JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech ELECTRICAL POWER ENGINEERING
COURSE STRUCTURE AND SYLLABUS

I YEAR I SEMESTER

Code	Group	Subject	L	P	Credits
		Power System Dynamics	3	0	3
		HVDC Transmission	3	0	3
		Modern Control Theory	3	0	3
		Microprocessors & Microcontrollers	3	0	3
	Elective -1	High Voltage Engineering and Insulation Co-ordination Voltage Stability Operation Research	3	0	3
	Elective -2	Analysis of Power Electronic Converters Energy Conversion systems EHV AC Transmission	3	0	3
	Lab	Microprocessor & Micro Controller Lab	0	3	2
		Seminar	-	-	2
		Total Credits (6 Theory + 1 Lab.)			22

I - Semester

POWER SYSTEM DYNAMICS

Unit 1
Basic concepts: Power system stability states of operation and system security system dynamics problems system model analysis of steady State stability and transient stability, simplified representation of Excitation control.

Unit 2
Modeling of synchronous machine: synchronous machine park's Transformation Transformation of flux linkages, Transformation of stator voltage equations and rotor equations.

Unit 3
Analysis of steady state performance, per unit quantities - Equivalent circuits of synchronous machine - determination of parameters of equivalent circuits.

Unit 4
Excitation system: Excitation system modeling, excitation systems block Diagram system representation by state equations.

Unit 5
Dynamics of a synchronous generator connected to infinite bus: system model Synchronous machine model, stator equations rotor equations, Synchronous machine model with field circuit and with field circuit and one equivalent damper winding on q axis (model 1.1), calculation of Initial conditions.

Unit 6
Analysis of single machine system: small signal analysis with block diagram Representation characteristic equation and application of routh hurwitz criterion

Unit 7
Synchronizing and damping torque analysis, small signal model State equations.

Unit 8
Application of power system stabilizers: basic concepts in applying PSS, Control signals, structure and tuning of PSS, washout circuit, dynamic compensator analysis of single machine infinite bus system with and without PSS.

Text book
1. Power system dynamics K.R. PADIYAR, B.S. Publications Hyderabad

Reference
1. Power system control and stability P.M. Anderson and A.A. Fouad John wiley sons

H V D C TRANSMISSION

Unit 1

Comparison of DC transmission and AC Transmission. Application of DC transmission, Description of DC transmission systems, planning for HVDC transmission, Modern trends in DC transmission.

Unit 2

Static Power Conversion _Basic conversion principle, pulse number, analysis of GRAETZ circuit with and without overlap, equivalent circuit, inverter equations, Power Factor and reactive power, 12 pulse converter unit.

Unit 3

Basic philosophy, constant current Vs constant voltage, desired features of control, actual control characteristics, individual characteristics of rectifier and inverter, combined characteristics of rectifier and inverter, constant-minimum-ignition-angle control, constant current control, constant-extinction-angle control, individual phase-control, equidistant firing control, voltage dependent current order limit (VDCOL), basic philosophy of system control, direction of DC power flow, reversal of power flow, starting and stopping of DC link.

Unit 4

DC system model for load flow studies. Load flow study of Ac Dc system sequential method, simultaneous method.

Unit 5

Reactive power requirements in steady state, conventional control strategies, alternate control strategies equipment for reactive power.

Unit 6

short circuit ratio, Effective short circuit ratio, dynamic over voltages, DC power modulation, commutation failure, disturbances on AC side, disturbances on DC side.

Unit 7

Characteristic harmonics, derivation of relevant equations for 12 pulse converter.
Unit

Unit 8

AC filters, single tuned, doubled tuned
filters. Brief introduction to DC circuit breakers, multi terminal DC transmission.

REFERENCE BOOKS:

1. "Direct current transmission" by E.W. Kimbark. Wiley Interscience 1971.
2. "HVDC Transmission " by K.R. Padiyar.
3. "High voltage Direct current transmission" by J. Arrillaga IEE control engineering series 2000.

MODERN CONTROL THEORY

UNIT –I MATHEMATICAL PRELIMINARIES

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigenvalues, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Nonuniqueness 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 it's properties.

UNIT-III CONTROLLABILITY AND OBSERVABILITY

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- IV NON LINEAR SYSTEMS -I

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

UNIT-V NON LINEAR SYSTEMS -II

Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

UNIT-VI 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.

