JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH. (POWER ENGINEERING & 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	1	4
PC-5	Flexible AC Transmission Systems (FACTS)	25	75	4	0	1	4
PC-6	Smart Grid Technologies	25	75	4	0	1	4
PE-3	1. Energy Auditing Conservation and Management 2. Programmable Logic Controllers and their 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 I	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 II	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	200	0	0	0	16
Total	**100**	**200**	**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 – I SEM. (PEES)

ADVANCED POWER SYSTEM ANALYSIS
(Professional Core - I)

Prerequisite: Computer Methods in Power Systems

Course Objectives:

- To analyze a Power System Network using graph theory.
- To interpret the formation of Network matrices.
- To construct the necessity of load flow studies and various methods of Analysis.
- To examine short circuit analysis using Z_{Bus}.

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

- Remember proper mathematical models for analysis.
- Conclude methodologies of load flow studies for the power network.
- Apply contingency Analysis.
- Analyze power system studies.

UNIT-I:

Admittance Model and Network Calculations, Branch and Node Admittances, Mutually Coupled Branches in Y_{BUS} , An Equivalent Admittance Network, Modification of Y_{BUS} , Network Incidence Matrix and Y_{BUS} , Method of Successive Elimination, Node Elimination, Triangular Factorization, Sparsity and Near Optimal Ordering.

UNIT-II:

Impedance Model and Network Calculations, the BUS Admittance and Impedance Matrices, Thevenin's Theorem and Z_{BUS} ,Algorithms for building Z_{BUS} Modification of existing $Z_{BUS,}$ Calculation of Z_{BUS} elements from $Y_{BUS,}$ Power Invariant Transformations, Mutually Coupled Branches in $Z_{BUS.}$

UNIT-III:

Gauss Seidel method, N-R Method, Decoupled method, fast decoupled method, comparison between power flow solutions. DC load flow.

UNIT-IV:

Z_{BUS} Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies.

UNIT-V:

Fault Analysis: Symmetrical faults-Fault calculations using Z_{BUS}- Fault calculations using Z_{BUS} equivalent circuits –Selection of circuit breakers- Unsymmetrical faults-Problems on various types of faults.

TEXT BOOKS:

1. John J. Grainger and W. D. Stevenson, "Power System Analysis"- T.M.H. Edition.
2. Modern Power System Analysis– by I. J. Nagrath & D. P. Kothari Tata McGraw – Hill Publishing Company Ltd, 2nd edition.

REFERENCE BOOKS:

1. Power System Analysis and Design by J. Duncan Glover and M.S. Sarma., Cengage 3rd Edition.
2. Olle. L.Elgard, "Electrical Energy Systems Theory"-T.M.H. Edition.
3. Power systems stability and control, Prabha Kundur, The McGraw – Hill companies.
4. Power System Operation and Control, Dr. K. Uma Rao, Wiley India Pvt. Ltd.
5. Operation and Control in Power Systems, PSR Murthy, Bs Publications.
6. Power System Operation, Robert H. Miller, Jamesh H. Malinowski, The McGraw – Hill companies.
7. Power Systems Analysis, operation and control by Abhijit Chakrabarti, Sunitha Halder, PHI 3/e , 2010

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

ADVANCED POWER SYSTEM PROTECTION
(Professional Core - II)

Prerequisite: Switch Gear and Protection
Course Objectives:
- To distinguish all kinds of circuit breakers and relays for protection of Generators, Transformers and feeder bus bars from Over voltages and other hazards.
- To generalize neutral grounding for overall protection.
- To illustrate the phenomenon of Over Voltages and its classification.

Course Outcomes: Upon the completion of the subject, the student will be able to
- Understand the basic function of a circuit breaker, all kinds of circuit breakers and differentiate fuse and circuit breakers under fault condition.
- Describe the necessity for the protection of alternators, transformers and feeder bus bars from over voltages and other hazards
- Illustrate neutral grounding, and how over voltages can be generated and how system can be protected against lightning and switching transient over voltages with various protective means
- Identify operation and control of microprocessor based relays.

UNIT-I:
Static Relays: Advantages of static relays-Basic construction of static relays-Level detectors-Replica impedance –Mixing circuits-General equation for two input phase and amplitude comparators-Duality between amplitude and phase comparators.
Amplitude Comparators: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators.

UNIT-II:
Phase Comparators: Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type- Phase comparators.
Static Over Current Relays: Instantaneous over-current relay-Time over-current relays-basic principles –definite time and Inverse definite time over-current relays.

