JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH. (POWER & ENERGY SYSTEMS)
EFFECTIVE FROM ACADEMIC YEAR 2017- 18 ADMITTED BATCH

COURSE STRUCTURE AND SYLLABUS

I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Advanced Power System Analysis	25	75	4	0	0	4
PC-2	Advanced Power System Protection	25	75	4	0	0	4
PC-3	Renewable Energy Technologies	25	75	4	0	0	4
PE-1	1. EHV AC Transmission 2. High Voltage Engineering 3. Advanced Digital Signal Processing	25	75	3	0	0	3
PE-2	1. Power Quality 2. Microcontrollers and applications 3. Distribution Automation	25	75	3	0	0	3
OE-1	***Open Elective – I**	25	75	3	0	0	3
Laboratory I	Power and Energy Systems Lab-I	25	75	0	0	3	2
Seminar I	Seminar –I	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	Modern Control Theory	25	75	4	0	0	4
PC-5	Flexible AC Transmission Systems (FACTS)	25	75	4	0	0	4
PC-6	Smart Grid Technologies	25	75	4	0	0	4
PE-3	1. Energy Auditing Conservation and Management 2. Programmable Logic Controllers and applications 3. High Frequency Magnetic Components	25	75	3	0	0	3
PE4	1. Reactive Power Compensation and Management 2. Power System Reliability 3. Voltage Stability	25	75	3	0	0	3
OE-2	***Open Elective – II**	25	75	3	0	0	3
Laboratory II	Power and Energy Systems Lab-II	25	75	0	0	3	2
Seminar II	Seminar –II	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	**200**	**100**	0	**3**	22	**14**

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	**100**	**100**	**0**	**0**	**24**	**24**

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

 # For Project review I, please refer 7.10 in R17 Academic Regulations.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH – I YEAR – II SEM. (PES)

MODERN CONTROL THEORY
(Professional Core - IV)

Prerequisite: Control Systems

Course Objectives:

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

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

- Apply the knowledge of basic and modern control system for the real time analysis and design of control systems.
- Understand the concepts of state variables analysis.
- Analyze the concept of stability of nonlinear systems and optimal control.

UNIT– I:
Mathematical Preliminaries: 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 operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

UNIT- II:
State Variable Analysis: Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

UNIT- III:
Non Linear Systems: Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

UNIT- IV:
Stability Analysis: Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order.

UNIT-V:
Optimal Control: Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator.

TEXT BOOKS:

1. modern control system theory by M. Gopal – new age international -1984
2. Control System Engineering, Nagrath and Gopal - New Age International – Fourth Edition

REFERENCES:

1. Optimal control by Kirck , Dover Publications
2. Advanced Control Theory A. Nagoor Kani, RBA Publications, 1999
3. Modern Control Engineering by Ogata.K – Prentice Hall - 1997

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)
(Professional Core - V)

Prerequisite: Power Electronics and Power Systems - II

Course Objectives:

- To understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & their benefits
- To recall the oobjectives of Shunt and Series compensation
- To explain ccontrol of STATCOM and SVC and their comparison And the regulation of STATCOM
- To analyze the functioning and control of GCSC, TSSC and TCSC

Course Outcomes: Upon the completion of the subject, the student will be able to

- Choose proper controller for the specific application based on system requirements
- 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 and TCSC

UNIT- I:
Facts Concepts
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 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:
SVC And STATCOM
The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

UNIT- V:
Static Series Compensators
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)
Control schemes for GSC TSSC and TCSC.

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. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012
2. Yong-Hua Song, Allan Johns, "Flexible AC Transmission Systems", IET, 1999

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PES)

SMART GRID TECHNOLOGIES
(Professional Core – VI)

Prerequisites: Electrical Distribution Systems, Power Systems

Course Objectives:

- To understand various aspects of smart grid
- To study various smart transmission and distribution technologies
- To appreciate distribution generation and smart consumption
- To know the regulations and market models for smart grid

Course Outcomes: Upon the completion of the subject, the student will be able to

- Understand technologies for smart grid
- Appreciate the smart transmission as well distribution systems
- Realize the distribution generation and smart consumption
- Know the regulations and market models for smart grid