UNIT- VII STATE FEEDBACK CONTROLLERS AND OBSERVERS

State feedback controller design through Pole Assignment – State observers: Full order and Reduced order

UNIT – VIII

Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functionals, variation of functionals – 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

1. Modern Control Engineering by Ogata.K – Prentice Hall - 1997

REFERENCES:

1. Optimal control by Kircks

MICROPROCESSORS & MICROCONTROLLERS

Unit 1: 8086/8088 processors : Introduction to 8086 Microprocessors, ,Architecture, Addressing modes, Instruction set, Register Organization, Assembler directives.

Unit 2: Hard ware description: Pindiagram signal description min & max modes, bus timing, ready & wait states, 8086 based micro computing system.

Unit 3: Special features & Related Programming : Stack structure of 8086, Memory segmentation, Interrupts, ISR, NMI, MI and interrupt Programming, Macros.

Unit 4: Advanced Microprocessors: Intel 80386 programming model ,memory paging, Introduction to 80486, Introduction to Pentium Microprocessors and special Pentium pro features.

Unit 5 :-Basic peripherals & Their Interfacing:-Memory Interfacing (DRAM) PPI-Modes of operation of 8255 ,Interfacing to ADC & DAC.

Unit 6:- Special Purpose of Programmable Peripheral Devices and Their interfacing :-Programmable interval timer , 8253 , PIC 8259A,display controller Programmable communication Interface 8251,USART and Exercises.

Unit 7 :-Microcontrollers : Introduction to Intel 8 bit &16 bit Microcontrollers, 8051-Architecture, Memory organization, Addressing Modes and exercises

Unit 8:- Hardware description of 8051: Instruction formats ,Instruction sets, interrupt Structure & interrupt priorities, Port structures &Operation linear counter Functions ,different Modes of Operation and Programming examples.

TEXT BOOKS :-

1."The Intel Microprocessors" Architecture Programming &Interfacing by Barry b Brey.

2.Advanceed Microprocessors by kenrith J Ayala , Thomson publishers.

3.Microcontrollers by kentrith J ayala,Thomson publishers.

Reference Books:-

1. Microprocessors & Interfacing Programming & Hard ware by DOUGLAS V.Hall
2. Microprocessors & Microcontrollers by Prof. C.R.Sarma

HIGH VOLTAGE ENGINEERING & INSULATION CO-ORDINATION

(Elective - I)

Unit 1: Conduction and Breakdown in Gases:

Ionization process, Twonsend's current growth equation, current growth in the secondary processes, Twonsend's criterion for breakdown, streamer theory of breakdown in gases, Paschen law, breakdown in non uniform fields and corona discharge.

Unit 2: Conduction, Breakdown in liquids and solids:

Pure liquids and commercial liquids, conduction and breakdown in pure liquids, breakdown in solids dielectrics, Intrinsic breakdown, Electromechanical breakdown and thermal breakdown.

Unit 3: Generation of High Voltage and Currents:

Generation of high D.C. generation of high alternating voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators

Unit 4: Measurement of high voltage and currents:

Measurement of high d.c.voltages, Measurement of high a.c. and impulse voltages,
Measurement of high d.c., a.c. and impulse currents. Cathode Ray Oscilloscope for impulse voltage and current measurements.

Unit 5: Testing of Materials and Apparatus

Measurement of D.C. resistivity, measurement of dielectric constant and loss factor, partial discharge measurements, testing of insulators, bushing, circuits breakers, transformers and surge divertors.

Unit 6: Over Voltage Phenomenon Insulation Coordination:

Causes of over voltage, lighting phenomenon, switching over voltages and power frequency over voltages in power systems,

Unit 7: Insulation Coordination:

Principle of insulation coordination on high voltage and extra high voltage power systems.

Unit 8: Gas insulated substations:

Advantages of Gas Insulated Substations, Comparison of Gas Insulated substations and Air Insulated Substations, Design and Layout of Gas Insulated Substations, Description of Various components in GIS.

TEXT BOOKS:

1. High Voltage Engineering by M.S.Naidu and V.Kamaraju – TMH.
2. High Voltage Engineering fundamentals by Kuffel and Zungel, Elsavier Publications
3. Switchgear By BHEL, TMH

REFERENCES:

1. Fundamentals of Gaseous Ionization and plasma Electronics by Essam Nasser – Wiley - Inter Science.
2. High Voltage Technology by ALSTOM
3. Gaseous Dielectrics by Arora, TMH

VOLTAGE STABILITY

(Elective - I)

Unit – 1: 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 – 2: 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 – 3: Analysis of Voltage Stability

Analysis of voltage stability on SMLB system: Analytical treatment and analysis.

Unit – 4: Voltage Stability Indices

Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stability margin.