UNIT-III:
Static Differential Relays: Analysis of Static Differential Relays –Static Relay schemes –Duo bias transformer differential protection –Harmonic restraint relay.
Static Distance Relays: Static impedance-reactance–MHO and angle impedance relay-sampling comparator –realization of reactance and MHO relay using sampling comparator.

UNIT-IV:
Multi-Input Comparators: Conic section characteristics-Three input amplitude comparator –Hybrid comparator-switched distance schemes –Poly phase distance schemes- phase fault scheme –three phase scheme – combined and ground fault scheme.
Power Swings: Effect of power swings on the performance of distance relays –Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.

UNIT-V:

Microprocessor based Protective Relays: (Block diagram and flowchart approach only)-Over current relays–impedance relays-directional relay-reactance relay .Generalized mathematical expressions for distance relays-measurement of resistance and reactance –MHO and offset MHO relays-Realization of MHO characteristics- Realization of offset MHO characteristics -Basic principle of Digital computer relaying, Introduction to wide area control(qualitative).

TEXT BOOKS:

1. Badri Ram and D.N. Vishwakarma, “Power system protection and Switch gear “, TMH publication New Delhi 1995.
2. T.S. Madhava Rao , “Static relays”, TMH publication, second edition 1989.

REFERENCE:

1. Protection and Switchgear, Bhavesh Bhalja, R. P. Mahesheari, Nilesh G. Chothani, Oxford University Press.
2. Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

RENEWABLE ENERGY TECHNOLOGIES
(Professional Core - III)

Course Objective

- To provide necessary knowledge about the modeling, design and analysis of various PV systems
- To show that PV is an economically viable, environmentally sustainable alternative to the world's energy supplies
- To understand the power conditioning of PV and WEC system's power output

Course Outcome: After Completion of the course the student is able to

- Model, analyze and design various photovoltaic systems
- Know the feasibility of PV systems as an alternative to the fossil fuels
- Design efficient stand alone and grid connected PV and WEC power systems

UNIT - I

Introduction To Photovoltaic (PV) Systems: Historical development of PV systems- Overview of PV usage in the world Photovoltaic effect-conversion of solar energy into electrical energy.

Solar Cells And Arrays: Behavior of solar cells-basic structure and characteristics:
types - equivalent circuit-modeling of solar cells including the effects of temperature, irradiation and series/shunt resistances on the open-circuit voltage and short-circuit current-Solar cell arrays- PV modules-PV generators- shadow effects and bypass diodes- hot spot problem in a PV module and safe operating area- Terrestrial PV module modeling- Interfacing PV modules with different loads.

UNIT - II

Energy Storage Alternatives for PV Systems: Methods of Energy storage –Pumped Energy Storage – Compressed Energy Storage – Storage batteries- lead-acid- nickel cadmium-nickel-metal-hydride and lithium type batteries. Small storage systems employing ultra capacitors- properties- modeling of batteries.

UNIT - III

Inverters for PV Systems: Inverter-Basic operation – different control topologies for standalone and grid connected operation-Analysis of inverter at fundamental frequency and at switching frequency- Feasible operating region of inverter at different power factor values for grid connected systems and stand-alone PV systems. Consumer applications-residential systems-PV water pumping-PV powered lighting-rural electrification.

UNIT - IV

Power Conditioning of PV Systems: Power conditioning and maximum power point tracking (MPPT) -Maximum power point tracking (MPPT) algorithms-Grid-connected PV systems-Active power filtering with real power injection- complete stand-alone and grid-connected PV systems.

UNIT - V

Wind Energy Conversion (WEC): Basic Principle of wind energy conversion - nature of wind - wind survey in India -Power in the wind - components of wind energy - conversion system –Basic Principle and Performance of induction generators for WECS - classification of WECS. Stand alone and Grid connected WECS.

TEXT BOOKS:

1. Goetzberger, Hoffmann V. U., “Photovoltaic Solar Energy Generation”, Springer-Verlag, Berlin, 2005.
2. Rai, G.D., “Non-conventional Energy Sources”, Khanna Publishers Limited, New Delhi, 2002.
3. Patel M. R., “Wind and Solar Power Systems Design, Analysis, and Operation”, CRC Press, New York, 2nd Edition, 2005.