UNIT - I:
Introduction to Smart Grids: Definition, justification for smart grids, smart grid conceptual model, smart grid architectures, Interoperability, communication technologies, role of smart grids standards, intelligrid initiative, national smart grid mission (NSGM) by Govt. of India

UNIT - II:
Smart Transmission Technologies: Substation automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area measurement systems (WAMS)

UNIT - III:
Smart Distribution Technologies: Distribution automation, outage management systems, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), Energy Storage, Renewable Integration

UNIT - IV:
Distributed Generation and Smart Consumption: Distributed energy resources (DERs), smart appliances, low voltage DC (LVDC) distribution in homes / buildings, home energy management system (HEMS), Net Metering, Building to Grid B2G, Vehicle to Grid V2G, Solar to Grid, Microgrid

UNIT - V:
Regulations and Market Models for Smart Grid: Demand Response, Tariff Design, Time of the day pricing (TOD), Time of use pricing (TOU), Consumer privacy and data protection, consumer engagement etc.
Cost benefit analysis of smart grid projects.

TEXT BOOKS:

1. Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”-CRC Press, 2009.
2. Jean Claude Sabonnadière, Nouredine Hadjsaïd, “Smart Grids”, Wiley-ISTE, IEEE Press, May 2012

REFERENCES:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis" - Wiley, IEEE Press, 2012.
3. India Smart Grid Knowledge Portal

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

Energy Auditing Conservation and Management
(Professional Elective – III)

Course Objectives:

- To know the necessity of conservation of energy
- To generalize the methods of energy management
- To illustrate the factors to increase the efficiency of electrical equipment
- To detect the benefits of carrying out energy audits.

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

- Tell energy audit of industries
- Predict management of energy systems
- Sequence the methods of improving efficiency of electric motor
- Analyze the power factor and to design a good illumination system
- Determine pay back periods for energy saving equipment

UNIT- I:
Basic Principles of Energy Audit: Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT- II:
Energy Management: Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting- Energy manger, Qualities and functions, language, Questionnaire – check list for top management.

UNIT- III:
Energy Efficient Motors: Energy efficient motors, factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit

UNIT- IV:
Power Factor Improvement, Lighting and Energy Instruments: Power factor – methods of improvement, location of capacitors, pf with non linear loads, effect of harmonics on power factor, power factor motor controllers - Good lighting system design and practice, lighting control, lighting energy audit - Energy Instruments- wattmeter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's.

UNIT- V:
Economic Aspects and Analysis: Economics Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment .

TEXT BOOKS:

1. Energy management by W.R. Murphy AND G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998

REFERENCES:

1. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995-
2. Energy management hand book by W.C.Turner, John wiley and sons
3. Energy management and good lighting practice : fuel efficiency- booklet 12-EEO

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS
(Professional Elective – III)

Prerequisite: No Prerequisite

Course Objectives:

- It is to provide and ensure a comprehensive understanding of using advanced controllers in measurement and control instrumentation.
- To illustrate about data acquisition - process of collecting information from field instruments.
- To analyze Programmable Logic Controller (PLC), IO Modules and internal features.
- To Comprehend Programming in Ladder Logic, addressing of IO.
- To apply PID and its Tunning.

Course Outcomes:

- Describe the main functional units in a PLC and be able to explain how they interact.
- They should know different bus types used in automation industries.
- Development of ladder logic programming for simple process.
- At the end of each chapter, review question, problems given to reinforce their understanding of the concepts.

UNIT- I:
PLC Basics PLC system, I/O modules and interfacing CPU processor programming equipment programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT- II:
PLC Programming input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill-press operation.
Digital logic gates programming in the Boolean algebra system, conversion examples Ladder diagrams for process control Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT- III:
PLC Registers: Characteristics of Registers module addressing holding registers input registers, output registers. PLC Functions Timer functions and industrial applications counters counter function industrial applications, Architecture functions, Number comparison functions, number conversion functions.

UNIT- IV:
Data handling functions: SKIP, Master control Relay Jump Move FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axes and three axis Robots with PLC, Matrix functions.

UNIT- V:
Analog PLC operation: Analog modules and systems Analog signal processing multi bit data processing , analog output application examples, PID principles position indicator with PID control, PID modules, PID tuning, PID functions

TEXT BOOKS:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI
2. Digital Design by Morris Mano, PHI, 3rd Edition 2006.

