, Relationship between Fourier and Walsh coefficients.

**UNIT-II: Basic Elements of Digital Protection**

Basic components of a digital relay, Signal conditioning subsystems, Conversion subsystem, Digital relay subsystem, The digital relay as a unit.

**UNIT-III: Digital Relaying Algorithms-I**

Sinusoidal-Wave-Based algorithms: Sample and first-derivative methods, First and second-derivative methods, Two-sample technique, Three-sample technique, An early relaying scheme.

Fourier analysis based algorithms: Full cycle window algorithm, Fractional-cycle window algorithms, Fourier-transform based algorithm. Walsh-function-based algorithms.

**UNIT-IV: Digital Relaying Algorithms-II**

Least squares based methods: Integral LSQ fit, Power series LSQ fit, Multi-variable series LSQ technique, Determination of measured impedance estimates.

Differential equation based techniques: Representation of transmission lines with capacitance neglected, Differential equation protection with selected limits, Simultaneous differential equation techniques.

Travelling-wave based protection: Fundamentals of Travelling-wave based protection, Bergeron's-equation based protection scheme, Ultra-high-speed polarity comparison scheme, Ultra-high-speed wave differential scheme, Discrimination function based scheme, Superimposed component trajectory based scheme.

**UNIT-V: Digital protection of Transformers and Transmission lines**

Principles of transformer protection, Digital protection of Transformer using: FIR filter based algorithm, Least squares curve fitting based algorithms, Fourier-based algorithm, Flux-restrained current differential relay.

Digital Line differential protection: Current-based differential schemes, Composite voltage- and current-based scheme.

**TEXT BOOKS:**

1. A.G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009.
2. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press, 1999.

**REFERENCES:**

1. Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing, 2006.
2. S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**POWER SYSTEM DYNAMICS (Professional Core - IV)**

**Prerequisite:** Power Systems and Electrical Machines

**Course Objectives:** to prepare students to:

- Develop mathematical models for synchronous machine, Exciter, Governor and Prime mover.
- Study power system dynamic phenomena and the effects of exciter and governor control.
- Understand methods to improve dynamic stability.

**Course Outcomes:** Students will be able to:

- Understand the modeling of synchronous machine in details
- Understand the modeling of Exciter and Governor control
- Carry out simulation studies of power system dynamics using MATLAB-SIMULINK, MI-POWER
- Carry out stability analysis with and without power system stabilizer (PSS)

**UNIT-I: POWER SYSTEM STABILITY: A CLASSICAL APPROACH**

Introduction, Requirements of a Reliable Electrical Power Service, Swing Equation, Power-Angle Curve, Stability analysis of SMIB system, Equal area criteria, Classical Model of a Multimachine System, Shortcomings of the Classical Model, Block Diagram of One Machine infinite bus system, System Response to Small Disturbances: Types of Problems Studied, The Unregulated Synchronous Machine, Modes of Oscillation of an Unregulated Multimachine System, Regulated Synchronous Machine.

**UNIT-II: SYNCHRONOUS MACHINE MODELING-I**

Introduction, Park's Transformation, Flux Linkage Equations, Voltage Equations, Formulation of State-Space Equations, Current Formulation, Per Unit Conversion, Normalizing the Voltage and Torque Equations, Equivalent Circuit of a Synchronous Machine, The Flux Linkage State-Space Model, Load Equations, Sub-transient and Transient Inductances and Time Constants, Simplified Models of the Synchronous Machine, Turbine Generator Dynamic Models.

**UNIT-III: SYNCHRONOUS MACHINE MODELING-II**

Steady state equations and phasor diagrams, Determining steady state conditions, Evaluation of Initial conditions, Determination of machine parameters, Digital simulation of Synchronous machines, Linearization and Simplified Linear model and state-space representation of simplified model.

**UNIT-IV: EXCITATION AND PRIME MOVER CONTROL**

Simplified view of excitation control, control configurations, typical excitation configurations, excitation control system definitions, voltage regulator, exciter buildup, excitation system response, state-space description of the excitation system, computer representation of excitation systems, Typical system constants, and the effects of excitation on generator power limits, transient stability and dynamic stability of the power system, Prime mover control: Hydraulic turbines and governing systems, Steam turbines and governing systems.

**UNIT-V: SMALL SIGNAL STABILITY ANALYSIS**

Fundamental concepts of stability of dynamic systems, Eigenproperties of the state matrix, Small-signal stability of a single-machine infinite bus system, Effects of excitation system, Power system stabilizer, System state matrix with amortisseurs, Characteristics of small-signal stability problems.