Unit – 5: Power System Loads

Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heat pumps, electronic power supplies, OH lines and cables.

Unit – 6: Reactive Power Compensation

Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous condensers, SVC s; OLTC s; Booster Transformers.

Unit – 7: Voltage Stability Margin

Stabilty Margin: Compensated and un-comensated systems.

Unit – 8: 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.

Reference:

"Power System Voltage Stability"- C.W.TAYLOR, Mc Graw Hill, 1994.

OPERATIONS RESEARCH

(Elective - I)

Unit 1:

Linear Programming Problem: Formulation – Graphical method - Simplex method – Artificial variable techniques – Big-M tune –phase methods

Unit 2:

Duality theorem – Dual simplex method – Sensitivity analysis - effect of changes in cost coefficients, Constraint constants, Addition/Deletion of variables & constraints

Unit 3:

Transportation problem – formulation – Initial basic feasible solution methods – Northwest, Least cost & Vogels methods, MODI optimization - Unbalanced & degeneracy treatment

Unit 4:

Assignment problem – Formulation – Hungarian method – Variants of assignment problems, Sequencing problems – Flow shop sequencing – n jobs×2 machines sequencing - n jobs×3 machines sequencing – Job-shop sequencing – 2 jobs×m machines sequencing – Graphical methods

Unit 5:

Game Theory - Introduction - Terminology – Saddle point games - with out Saddle point games - 2×2 games, analytical method - 2×n and m×2 games – graphical method – dominance principle

Unit 6:

Dynamic programming – Bellman's principle of optimality – short route – capital investment – inventory allocation

Unit 7:

Non linear optimization – Single variable optimization problem – Unimodal function - Elimination methods – Fibinocci & Golden reaction methods - Interpolation methods - Quadratic & cubic interpotation method.

Multi variable optimization problem – Direct research methods – Univariant method – Pattern search methods – Powell's , Hook-Jeaves & Rosen-brock's search method.

Unit 8:

Geometric programming – Polynomial – Arithmetic – Seametric inequality – Unconstrained G.P – Constraint G.P with ≤ type constraint.

Simulation: Definition – Types- steps- Simulation of simple electrical systems – Advantages and Disadvantages

TEXT BOOKS:

1. Optimization theory & Applications – S.S.Rao, New Age Internationals
2. Operations Research - S.D.Sharma, Galgotia publishers
3. Operations Research – Kausur & Kumar, Spinger Publishers

REFERENCES:

1. Optimization techniques: Theory & Practice – M.C.Joshi & K.M. More Ugalya, Narosa Publications
2. Optimization : Theory & Practice – Beweridze, Mc Graw Hill
3. Simulation Modelling & Analysis – Law & Kelton –TMH
4. Optimization Concepts and Applications in Engineering- A.D. Belegundu , J.R. Chandrupata, Pearson Education, Asia

ANALYSIS OF POWER ELECTRONIC CONVERTERS
(Elective II)

Unit I Single Phase AC Voltage Controllers.

Single phase AC voltage controllers with Resistive, Resistive-inductive and Resistive-inductive-induced e.m.f. loads – ac voltage controllers with PWM Control – Effects of source and load inductances - Synchronous tap changers- Applications - numerical problems.

Unit II Three Phase AC Voltage Controllers.

Three phase AC voltage controllers – Analysis of controllers with star and delta Connected Resistive, Resistive-inductive loads – Effects of source and load Inductances – applications – numerical problems.

Unit III Cycloconverters.

Single phase to single phase cycloconverters – analysis of midpoint and bridge Configurations – Three phase to three phase cycloconverters – analysis of Midpoint and bridge configurations – Limitations – Advantages – Applications - numerical problems.

Unit IV Single Phase Converters.

Single phase converters – Half controlled and Fully controlled converters – Evaluation of input power factor and harmonic factor – continuous and Discontinuous load current – single phase dual converters – power factor Improvements – Extinction angle control – symmetrical angle control – PWM – single phase sinusoidal PWM – single phase series converters – Applications - Numerical problems.

Unit V Three Phase Converters.

Three phase converters – Half controlled and fully controlled converters – Evaluation of input power factor and harmonic factor – continuous and Discontinuous load current – three phase dual converters – power factor Improvements – three phase PWM - twelve pulse converters – applications – Numerical problems.

Unit VI D.C. to D.C. Converters.

Analysis of step-down and step-up dc to dc converters with resistive and Resistive-inductive loads – Switched mode regulators – Analysis of Buck Regulators - Boost regulators – buck and boost regulators – Cuk regulators – Condition for continuous inductor current and capacitor voltage – comparison Of regulators –Multiouput boost converters – advantages – applications – Numerical problems.