REFERENCE BOOKS:

1. Programmable logic Controllers, Frank D. Petruzella, 4th Edition, McGraw Hill Publishers.

2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth & F.D Hackworth Jr. – Pearson, 2004.
3. Programmable logic controllers and their Engineering Applications, 2nd Edition, Alan J. Crispin.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (PES)

HIGH FREQUENCY MAGNETIC COMPONENTS
(Professional Elective – III)

UNIT- I:
Fundamentals of Magnetic Devices: Introduction, Magnetic Relationships, Magnetic Circuits, Magnetic Laws, Eddy Currents, Core Saturation, Volt-Second Balance, Inductance, Inductance Factor, Magnetic Energy, Self-Resonant Frequency, Classification of Power Losses in Magnetic Components, Non-inductive Coils.
Magnetic Cores: Introduction, Properties of Core Materials, Magnetic Dipoles, Magnetic Domains, Curie Temperature, Magnetization, Magnetic Materials, Hysteresis, Core Permeability, Core Geometries, Iron Alloy Cores, Amorphous Alloy Cores, Nickel–Iron and Cobalt–Iron Cores, Ferrite Cores, Powder Cores, Nano-crystalline Cores, Superconductors, Hysteresis Core Loss, Eddy-Current Core Loss, Total Core Loss, Complex Permeability.

UNIT- II:
Skin Effect & Proximity Effect: Introduction, Magnet Wire, Wire Insulation, Skin Depth, Ratio of AC-to-DC Winding Resistance, Skin Effect in Long Single Round Conductor, Current Density in Single Round Conductor, Impedance of Round Conductor, Magnetic Field Intensity for Round Wire, Other Methods of Determining the Round Wire Inductance, Power Density in Round Conductor, Skin Effect on Single Rectangular Plate. Proximity and Skin Effects in Two Parallel Plates, Anti-proximity and Skin Effects in Two Parallel Plates, Proximity Effect in Multiple-Layer Inductor, Appendix: Derivation of Proximity Power Loss.
Winding Resistance at High Frequencies: Introduction, Winding Resistance, Square and Round Conductors, Winding Resistance of Rectangular Conductor, Winding Resistance of Square Wire, Winding Resistance of Round Wire, Leakage Inductance, Solution for Round Conductor Winding in Cylindrical Coordinates, Litz Wire, Winding Power Loss for Inductor Current with Harmonics, Effective Winding Resistance for Non-sinusoidal Inductor Current, Thermal Model of Inductors.

UNIT- III:
Transformers: Introduction, Neumann's Formula for Mutual Inductance, Mutual Inductance, Energy Stored in Coupled Inductors, Magnetizing Inductance, Leakage Inductance, Measurement of Transformer Inductances, Stray Capacitance, High-Frequency Transformer Model, Non-interleaved Windings, Interleaved Windings, AC Current Transformers, Winding Power Losses with Harmonics, Thermal Model of Transformers.
Design of Transformers: Introduction, Area Product Method, Optimum Flux Density, Transformer Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in DCM, Transformer Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in DCM.

UNIT- IV:
Integrated Inductors: Introduction, Resistance of Rectangular Trace, Inductance of Straight Rectangular Trace, Construction of Integrated Inductors, Meander Inductors, Inductance of Straight Round Conductor, Inductance of Circular Round Wire Loop, Inductance of Two-Parallel Wire Loop, Inductance of Rectangle of Round Wire, Inductance of Polygon Round Wire Loop, Bond-wire Inductors, Single-Turn Planar Inductor, Inductance of Planar Square Loop, Planar Spiral Inductors, Multi-metal Spiral Inductors, Planar Transformers, MEMS Inductors, Inductance of Coaxial Cable, Inductance of Two-Wire Transmission Line, Eddy Currents in Integrated Inductors, Model of RF Integrated Inductors, PCB Inductors.
Design of Inductors: Introduction, Restrictions on Inductors, Window Utilization Factor, Temperature Rise of Inductors, Mean Turn Length of Inductors, Area Product Method, AC Inductor Design, Inductor Design for Buck Converter in CCM, Inductor Design for Buck Converter in DCM method.