**TEXT BOOKS:**

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotia , New Delhi, 1981
2. J Machowski, J Bialek & J. R W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997

**REFERENCES:**

1. P.Kundur, "Power System Stability and Control", McGraw Hill Inc., 1994.
2. E.W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002
3. L. Leonard Grigsby (Ed.); "Power System Stability and Control", 2<sup>nd</sup> edition, CRC Press, 2007
4. NPTEL online course, Prof. A. M. Kulkarni, Power System Dynamics and Control, <https://www.youtube.com/playlist?list=PLuv3GM6-gsE2WXbxLSngKHf5gcnedXCZH>

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. I Year II Sem. (EPE/EPS)**

**RESTRUCTURED POWER SYSTEMS (Professional Elective - III)**

**Prerequisite:** Power Systems

**Course Objectives:** to prepare students to

- Understand restructuring of the electricity market
- Understand deregulation of the electricity market
- Understand the money, power & information flow in a deregulated power system

**Course Outcomes:** Students will be able to

- Know about various types of regulations in power systems.
- Identify the need of regulation and deregulation.
- Understand technical and Non-technical issues in deregulated Power Industry.
- Identify existing electricity markets.
- Classify different market mechanisms and summarize the role of various entities in the market.

**UNIT-I:**

Fundamentals of restructured system, Market architecture, Load elasticity, Social welfare maximization

**UNIT-II:**

Optimal power flow (OPF): Role in vertically integrated systems and in restructured markets, congestion management

**UNIT-III:**

Optimal bidding, Risk assessment, Hedging, Transmission pricing, Tracing of power

**UNIT-IV:**

Ancillary services, Standard market design, Distributed generation in restructured markets, renewable energy markets

**UNIT-V:**

Developments in India, IT applications in restructured markets, Working of restructured power systems, Pennsylvania-New Jersey-Maryland Interconnection (PJM) market, Recent trends in Restructuring

**TEXT BOOKS:**

1. Lorrin Philipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub., 1998.
2. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002.

**REFERENCES:**

1. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boelen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
2. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**EHV AC TRANSMISSION (Professional Elective – III)**

**Prerequisite:** Power Systems

**Course objectives:** to prepare the students to

- identify the different aspects of Extra High Voltage AC Transmission design and analysis
- understand the importance of modern developments of EHV and UHV transmission systems.
- demonstrate EHV AC transmission system components, protection and insulation level for over voltages.

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Understand the importance of EHV AC transmission
- estimate choice of voltage for transmission, line losses and power handling capability of EHV Transmission.
- apply statistical procedures for line designs, scientific and engineering principles in power systems.

**UNIT- I:**

Extra high voltage (EHV) AC. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters-Bundle conductor systems-Inductance and Capacitance of EHV lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

**UNIT- II:**

Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect of high electrostatic field on biological organisms and human beings - surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor.

**UNIT- III:**

Electrostatic induction in unenergized lines – measurement of field and voltage gradients for three phase single and double circuit lines – unenergized lines. Power Frequency Voltage control and over-voltages in EHV lines: No load voltage – charging currents at power frequency-voltage control – shunt and series compensation – static VAR compensation.

**UNIT - IV:**

Corona in EHV lines – Corona loss formulae- attention of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits. Measurements of audio noise radio interference due to Corona - properties of radio noise – frequency spectrum of RI fields – Measurements of RI and RIV.

**UNIT- V:**

Design of EHV lines based on steady state and transient limits - EHV cables and their characteristics.

**TEXT BOOKS:**

1. R. D. Begamudre, "EHVAC Transmission Engineering", New Age International (p) Ltd. 3<sup>rd</sup> Edition.
2. K. R. Padiyar, "HVDC Power Transmission Systems" New Age International (p) Ltd. 2<sup>nd</sup> revised Edition, 2012.

**REFERENCES:**

1. S. Rao "EHVAC and HVDC Transmission Engineering. Practice" Khanna publishers.
2. Arrillaga. J "High Voltage Direct Current Transmission" 2<sup>nd</sup> Edition (London) Peter Peregrines, IEE, 1998.
3. Padiyar. K. R, "FACTS Controllers in Power Transmission and Distribution" New Age International Publishers, 2007.
4. Hingorani H G and Gyugyi. L "Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.
5. Advances in UHV Transmission and Distribution, online course <https://www.youtube.com/channel/UCWKPSjLRz-TAFgFWCfMmGg/videos>

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**SWARM INTELLIGENCE TECHNIQUES IN POWER SYSTEMS (Professional Elective - III)**

**Prerequisite:** Artificial Intelligence techniques in power systems

**Course Objectives:** to prepare students to:

- Understand evolutionary algorithms like GA, PSO, ANT COLONY and BEE COLONY etc.
- Apply evolutionary algorithms to solve power systems problems
- understand solution of Multi-Objective optimization using these algorithms

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Discriminate the capabilities of bio-inspired system and conventional methods in solving optimization problems.
- Examine the importance of exploration and exploitation of swarm intelligent system to attain near global optimal solution.
- Distinguish the functioning of various swarm intelligent systems.
- Employ various bio-inspired algorithms for power systems engineering applications.