REFERENCES:

1. Komp R.J., “Practical Photovoltaics: Electricity from solar cells”, Aatec Publications, Michigan, 3rd Edition, 2001.
2. Castaner L., Silvestre S., “Modeling Photovoltaic Systems Using PSpice”, John Wiley & Sons, England, 2002.
3. Jenny Nelson, “The physics of solar cells”, Imperial College Press, London, 2004.
4. Komp R.J., “Practical Photovoltaics: Electricity from solar cells”, Aatec Publications,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

EHV AC TRANSMISSION
(Professional Elective - I)

Prerequisite: Power Systems -II
Course objectives:

- To identify the different aspects of Extra High Voltage A.C and D.C Transmission design and Analysis
- To understand the importance of modern developments of E.H.V and U.H.V transmission systems.
- To demonstrate EHV ac transmission system components, protection and insulation level for over voltages.

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

- List the necessity of EHV AC transmission, choice of voltage for transmission, line losses and power handling capability.
- Estimate the Statistical procedures for line designs, scientific and engineering principles in power systems.
- Construct commercial transmission system.

UNIT- I:
E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters-Bundle conductor systems-Inductance and Capacitance of E.H.V. 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 – un energized 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 E.H.V. 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. 3rd Edition.

2. K. R. Padiyar, "HVDC Power Transmission Systems" New Age International (p) Ltd. 2nd revised Edition, 2012.

REFERENCES:

1. S. Rao "EHVAC and HVDC Transmission Engg. Practice" Khanna publishers.
2. Arrillaga. J"High Voltage Direct Current Transmission" 2nd Edition (London) peter Peregrines, IEE, 1998.
3. Padiyar. K.R, "FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007.
4. Hingorani H G and Gyugyi. L "Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

HIGH VOLTAGE ENGINEERING
(Professional Elective - I)

Prerequisite: Power Systems and Electrical & Electronics Instrumentation
Course Objectives:

- To distinguish the Gaseous, liquid and solid dielectric behavior under High Voltage.
- To understand the generation methods of High A.C, DC & Impulse Voltages required for various application.
- To apply the measuring techniques of High A.C., D.C & Impulse voltages and currents.
- To identify the testing techniques for High Voltage Equipment.

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

- Know conduction and breakdown will occur in gases, liquids and solids dielectrics, and different applications of the insulating materials in electrical power apparatus.
- Explain the insulation testing of various components in power systems for different types of voltages, namely power frequency A.C, high frequency, switching or lightning impulses, for which generation of high voltages in laboratories is essential
- Interpret the necessity to measure the voltages and currents accurately, ensuring perfect safety to the personnel and equipment.
- Detect the necessary condition for all the electrical equipment which are capable of withstanding the over voltages which met in service like natural causes lightning or system originated ones switching or power frequency transient voltages.

UNIT- I:
Introduction To High Volatge Engineering: Electric Field Stresses, Gas / Vacuum as Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings.

UNIT- II:
Break Down In Dielectric Materials: Gases as insulating media, collision process, Ionization process, Townsend's criteria of breakdown in gases, Paschen's law. Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids. Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice.

UNIT-III:
Generation & Measurement of High Voltages & Currents : Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators. Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements.

UNIT-IV:
Over Voltages & Insulation Co-Ordination: Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

UNIT- V:

Testing of Materials & Electrical Apparatus: Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements. Testing of Insulators and bushings, Testing of Isolators and circuit breakers, testing of cables, Testing of Transformers, Testing of Surge Arresters, and Radio Interference measurements.

TEXT BOOKS:

1. High Voltage Engineering by M.S. Naidu and V. Kamaraju – TMH Publications, 3rd Edition
2. High Voltage Engineering: Fundamentals by E. Kuffel, W.S. Zaengl, J.Kuffel by Elsevier, 2nd Edition.

REFERENCES:

1. High Voltage Engineering by C.L. Wadhwa, New Age Internationals (P) Limited, 1997.
2. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.
3. High Voltage Engineering, Theory and Practice by Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, Roshdy Radwan , Marcel Dekker

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

ADVANCED DIGITAL SIGNAL PROCESSING
(Professional Elective - I)

Prerequisite: Digital Signal Processing
Course Learning Objectives

- To Comprehend characteristics of discrete time signals and systems
- To analyze and process signals using various transform techniques
- To identify various factors involved in design of digital filters
- To illustrate the effects of finite word length implementation**.**

Course Outcomes

- Analyze and process signals in the discrete domain
- Design filters to suit specific requirements for specific applications
- Perform statistical analysis and inferences on various types of signals
- Design multi rate signal processing of signals through systems.
- Analyze binary fixed point and floating-point representation of numbers and arithmetic operations

UNIT–I:
Digital Filter Structures: Block diagram representation – Equivalent Structures – FIR and IIR digital filter Structures AII pass Filters-tunable IIR Digital Sine-cosine generator- Computational complexity of digital filter structures.