UNIT- V:
Self-Capacitance: Introduction, High-Frequency Inductor Model, Self-Capacitance Components, Capacitance of Parallel-Plate Capacitor, Self-Capacitance of Foil Winding Inductors, Capacitance of

Two Parallel Round Conductors, Capacitance of Round Conductor and Conducting Plane, Self-Capacitance of Single-Layer Inductors, Self-Capacitance of Multi-layer Inductors, Capacitance of Coaxial Cable.

TEXT BOOK:

1. Design of Magnetic Components for Switched Mode Power Converters, Umanand L., Bhat,S.R., ISBN:978-81-224-0339-8, Wiley Eastern Publication, 1992.

REFERENCES:

1. High-Frequency Magnetic Components, Marian K. Kazimierczuk, ISBN: 978-0-470-71453-9 John Wiley & Sons, Inc.
2. G. C. Chryssis, High frequency switching power supplies, McGraw Hill, 1989 (2nd Edn.)
3. Eric Lowdon, Practical Transformer Design Handbook, Howard W. Sams& Co., Inc., 1980
4. “Thompson --- Electrodynamic Magnetic Suspension.pdf”
5. Witulski --- “Introduction to modeling of transformers and coupled inductors” Beattie --- “Inductance 101.pdf”
6. P. L. Dowell, "Effects of eddy currents in transformer windings.pdf"
7. Dixon--- “Eddy current losses in transformer windings.pdf”
8. J J Ding, J S Buckkeridge, “Design Considerations For A Sustainable Hybrid Energy System” IPENZ Transactions, 2000, Vol. 27, No. 1/EMCh.
9. Texas Instruments --- “Windings.pdf”
10. Texas Instruments --- “Magnetic core characteristics.pdf”
11. Ferroxcube --- “3f3 ferrite datasheet.pdf”
12. Ferroxcube --- “Ferrite selection guide.pdf”
13. Magnetics, Inc., Ferrite Cores (www.mag-inc.com).

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

REACTIVE POWER COMPENSATION AND MANAGEMENT
(Professional Elective – IV)

Prerequisite: Power Systems - II

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 contrast reactive power coordination system
- To characterize distribution side and utility side reactive power management.

Course Outcomes: Upon the completion of the subject, 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 Reactive Power Compensation in Transmission System: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation –examples
Transient state reactive power compensation in transmission systems: 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:
Demand Side Management: Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels
Distribution side Reactive power Management:: System losses –loss reduction methods – examples – Reactive power planning – objectives – 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 are 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, Wiely publication.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

POWER SYSTEM RELIABILITY
(Professional Elective – IV)

Prerequisite: Reliability Engineering

Course Objectives:
- To identify the generation system model and recursive relation for capacitive model building
- To calculate the equivalent transitional rates, cumulative probability and cumulative frequency
- To classify the risk, system and load point reliability indices
- To evaluate the basic reliability indices

Course Outcomes: Upon the completion of the subject, the student will be able to
- Find loss of load and energy indices for generation systems model
- Describe merging generation and load models
- Apply various indices for distribution systems

UNIT - I:
Generating System Reliability Analysis – I: Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices – Examples.

UNIT - II:
Generating System Reliability Analysis – II: Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2- level daily load representation - merging generation and load models – Examples.

UNIT - III:
Operating Reserve Evaluation: Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units – Modelling using STPM approach.
Bulk Power System Reliability Evaluation: Basic configuration – conditional probability approach – system and load point reliability indices – weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

UNIT - IV:
Inter Connected System Reliability Analysis: Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads – Expression for cumulative probability and cumulative frequency.
Distribution System Reliability Analysis – I (Radial configuration): Basic Techniques – Radial networks –Evaluation of Basic reliability indices, performance indices – load point and system reliability indices – customer oriented, loss and energy oriented indices – Examples.

UNIT - V:
Distribution System Reliability Analysis - II (Parallel Configuration): Basic techniques – inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices – Examples
Substations and Switching Stations: Effects of short-circuits - breaker operation – Open and Short-circuit failures – Active and Passive failures – switching after faults – circuit breaker model – preventive maintenance – exponential maintenance times.