**UNIT-I: FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES**

Definition-classification of optimization problems-unconstrained and constrained optimization optimality conditions-Introduction to intelligent systems-soft computing techniques-conventional computing versus swarm computing-classification of meta-heuristic techniques-single solution based and population based algorithms-exploitation and exploration in population based algorithms-Properties of Swarm intelligent Systems-application domain-Discrete and continuous problems-single objective and multi-objective problems.

**UNIT-II: GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION**

Genetic algorithms-Genetic algorithm versus Conventional Optimization Techniques-Genetic representations and selection mechanisms: Genetic operators-different types of crossover and mutation operators-Bird flocking and Fish Schooling-anatomy of a particle-equations based on velocity and positions-PSO topologies-control parameters-GA and PSO algorithms for solving ELD problems.

**UNIT-III: ANT COLONY OPTIMIZATION and ARTIFICIAL BEE COLONY ALGORITHMS**

Biological ant colony system-Artificial ants and assumptions –Stigmergic communications-pheromone updating-local-global-pheromone evaporation-ant colony system-ACO models-Touring ant colony system-max min ant system-concept of elastic ants-Task partitioning in honey bees-Balancing foragers and receivers-Artificial bee colony (ABC) algorithms-binary ABC algorithms-ACO and ABC algorithms for solving Economic Dispatch of thermal units.

**UNIT-IV: SHUFFLED FROG-LEAPING ALGORITHM and BAT OPTIMIZATION ALGORITHM**

Bat algorithm-Echolocation of bats-Behaviour of micro bats-Acoustics of echolocation-Movement of Virtual bats-Loudness and pulse Emission-Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes-memeplex formation-memeplex updation-BA and SFLA algorithms for solving ELD and optimal placement and sizing of the DG problem.

**UNIT-V: MULTI OBJECTIVE OPTIMIZATION**

Multi-Objective optimization introduction-concept of pareto optimality-Non-dominant sorting technique- pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and applications to power systems

**TEXT BOOKS:**

1. Xin-She Yang, 'Recent Advances in Swarm Intelligence and Evolutionary Computation' Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb 'Multi-Objective Optimization using Evolutionary Algorithms', John Wiley & Sons, 2001.

**REFERENCES:**

1. James Kennedy and Russel E Eberheart, 'Swarm Intelligence', The Morgan Kaufmann Series in Evolutionary Computation, 2001.
2. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, 'Swarm Intelligence-From natural to Artificial Systems', Oxford university Press, 1999.
3. David Goldberg, 'Genetic Algorithms in Search, Optimization and Machine Learning', Pearson Education, 2007.
4. Konstantinos E. Parsopoulos and Michael N. Vrahatis, ' Particle Swarm Optimization and Intelligence: Advances and Applications', Information Science reference, IGI Global, 2010.
5. N P Padhy, 'Artificial Intelligence and Intelligent Systems', Oxford University Press, 2005.

**REFERENCE PAPERS:**

1. "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization" by Muzaffar eusuff, Kevin lansey and Fayzul pasha, Engineering Optimization, Taylor & Francis, Vol. 38, No. 2, pp.129-154, March 2006.
2. "A New Metaheuristic Bat-Inspired Algorithm" by Xin-She Yang, Nature Inspired Cooperative Strategies for Optimization (NISCO 2010) (Eds. J.R. Gonzalez et al.), Studies in Computational Intelligence, Springer Berlin, 284, Springer, 65-74 (2010).
3. "Firefly Algorithms for Multimodal Optimization" Xin-She Yang, O. Watanabe and T. Zeugmann (Eds.), Springer-Verlag Berlin Heidelberg, pp. 169-178, 2009.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. I Year II Sem. (EPE/EPS)**

**INDUSTRIAL LOAD MODELLING AND CONTROL (Professional Elective - III)**

**Prerequisite:** Power Systems

**Course Objectives:** to prepare the students to

- understand the energy demand scenario
- model the industrial loads and study load demand
- Study reactive power management in Industries

**Course Outcomes:** Students will be able to

- gain knowledge about load control techniques in industries and its application.
- understand different types of industrial processes and optimize the process
- apply load management to reduce demand of electricity during peak time
- apply different energy saving opportunities in industries.