UNIT–II:
Digital Filter Design: Preliminary considerations- Bilinear transformation method of IIR filter design – design of Low pass high-pass – Band-pass, and Band stop- IIR digital filters – Spectral transformations of IIR filters – FIR filter design –based on Windowed Fourier series – design of FIR digital filters with least – mean square-error – constrained Least –square design of FIR digital filters.

UNIT-III:
DSP Algorithm Implémentation : Computation of the discrete Fourier transform- Number representation – Arithmetic operations – handling of overflow – Tunable digital filters – function approximation.

UNIT-IV:
Analysis Of Finite Word Length Effects: The Quantization process and errors-Quantization of fixed –point and floating –point Numbers – Analysis of coefficient Quantization effects – Analysis of Arithmetic Round-off errors- Dynamic range scaling – signal –to- noise in Low –order IIR filters- Low –Sensitivity Digital filter – Reduction of Product round-off errors feedback – Limit cycles in IIR digital filter – Round – off errors in FFT Algorithms.

UNIT-V:
Power Spectrum Estimation: Estimation of spectra from Finite Duration Observations signals- Non-parametric methods for power spectrum Estimation- parametric method for power spectrum Estimation- Estimation of spectral form-Finite duration observation of signals- Non-parametric methods for power spectrum estimation – Walsh methods – Blackman and torchy method.

TEXT BOOKS:

1. Digital Signal Processing principles –algorithms and Applications- john G. Proakis –PHI – 3rd edition 2002.
2. Digital Time Signal Processing: Alan V. Oppenheim, Ronald W ,Shafer – PHI 1996 1st Edition reprint
3. Advanced Digital Signal Processing – Theory and Applications – Glenn Zelniker, Fred J. Taylor.

REFERENCE BOOKS

1. Digital Signal Processing – S Salivahanan. A Vallavaraj C. Gnanapriya –TMH – 2nd reprint 2001.
2. Digital Signal Processing – Sanjit K. Mitra – TMH second edition.
3. Theory and Applications of Digital Signal Processing – Lourens R Rebinarand Bernold.
4. Digital Filter Analysis and Design Auntoniam – TMH
5. Digital Signal Processing – J.S. Chitode – First Edition, 2008, Technical Publications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

POWER QUALITY
(Professional Elective - II)

Prerequisite: Power Systems and Power Electronics
Course Objectives

- To know different terms of power quality.
- To Illustrate of voltage power quality issue - short and long interruption
- To construct study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- To know the behavior of power electronics loads; induction motors, synchronous motor etc by the power quality issues
- To prepare mitigation of power quality issues by the VSI converters.

Course Outcomes: Upon the completion of the subject, 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 concept of improving the power quality to sensitive load by 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:
1 & 3-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.

TEXTBOOKS:

1. Math H J Bollen “Understanding Power Quality Problems”, IEEE Press.
2. R.C. Dugan, M.F. Mc Granaghan 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 – I SEM. (PEES)

MICROCONTROLLERS AND APPLICATIONS
(Professional Elective - II)

Prerequisite: Microprocessors and Interfacing Devices
Course Objectives:

- To relate the basic architecture and addressing modes of a microcontroller.
- To summarize the principles of top down design to microcontroller software development
- To demonstrate assembly language programs for the advanced Microcontroller , assembly language code for high-level language structures such as IF-THEN-ELSE and DO-WHILE
- To analyze a typical I/O interface and to discuss timing issues
- To identify different types of memory used in microcontroller systems

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

- Distinguish Types of computers & microcontrollers,
- Generalize 8-Bit, 16- Bit & 32 Bit advanced Microcontrollers.
- Construct Real time Applications of Microcontrollers.
- Demonstrate RTOS for Microcontrollers.
- Translate Hardware applications using Microcontrollers.

UNIT-I:
Overview of Architecture & Microcontroller Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – 8051 microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication - Interrupts.

UNIT-II:
8051- Microcontrollers Instruction Set : Basic assembly language programming – Data transfer instructions – Data and Bit-manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt control flow.

UNIT-III:
Real Time Control: Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051.
Timers: Programmable Timers in the MCU's – Free running counter and real time control – Interrupt interval and density constraints.
UNIT-IV:
Systems Design: Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to High Power Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments – Robotics and Embedded control – Digital Signal Processing and digital filters.

UNIT-V:

Real Time Operating System for Microcontrollers: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers.

16-Bit Microcontrollers: Hardware – Memory map in Intel 80196 family MCU system – IO ports – Programmable Timers and High-speed outputs and input captures – Interrupts – instructions. ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

TEXT BOOKS:

1. Raj Kamal," Microcontrollers Architecture, Programming, Interfacing and System Design"– Pearson Education, 2005.
2. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems" – PHI, 2000.