Unit VII Pulse Width Modulated Inverters(single phase).

Principle of operation – performance parameters – single phase bridge inverter - evaluation of output voltage and current with resistive, inductive and Capacitive loads – Voltage control of single phase inverters – single PWM – Multiple PWM – sinusoidal PWM – modified PWM – phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – Advantage – application – numerical problems.

Unit VIIIPulse Width Modulated Inverters(three phase).

Three phase inverters – analysis of 180 degree condition for output voltage And current with resistive, inductive loads – analysis of 120 degree Conduction – voltage control of three phase inverters – sinusoidal PWM – Third Harmonic PWM – 60 degree PWM – space vector modulation – Comparison of PWM techniques – harmonic reductions – Current Source Inverter – variable d.c. link inverter – boost inverter – buck and boost inverter - inverter circuit design – advantages – applications – numerical problems.

Text books:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition – First Indian reprint 2004.

2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley & Sons – Second Edition.

ENERGY CONVERSION SYSTEMS

(Elective - II)

Unit 1:

Photo voltaic power generation ,spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for pv systems, applications of super conducting materials in electrical equipment systems.

Unit 2:

Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology.

Unit 3:

Wind Energy conversion: Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

Unit 4:

Tides and tidal power stations, modes of operation , tidal project examples, turbines and generators for tidal power generation. Wave energy conversion: properties of waves and power content, vertex motion of Waves, device applications. Types of ocean thermal energy conversion systems Application of OTEC systems examples,

Unit 5:

Miscellaneous energy conversion systems: coal gasification and liquefaction, biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, description of fuel cells

Unit 6:

Co-generation and energy storage, combined cycle co-generation, energy storage. Global energy position and environmental effects: energy units, global energy position..

Unit 7:

Types of fuel cells, H_2-O_2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power.

Unit 8:

Environmental effects of energy conversion systems, pollution from coal and preventive measures steam stations and pollution, pollution free energy systems.

TEXT BOOKS

1. "Energy conversion systems" by Rakosh das Begamudre, New age international publishers, New Delhi - 2000.
2. "Renewable Energy Resources" by John Twidell and Tony Weir, 2nd edition, Fspon & Co

EHV A.C. TRANSMISSION

(Elective - II)

Unit 1:

E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters

Unit 2:

Bundle conductor systems inductance and capacitance of E.H.V. lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

Unit 3:

Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect 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 4:

Electrostatic induction in unenergised lines – measurements of field and voltage gradients for three phase single and double circuit lines – unenegised lines.

Unit 5:

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 6:

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

Unit 7:

Measurements of audio noise radio interference due to Corona RF properties of radio noise – frequency spectrum of RI fields – Measurements of RI and RIV.

Unit 8:

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

Reference Books :

1. Extra High Voltage AC Transmission Engineering – Rokosh Das Begamudre, Wiley EASTERN LTD., NEW DELHI – 1987.
2. EHV Transmission line reference Books – Edison Electric Institution (GEC 1968).

MICROPROCESSORS AND MICROCONTROLLERS LAB

LIST OF EXPERIMENTS

IMicroprocessor 8086

1) Introduction to MASM / TASM
2) Arithmetic operations : Multi byte addition, subtraction, Multiplication and Division, Signed and Unsigned Arithmetic operation, ASCII – arithmetic.
3) Logic operations : Shift and rotate – converting packed BCD to unpacked BCD, BCD to ASCII conversion.
4) By using string operation and instruction prefix – Move block, reverse string, sorting, inserting, deleting, length of string, string comparison.
5) Modular programming – Procedure, near and far implementation, recursion.
1) DOS/BIOS programming – Reading key board (buffered with and without echo) – display characters, string.

II Interfacing to 8086

1) 8259 – interrupt controller
2) 8279 – keyboard / display
3) 8255 – PPI
4) 8251 – USART
5) Stepper Motor
6) Traffic light control
7) GPIB (IEEE 488) Interface
8) Numeric printer interface
9) RTC interface
10) A/D and D/A
1) DMA interface
2) FDC-EPROM Programmer Interface

IIIMicrocontroller 8051

1) Reading and writing on a parallel port
2) Timer in different modes
3) Serial communication implementation
4) Understanding three memory areas of 00-FF (Programs using above areas)
5) ing external interrupts
1) Programs using special instructions like SWAP, Bit/Byte, Set/ Reset etc.
2) Program based on sort, Page, absolute addressing.