**UNIT-I: INTRODUCTION TO INDUSTRIAL LOAD MODELING**

Electric Energy Scenario-Demand Side Management-Industrial Load Management. Load Curves-Load Shaping Objectives-Methodologies. Barriers; Classification of Industrial Loads- Continuous and Batch processes -Load Modeling.

**UNIT-II: LOAD CONTROL METHODS**

Direct load control- Interruptible load control. Bottom up approach- scheduling- Formulation of load models- Optimization and control algorithms - Case studies. Reactive power management in industries- controls-power quality impacts, application of filters, Energy saving in industries.

**UNIT-III: COOLING AND HEATING**

load profiling- Modeling. Cool storage-Types- Control strategies. Optimal operation-Problem formulation- Case studies.

**UNIT-IV: CAPTIVE POWER MANAGEMENT**

Captive power units- Operating and control strategies- Power Pooling- Operation models. Energy banking-Industrial Cogeneration

**UNIT-V: OPTIMAL OPERATING STRATEGIES**

Selection of Schemes Optimal Operating Strategies. Peak load saving-Constraints-Problem formulation Case study. Integrated Load management for Industries

**TEXT BOOKS:**

1. C.O. Bjork "Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands, 1989.
2. C.W. Gellings and S.N. Talukdar, "Load management concepts," IEEE Press, New York, 1986, pp. 3-28.

**REFERENCES:**

1. Y. Manichaikul and F.C. Schweppe, " Physically based Industrial load", IEEE Trans. on PAS, April 1981.
2. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
3. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995.

4. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**AI TECHNIQUES IN POWER SYSTEMS (Professional Elective - IV)**

**Prerequisite:** Power System Analysis

**Course Objectives:** to prepare students to

- Understand fuzzy logic, artificial neural network (ANN)
- Understand genetic algorithm (GA) & evolutionary programming (EP)

**Course Outcomes:** Students will be able to

- Learn the concepts of biological foundations of artificial neural networks
- Learn Feedback networks and radial basis function networks and fuzzy logics
- Identifications of fuzzy and neural network
- Acquire the knowledge of GA

**UNIT-I:**

Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks.

**UNIT-II:**

Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods. Fuzzy Neural Networks and their learning methods

**UNIT-III:**

System Identification using Fuzzy and Neural Network.

**UNIT-IV:**

Genetic algorithm, Reproduction cross over, mutation, Introduction to evolutionary program.

**UNIT-V:**

Applications of above mentioned techniques to practical problems on power engineering

**TEXT BOOKS:**

1. J M Zurada , "An Introduction to ANN", Jaico Publishing House
2. Simon Haykins, "Neural Networks", Prentice Hall

**REFERENCES:**

1. Timothy Ross, "Fuzzy Logic with Engg.Applications", McGraw. Hill
2. Driankov, Dimitra, "An Introduction to Fuzzy Control", Narosa Publication
3. Golding, "Genetic Algorithms", Addison-Wesley Publishing Co.
4. NPTEL Course on "Introduction to Soft Computing" by Prof. Debasis Samanta,  
[https://www.youtube.com/playlist?list=PLJ5C\\_6qdAvBFqAYS0P9INAogIMkIG8E-9](https://www.youtube.com/playlist?list=PLJ5C_6qdAvBFqAYS0P9INAogIMkIG8E-9)
5. NPTEL Course on Neural Networks and Applications,  
<https://www.youtube.com/playlist?list=PL53BE265CE4A6C056>

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. I Year II Sem. (EPE/EPS)**

**POWER QUALITY (Professional Elective - IV)**

**Prerequisite:** Power Systems and Power Electronics

**Course Objectives:** to prepare students to

- know different terms of power quality.
- illustrate power quality issues for short and long interruptions.
- construct study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- know the behavior of power electronics loads, induction motors, synchronous motor etc. by the power quality issues
- know mitigation of power quality problems by using VSI converters.

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Know the severity of power quality problems in distribution system;
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
- Compute the power quality improvement by using various mitigating custom power devices.

**UNIT- I: INTRODUCTION**

Introduction of the Power Quality (PQ) problem: Terms used in PQ - Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

**UNIT- II: LONG & SHORT INTERRUPTIONS**

Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

**Short interruptions:** definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

**UNIT - III: SINGLE-PHASE & THREE-PHASE VOLTAGE SAG CHARACTERIZATION**

Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration.

Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

**UNIT-IV: POWER QUALITY CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS**

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

**UNIT-V: MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS**

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

**Power Quality and EMC Standards:**

Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

**TEXT BOOKS:**

1. Math H J Bollen “Understanding Power Quality Problems”, IEEE Press.
2. R.C. Dugan, M.F. McGranaghan and H.W. Beaty, “Electric Power Systems Quality.” New York: McGraw-Hill.1996

**REFERENCES:**

1. G.T. Heydt, ‘Electric Power Quality’, 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994).
2. Power Quality VAR Compensation in Power Systems, R. Sastry Vedam Mulukutla S.Sarma,CRC Press.
3. A Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power Devices. Kluwer Academic, 2002

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**POWER APPARATUS DESIGN (Professional Elective - IV)**

**Prerequisite:** Electrical Machines

**Course Objectives:** to prepare the students to

- design and model AC and DC rotating machines
- Learn electromagnetic energy conversion
- know about rating of machines

**Course Outcomes:** Students will be able to

- give a systematic approach for design, modeling and analysis of rotating machines
- design and model special machines.

**UNIT-I:**

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling.

**UNIT-II:**

Specific loadings, choice of magnetic and electric loadings Real and apparent flux -densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating.

**UNIT-III:**

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, Calculation of losses, efficiency and regulation, Forces winding during short circuit.

**UNIT-IV:**

General considerations, output equation, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor, Elimination of harmonic torques.

**UNIT-V:**

Design of stator and rotor winding, slot leakage flux, Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data. Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions Introduction to Computer Aided Electrical Machine Design Energy efficient machines.

**TEXT BOOKS:**

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman

**REFERENCES:**

1. Sawhney A.K, "A course in Electrical Machine Design", Dhanpat Rai & Sons, 5th Edition

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. I Year II Sem. (EPE/EPS)**

**POWER SYSTEM RELIABILITY AND PLANNING (Professional Elective - IV)**

**Prerequisite:** Reliability Engineering

**Course Objectives:** to prepare the students to:

- describe the generation system model and recursive relation for capacitive model building
- explain the equivalent transitional rates, cumulative probability and cumulative frequency
- develop the understanding of risk, system and load point reliability indices
- explain the basic and performance reliability indices

**Course Outcomes:** the student will be able to:

- Understand the importance of maintaining reliability of power system components.
- Apply the probabilistic methods for evaluating the reliability of generation and transmission systems.
- Assess the different models of system components in reliability studies.
- Assess the reliability of single area and multi area systems.

**UNIT-I: Basic Reliability Concepts:**

The general reliability function, exponential distribution – Mean time to failures – series and parallel systems. Markov process – continuous Markov process – Recursive techniques – Simple series and parallel system models.

**UNIT-II: Generating Capacity – Basic Probability Methods:**

The generation system model – Loss of load indices – Capacity expansion analysis – scheduled outages. Load forecast uncertainty Loss of energy indices. The frequency and duration method.

**UNIT-III: Transmission Systems Reliability Evaluation:**

Radial configuration – Conditional probability approach – Network configurations – State selection.

**UNIT-IV: Generation Planning:**

Comparative economic assessment of individual generation projects – Investigation and simulation models – Heuristic and linear programming models – Probabilistic generator and load models.

**UNIT-V: Transmission and Distribution Planning:**

Deterministic contingency analysis – Probabilistic transmission system – reliability analysis. Reliability calculations for single area and multi–area power systems. Network configuration design–consisting of schemes – security criteria configuration synthesis.

**TEXT BOOKS:**

1. Roy Billinton and Ronald Allan Pitam: Reliability Evaluation of Power Systems, 1996.
2. R.L. Sullivan: Power System Planning, McGraw Hill International, 1977.

**REFERENCES:**

1. Wheel Wright and Makridakis: Forecasting methods and Applications, John Wiley, 1992.
2. J. Endremyl: Reliability Modelling in Electric Power Systems, John Wiley, 2005.
3. International Renewable Energy Agency , Bonn Lecture Series: Planning for the Transformation of Power Systems [https://www.youtube.com/watch?v=sbZ2sY\\_E4QU](https://www.youtube.com/watch?v=sbZ2sY_E4QU)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. I Year II Sem. (EPE/EPS)**

**POWER SYSTEMS COMPUTATION LAB – II (Lab - III)**

**Prerequisite:**power systems and Artificial Neural Networks

**Course Objectives:** Students will be able to:

- Known Neural network tool box
- Know the various Evolutionary Algorithms
- Apply various Evolutionary Algorithms to power system problems

**Course Outcomes:** At the end of the course the student will be able to:

- Understood Neural network and fuzzy logic tool box
- Understood various Evolutionary Algorithms
- Solved power system problems by applying various Evolutionary Algorithms