REFERENCES:

1. A.V. Deshmuk, "Microcontrollers (Theory & Applications)" – WTMH, 2005.
2. John B. Peatman, "Design with PIC Microcontrollers" – Pearson Education, 2005.
3. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
4. The 8051 Microcontroller, Ayala, Cengage Learning.
5. Microprocessors and Microcontrollers, Architecture, Programming and System Design, Krishna Kant, PHI Learning PVT. Ltd.
6. Microprocessors, Nilesh B. Bahadure, PHI Learning PVT. Ltd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

DISTRIBUTION AUTOMATION
(Professional Elective - II)

Prerequisite: Electrical Distribution Systems
Course objectives:

- To list the distribution systems for load modeling
- To understand the design & working of substations.
- To compute system protection
- To give a comprehensive idea on communication systems.

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

- Find the transfer of electrical data in distribution system through Digital Communication.
- Predict load forecasting and reliability in economic point of view
- Apply Distribution Automation objectives and SCADA
- To have a knowledge on management of different electrical parameters.

Unit-I:
Distribution Automation and The Utility System: Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software.

Unit-II:
Distribution Automation Functions: DA capabilities, Automation system computer facilities, management processes, Information management, system reliability management, system efficiency management, voltage management, Load management.

Unit-III:
Communication Systems for DA: DA communication requirements, Communication reliability, Cost effectiveness, Data rate Requirements, Two way capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow
Communication systems used in DA : Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio, Microwave satellite. Fiber optics, Hybrid Communication systems, Communication systems used in field tests.

Unit-IV:
Technical Benefits: DA benefit categories, Capital deferred savings, Operation and Maintenance savings, Interruption related savings, Customer related savings, Operational savings, improved operation, Function benefits, Potential benefits for functions, and function shared benefits, Guidelines for formulation of estimating equations Parameters required, economic impact areas, Resources for determining benefits impact on distribution system, integration of benefits into economic evaluation.

Unit-V:
Economic Evaluation Methods: Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop Alternatives, Calculate operating and maintenance costs, Evaluate alternatives. Economic comparison of alternate plans, Classification of expenses and capital expenditures, Comparison of revenue requirements of alternative plans, Book Life and

Continuing plant analysis, Year by year revenue requirement analysis, short term analysis, end of study adjustment, Break even analysis, Sensitivity analysis computational aids.

TEXT BOOKS:

1. Control and Automation of Electrical Distribution Systems, James. Northcote – Green Robert Wilson, CRC Press.
2. Electric Power Distribution Automation, Dr. M. K. Khedkar, Dr. G.M.Dhole, University Science press.
3. Power Distribution Automation, Biswarup Das-IET Power and Energy Series 75.

REFERENCES:

1. IEEE Tutorial Course "Distribution Automation"
2. IEEE Working Group on "Distribution Automation"

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PEES)

POWER & ENERGY SYSTEMS LAB – I

Prerequisites: Power System Analysis, Power System Reliability, Voltage Stability

Course Objectives:

- Develop Programs for Power System Analysis.
- Design models for Power Systems and Power Electronics.
- Develop Programs of Power System Reliability and Power Electronics.

Course outcomes: Upon the completion of the lab, the student will be able to Understand / Simulate / Analyze

- Power System Analysis using Software.
- Models of Power Systems and Power Electronics.
- Programs of Power System Reliability and Power Electronics.

List of Experiments

1. Develop Program for Y_{BUS} formation.
2. Develop Program for G-S Load Flow Analysis.
3. Develop Program for N-R Load Flow Analysis.
4. Develop Program for FDLF Load Flow Analysis.
5. Develop Program for Short Circuit Analysis.
6. Develop Program for Transient Stability Analysis for Single Machine connected to Infinite Bus by Point by Point Method.
7. Develop Program for Generation System Reliability Analysis.
8. Develop Program for Distribution System Reliability Analysis.
9. Develop Simulation of RLC Circuit
10. Develop Simulation of Single Phase Full Converter with RLE Load
11. Develop Program model for Closed Loop Speed Control of Separately Excited D.C Motor.
12. Develop Program model for Sinusoidal Pulse Width Modulation.

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

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

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. (PEES)

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. (PEES)

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. (PEES)

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. (PEES)

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. (PEES)

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. (PEES)

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. (PEES)

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. (PEES)

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. (PEES)

POWER AND ENERGY SYSTEMS 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