TEXT BOOKS:
1. Reliability Evaluation of Power systems by R. Billinton, R.N.Allan, BS Publications, 2007.
2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978

REFERENCES:

1. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications.
2. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMH Publications.
3. Reliability Engineering by E. Balaguruswamy, TMH Publications.
4. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

VOLTAGE STABILITY
(Professional Elective – IV)

Prerequisite: Computers Methods in Power Systems

Course Objectives:
- To choose SEC Planning and Operational Standards of Security
- To estimate Reactive Power Control in Generation/Transmission Interconnected Networks
- To apply sstability/Instability in Generation/Transmission Interconnected Networks
- To analyze design and Operational Solutions
- To characterize voltage Control in Distribution Networks

Course Outcomes: Upon the completion of the subject, the student will be able to
- Understand issues related to power system stability and control.
- Demonstrate various load models in voltage stability analysis.
- Detect reactive power compensation techniques & their practical importance

UNIT– I:
Introduction to Voltage Stability
Definitions: Voltage Stability, Voltage Collapse, Voltage Security; Physical relation indicating dependency of voltage on reactive power flow; Factors affecting Voltage collapse and instability; Previous cases of voltage collapse incidences.

UNIT– II:
Graphical Analysis of Voltage Stability
Comparison of Voltage and angular stability of the system; Graphical Methods describing voltage collapse phenomenon: P-V and Q-V curves; detailed description of voltage collapse phenomenon with the help of Q-V curves.

UNIT– III:
Analysis of Voltage Stability
Analysis of voltage stability on SMLB system: Analytical treatment and analysis.
Voltage Stability Indices:
Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stability margin.

UNIT– IV:
Power System Loads
Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heat pumps, electronic power supplies, OH lines and cables.
Reactive Power Compensation:
Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous condensers, SVC s; OLTC s; Booster Transformers.

UNIT–V:
Voltage Stability Margin
Stability Margin: Compensated and un-compensated systems.
Voltage Security
Definition; Voltage security; Methods to improve voltage stability and its practical aspects.

TEXT BOOKS:
1. "Performance, operation and control of EHV power transmission system"-A. CHAKRABARTHY, D.P. KOTARI and A.K. MUKOPADYAY, A.H. Wheeler Publishing, I Edition, 1995.

2. “Power System Dynamics: Stability and Control” – K.R. PADIYAR, II Edition, B.S. Publications.

REFERENCES:

1. “Power System Voltage Stability”- C.W. TAYLOR, McGraw Hill, 1994.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – II SEM. (PES)

POWER AND ENERGY SYSTEM LAB – II

Prerequisites: Power System Analysis, Power System Protection

Course Objectives:

- To understand the Performance of Transformers and Synchronous Machines
- To select the Transmission Lines, UG Cables, String Insulators, CTs and PTs.
- To analyze the characteristics of OC, UV/OV, negative sequence relays.

Course Outcomes: Upon the completion of the lab, the student will be able to

- Test and evaluate the performance of Power Transformers and Synchronous Machines.
- Test and evaluate the performance of Transmission lines, UG Cables, Insulators and other Auxiliary Power Systems Equipment
- Test, Evaluate/Choose the various types of Relays (Electromagnetic, Static and Microprocessor based relays)

1. Determination of Equivalent circuit of a 3-Winding Transformer.
2. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine.
3. 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).
4. Determination of Sub-transient reactance's of a Salient Pole Synchronous Machine.
5. Determination of Sequence Impedances of Three Phase Transformer
6. Characteristics of Over Current Relays
    i. IDMT Electromagnetic Relay (7051 A).
    ii. Microprocessor based Relay (7051 B)
7. Characteristics of Percentage biased Differential Relay.
    i. Electromagnetic Relay (7054 A).
    ii. Static Relay (7054 B).
8. Characteristics of Over Voltage Relay.
    I. Electromagnetic Relay (7053 A).
    II. Microprocessor based Relay (7053 B).
9. Characteristics of Under Voltage (UV) and Negative sequence Relays
    i. Uv Electromagnetic Relay (7052 A).
    ii. Uv Microprocessor Based Relay (7052 B).
    iii. Static Negative Sequence Relay (7055 B).
10. Performance and Testing of Generator Protection System.
11. Performance and Testing of Transformer Protection System.
12. Performance and Testing of Feeder Protection System.
13. Performance and Testing of Transmission Line Model.
14. Differential protection on Single Phase Transformer.

Note: From the above list minimum 10 experiments are to be conducted