**List of Experiments**

1. Load Flow analysis using Neural Network
2. State Estimations using Neural Network
3. Contingency Analysis using Neural Network
4. Power system Security using Neural Network
5. Fuzzy Logic based AGC – Single area system – Two area system
6. Fuzzy Logic based small signal stability analysis
7. Economic Dispatch of Thermal Units using ANN
8. Economic Dispatch of Thermal Units using GA
9. Unit commitment problem by using GA
10. Unit commitment problem by using PSO
11. Optimal location and sizing of capacitor in distribution system using PSO
12. Security constrained optimal power dispatch using GA
13. Optimal Reactive power dispatch using PSO

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. I Year II Sem. (EPE/EPS)**

**POWER SYSTEM PROTECTION LAB (Lab - IV)**

**Prerequisite:**Power systems protection

**Course Objectives:** Upon successful completion of the lab students will be familiar with:

- Different types of Faults occurring in power systems
- Characteristics of different types of relays
- Protection schemes

**Course Outcomes:** At the end of the course, the student should be able to:

- Calculate various faults
- Analyze the various time-current characteristics of protective relays
- Know the Performance and Testing of various electrical models and systems

**List of Experiments**

1. Characteristics of Electromechanical Non-Directional over current relay
2. Characteristics of Electromechanical Directional Over Current Relay
3. Characteristics of Electromechanical differential protection relay
4. Characteristics of Numerical Distance relay
5. Characteristics of Integrated Numerical under Voltage Relay
6. Characteristics of Numerical over current Relay
7. Zones protection characteristics of distance Relay
8. Differential protection on Single Phase Transformer
9. Performance and Testing of Feeder Protection System
10. Performance and Testing of Generator Protection System.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. II Year I Sem. (EPE/EPS)**

**POWER SYSTEM TRANSIENTS (Professional Elective - V)**

**Prerequisite:** Power Systems

**Course Objectives:** to prepare the students to:

- Learn the reasons for occurrence of transients in a power system.
- Understand the change in parameters like voltage & frequency during transients.
- know about the lightning phenomenon and its effect on power system.

**Course Outcomes:** Students will be able to:

- Know various transients in power system and their mathematical formulation.
- design various protective devices in power system for protecting equipment and personnel.
- Coordinate the insulation of various equipments in power system.
- Model the power system for transient analysis.

**UNIT-I:**

Fundamental circuit analysis of electrical transients, Laplace Transform method of solving simple Switching transients, Damping circuits - Abnormal switching transients, Three-phase circuits and transients, Computation of power system transients

**UNIT-II:**

Principle of digital computation – Matrix method of solution, Modal analysis- Z transform- Computation using EMTP, Lightning, switching and temporary over voltages, Lightning, Physical phenomena of lightning.

**UNIT-III:**

Interaction between lightning and power system, Influence of tower footing resistance and Earth Resistance, Switching: Short line or kilometric fault, Energizing transients - closing and re-closing of lines, line dropping, load rejection – over voltages induced by faults

**UNIT-IV:**

Switching HVDC line, Travelling waves on transmission line, Circuits with distributed Parameters, Wave Equation, Reflection, Refraction, Behaviour of Travelling waves at the line Terminations, Lattice Diagrams, Attenuation and Distortion factors, Multi-conductor system and Velocity wave.

**UNIT-V:**

Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Coordination between insulation and protection level, Statistical approach. Protective devices, Protection of system against over voltages, lightning arresters, substation earthing

**TEXT BOOKS:**

1. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991
2. Harold A Peterson: Transient in Power Systems, McGraw Hill, 1966.

**REFERENCES:**

1. Kuffel and Abdullah: High Voltage Engineering, PHI, 2000.
2. Rakesh D. Begamudre: EHV AC Transmission Engineering, PHI, 2006.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. II Year I Sem. (EPE/EPS)**

**FLEXIBLE AC TRANSMISSION SYSTEMS (Professional Elective - V)**

**Prerequisite:** Power Electronics and Power Systems

**Course Objectives:** to prepare the students to

- identify the limitations of uncompensated lines under various loading conditions.
- understand the concept and importance of compensation through FACTS devices
- explore shunt compensation, and basic operation of SVC, STATCOM and UPFC.
- analyze the functioning of series controllers like GCSC, TSSC, TCSC and SSSC

**Course Outcomes:** Upon the completion of this course, the student will be able to

- apply proper controller for a specific system requirement
- understand various systems thoroughly and their requirements
- interpret the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
- detect the power and control circuits of Series Controllers GCSC, TSSC, TCSC and SSSC

**UNIT-I: CONCEPT OF FACTS**

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

**UNIT-II: VOLTAGE & CURRENT SOURCE CONVERTERS**

Single phase & three phase full wave bridge converters, transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

**UNIT-III: STATIC SHUNT COMPENSATION**

Objectives of shunt compensation, mid-point voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators, hybrid VAR generators.

**UNIT-IV: STATIC SERIES COMPENSATION**

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), static synchronous series compensator (SSSC), control schemes for GSC, TSSC, TCSC and SSSC.

**UNIT-V: SVC & UPFC**

The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control., basic concept of unified power flow controller (UPFC).

**TEXT BOOKS:**

1. Hingorani H G and Gyugyi. L " Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.
2. Padiyar.K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007

**REFERENCES:**

1. Prof. Avik Bhattacharya , IIT Roorkee, NPTEL Course on Flexible AC Transmission Systems (FACTS), July 2018,  
[https://www.youtube.com/playlist?list=PLLy\\_2iUCG87AVyRAN4QwVQrC8vSg1vWa6](https://www.youtube.com/playlist?list=PLLy_2iUCG87AVyRAN4QwVQrC8vSg1vWa6)
2. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash “Flexible AC Transmission Systems: Modeling and Control”, Springer, 2012
3. Yong-Hua Song, Allan Johns, “Flexible AC Transmission Systems”, IET, 1999.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. TECH. II Year I Sem. (EPE/EPS)**

**GAS INSULATED SYSTEMS (Professional Elective - V)**

**Prerequisite:** Switch Gear and Protection

**Course objectives:** to prepare the students to

- understand the GIS concepts and principles
- distinguish Air Insulated and Gas insulated Substations
- demonstrate the design and constructional aspects of GIS
- analyze transient phenomenon, problems and diagnostic methods in GIS

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Know the advantages of GIS systems over air insulated systems
- Observe constructional design features of GIS design
- Discriminate the problems and design diagnostic methods of GIS

**UNIT-I: INTRODUCTION TO GIS AND PROPERTIES OF SF<sub>6</sub>**

Characteristics of GIS- Introduction to SF<sub>6</sub> - Physical properties-Chemical properties - Electrical properties-Specification of SF<sub>6</sub> gas for GIS application - Handling of SF<sub>6</sub> gas before use - Safe handling of SF<sub>6</sub> gas in electrical equipment - Equipment for handling the SF<sub>6</sub> Gas - SF<sub>6</sub> and environment.

**UNIT-II: LAYOUT OF GIS STATIONS**

Advancement of GIS station - Comparison with Air Insulated Substation - Economics of GIS - User Requirements for GIS - Main Features for GIS - Planning and Installation components of a GIS station.

**UNIT-III: DESIGN AND CONSTRUCTION OF GIS STATION**

Introduction - Rating of GIS components - Design Features - Estimation of different types of Electrical Stresses -Design Aspects of GIS components - Insulation Design for Components - Insulation Design for GIS - Thermal Considerations in the Design of GIS - Effect of very Fast Transient Over-voltages (VFTO) on the GIS design - Insulation Coordination systems - Gas handling and Monitoring System Design.

**UNIT-IV: FAST TRANSIENT PHENOMENA IN GIS**

Introduction - Disconnecter Switching in Relation to Very fast Transients-Origin of VFTO-Propagation and Mechanism of VFTO-VFTO Characteristics- Effects of VFTO-Testing of GIS for VFTO.

**UNIT-V: SPECIAL PROBLEMS IN GIS AND GIS DIAGNOSTICS**

Introduction - particles their effects and their control- Insulating Spacers and their Reliability - SF<sub>6</sub> Gas Decomposition - Characteristics of imperfections in insulation - Insulation Diagnostic methods - PD Measurement and UHF Method.

**TEXT BOOKS:**

1. M. S. Naidu, "Gas Insulated Substations"- IK International Publishing House.
2. Hermann J. Koch, "Gas Insulated Substations", June 2014, Wiley - IEEE Press.

**REFERENCES:**

1. Olivier Gallot-Lavellee, "Dielectric materials and Electrostatics" , Wiley - IEEE Press.
2. Jaun Martinez, "Dielectric Materials for Electrical Engineering", Wiley - IEEE Press.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. TECH. II Year I Sem. (EPE/EPS)**

**SCADA SYSTEM AND APPLICATIONS (Professional Elective - V)**

**Prerequisite:** None

**Course Objectives:** to prepare students to:

- understand about Supervisory Control and Data Acquisition System (SCADA)
- know SCADA communication and its functions
- get an insight into its application

**Course Outcomes:** Students will be able to:

- Describe the basic tasks of SCADA
- Acquire knowledge about SCADA architecture, various advantages and disadvantages of each System.
- understand about single unified standard architecture IEC 61850.
- learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
- apply SCADA systems in transmission and distribution sectors

**UNIT-I: Introduction to SCADA,**

Data acquisition systems, Evolution of SCADA, Communication technologies.

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA.

**UNIT-II: SCADA Components**

Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices(IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.

**UNIT-III: SCADA Architecture**

Various SCADA architectures, advantages and disadvantages of each System, single unified standard architecture -IEC 61850.

**UNIT-IV: SCADA Communication**

various industrial communication technologies,wired and wireless methods and fiber optics,Open standard communication protocols.

**UNIT-V: SCADA Applications:**

Utility applications,Transmission and Distribution sector operations, monitoring, analysis and improvement,Industries - oil, gas and water,Case studies, Implementation, Simulation Exercises.

**TEXT BOOKS:**

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

**REFERENCES:**

1. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006.
2. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
3. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. Tech. (EPE/EPS)**

**ENGLISH FOR RESEARCH PAPER WRITING (Audit Course - I & II)**

**Prerequisite:** None

**Course objectives:** Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

**UNIT-I:**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT-II:**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

**UNIT-III:**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

**UNIT-IV:**

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

**UNIT-V:**

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**TEXT BOOKS/ REFERENCES:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. Tech. (EPE/EPS)**

**DISASTER MANAGEMENT (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- 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

**UNIT-I:**

**Introduction:**

Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**Disaster Prone Areas in India:**

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

**UNIT-II:**

**Repercussions of Disasters and Hazards:**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

**UNIT-III:**

**Disaster Preparedness and Management:**

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT-IV:**

**Risk Assessment Disaster Risk:**

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

**UNIT-V:**

**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.

**TEXT BOOKS/ REFERENCES:**

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 &Deep Publication Pvt. Ltd., New Delhi.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. Tech. (EPE/EPS)**

**SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

**Course Outcomes:** Students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

**UNIT-I:**

Alphabets in Sanskrit,

**UNIT-II:**

Past/Present/Future Tense, Simple Sentences

**UNIT-III:**

Order, Introduction of roots,

**UNIT-IV:**

Technical information about Sanskrit Literature

**UNIT-V:**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

**TEXT BOOKS/ REFERENCES:**

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

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. Tech. (EPE/EPS)**

**VALUE EDUCATION (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

**Course outcomes:** Students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

**UNIT-I:**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

**UNIT-II:**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**UNIT-III:**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

**UNIT-IV:**

Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

**UNIT-V:**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

**TEXT BOOKS/ REFERENCES:**

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. Tech. (EPE/EPS)**

**CONSTITUTION OF INDIA (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- 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.
- 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 Outcomes:** Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- 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.
- Discuss the passage of the Hindu Code Bill of 1956.

**UNIT-I:**

**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working),  
**Philosophy of the Indian Constitution:** Preamble, Salient Features.

**UNIT-II:**

**Contours of Constitutional Rights & 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.

**UNIT-III:**

**Organs of Governance:** Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

**UNIT-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: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT-V:**

**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.

**TEXT BOOKS/ REFERENCES:**

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.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. Tech. (EPE/EPS)**

**PEDAGOGY STUDIES (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**Course Outcomes:** Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

**UNIT-I:**

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

**UNIT-II:**

**Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

**UNIT-III:**

Evidence on the effectiveness of pedagogical practices, Methodology for the indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT-IV:**

**Professional development:** alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**UNIT-V:**

**Research gaps and future directions:** Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

**TEXT BOOKS/ REFERENCES:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeamong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? *International Journal Educational Development*, 33 (3): 272–282.
5. Alexander RJ (2001) *Culture and pedagogy: International comparisons in primary education*. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. [www.pratham.org/images/resource%20working%20paper%202.pdf](http://www.pratham.org/images/resource%20working%20paper%202.pdf).

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
M. Tech. (EPE/EPS)**

**STRESS MANAGEMENT BY YOGA (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:**

- To achieve overall health of body and mind
- To overcome stress

**Course Outcomes:** Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

**UNIT-I:**

Definitions of Eight parts of yog. (Ashtanga)

**UNIT-II:**

Yam and Niyam.

**UNIT-III:**

Do`s and Don`ts in life.

- i) Ahinsa, satya, astheya, bramhacharya and aparigraha
- ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**UNIT-IV:**

Asan and Pranayam

**UNIT-V:**

- i) Various yog poses and their benefits for mind & body
- ii) Regularization of breathing techniques and its effects-Types of pranayam

**TEXT BOOKS/ REFERENCES:**

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

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**M. Tech. (EPE/EPS)**

**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**  
**(Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:**

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

**Course Outcomes:** Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

**UNIT-I:**

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

**UNIT-II:**

Neetisatakam-Holistic development of personality

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

**UNIT-III:**

Approach to day to day work and duties.

- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

**UNIT-IV:**

Statements of basic knowledge.

- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:

**UNIT-V:**

- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

**TEXT BOOKS/ REFERENCES:**

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