JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH (POWER ELECTRONICS/
POWER AND INDUSTRIAL DRIVES/POWER ELECTRONICS AND ELECTRIC DRIVES)
COURSE STRUCTURE AND SYLLABUS

I Year – I Semester

Category	Course Title	Int. marks	Ext. marks	L	P	C
Core Course I	Machine Modeling and Analysis	25	75	4	--	4
Core Course II	Modern Control Theory	25	75	4	--	4
Core Course III	Power Electronic Devices and Circuits	25	75	4	--	4
Core Elective I	1. Special Machines 2. HVDC Transmission 3. Programmable Logic Controllers and their Applications	25	75	4	--	4
Core Elective II	1. Microcontrollers and Applications 2. Embedded Systems 3. Digital Control Systems	25	75	4	--	4
Open Elective I	1. Optimization Techniques 2. Digital control systems 3. Renewable energy systems 4. HVDC Transmission 5. Analysis of power converters 6. Embedded Systems	25	75	4	--	4
Laboratory I	Power Converters Simulation Lab	25	75	--	4	2
Seminar I	Seminar-I	50	--	--	4	2
	Total Credits			**24**	**8**	**28**

I Year – II Semester

Category	Course Title	Int. marks	Ext. marks	L	P	C
Core Course IV	Power Electronic Converters	25	75	4	--	4
Core Course V	Power Electronic Control of DC Drives	25	75	4	--	4
Core Course VI	Power Electronic Control of AC Drives	25	75	4	--	4
Core Elective III	1. Power Quality 2. Advanced Digital Signal Processing 3. Switched Mode Power Supplies (SMPS)	25	75	4	--	4
Core Elective IV	1. Flexible AC Transmission Systems 2. High-Frequency Magnetic Components 3. Dynamics of Electrical Machines	25	75	4	--	4
Open Elective II	1. Instrumentation & Control 2. Intelligent Control 3. Smart grid technologies 4. AI Techniques in Electrical Engineering 5. Reliability Engineering 6. Energy Auditing, Conservation & Management	25	75	4	--	4
Laboratory II	Power Converters and Drives Lab	25	75	--	4	2
Seminar II	Seminar-II	50	--	--	4	2
Total Credits				**24**	**8**	**28**

II Year - I Semester

Course Title	Int. marks	Ext. marks	L	P	C
Comprehensive Viva-Voce	--	100	--	--	4
Project work Review I	50	--	--	24	12
Total Credits			--	24	**16**

II Year - II Semester

Course Title	Int. marks	Ext. marks	L	P	C
Project work Review II	50	--	--	8	4
Project Evaluation (Viva-Voce)	--	150	--	16	12
Total Credits			**--**	**24**	**16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

MACHINE MODELLING AND ANALYSIS

Course Objectives:

- Identifying the methods and assumptions in modeling of machines.
- Recognize the different frames for modeling of AC machines.
- To write voltage and torque equations in state space form for different machines.

Learning Outcomes:

- Develop the mathematical models of various machines like machines like dc machine, induction motor and Synchronous machines using modeling equations.
- Models have to be used for analysis using simulation study.

UNIT-I:
Basic Two-pole DC machine - primitive 2-axis machine – Voltage and Current relationship – Torque equation.

UNIT-II:
Mathematical model of separately excited DC motor and DC Series motor in state variable form – Transfer function of the motor - Numerical problems.
Mathematical model of D.C. shunt motor D.C. Compound motor in state variable form – Transfer function of the motor - Numerical Problems

UNIT-III:
Liner transformation – Phase transformation (a, b, c to α, β, o) – Active transformation (α .β, o to d, q).
Circuit model of a 3 phase Induction motor – Linear transformation - Phase Transformation – Transformation to a Reference frame – Two axis models for induction motor.
dq model based DOL starting of Induction Motors

UNIT-IV:
Voltage and current Equations in stator reference frame – equation in Rotor reference frame – equations in a synchronously rotating frame – Torque equation - Equations I state – space form.

UNIT-V:
Circuits model of a 3ph Synchronous motor – Two axis representation of Syn. Motor.
Voltage and current Equations in state – space variable form – Torque equation.
dq model based short circuit fault analysis- emphasis on voltage, frequency and recovery time.

TEXT BOOKS:

1. Generalized Machine theory - P.S. Bimbhra, Khanna Publishers
2. Analysis of electric machinery and Drives systems - Paul C. Krause, Oleg wasynezuk, Scott D. Sudhoff.
3. Thyristor control of Electric Drives - Vedam Subranmanyam, Add Publisher.
4. Power System Stability and Control – Prabha Kundur, EPRI.

REFERECES:

1. Performance optimization of induction motors during Voltage-controlled soft starting, Article In IEEE Transactions On Energy Conversion, July 2004.
2. A Novel Method for Starting of Induction Motor with Improved Transient Torque Pulsations, Nithin K.S, Dr. Bos Mathew Jos, Muhammed Rafeek, Dr. Babu Paul. International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 8, February 2013.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

MODERN CONTROL THEORY

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

REFERENCES:
Optimal control by Kircks

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PE/PEED/PID)

POWER ELECTRONIC DEVICES AND CIRCUITS

Course Objectives

- To understand the characteristics and principle of operation of modern power semi conductor devices.
- To comprehend the c o n c e p t s o f different power converters and their applications
- Students will be able to analyze and design switched mode regulator for various industrial applications.

Learning Outcomes

- Students will be able to choose appropriate device for a particular converter topology.
- Students will be able to use power electronic simulation packages for analyzing and designing power converters

UNIT-I:

Modern Power Semiconductor Devices: Modern power semiconductor devices – MOS turn Off Thyristor (MTO) – Emitter Turn off Thyristor (ETO) – Intergrated Gate-Commutated thyristor (IGCTs) – MOS-controlled thyristors (MCTs) – Insulated Gate Bipolar Transistor (IGBT) – MOSFET – comparison of their features.

UNIT-II:

Driver Circuits, Snubber Circuits and Heat Sinks: Introduction, MOSFET and IGBT Drive Circuits, Bipolar Transistor Drive Circuits, Thyristor Drive Circuits, Transistor Snubber Circuits, Energy Recovery Snubber Circuits, Thyristor Snubber Circuits, Heat Sinks and Thermal Management

UNIT-III:

AC Voltage Controllers & Cyclo-Converters: Single phase AC voltage controllers: with Resistive, Resistive –inductive and Resistive –inductive-induced EMF loads – AC voltage controllers with PWM Control – Effects of source and load inductances – Synchronous tap changers – Applications.

Single phase and Three phase cyclo-converters – analysis of midpoint and bridge Configurations – Limitations – Advantages – Applications.

UNIT-IV:

Single-Phase and Three-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.

Three-Phase Converters: Half controlled and fully controlled converters – Evaluation of input power factor and harmonic factor – continuous load current – three phase dual converters – three-phase PWM – Twelve phase converters – Applications.

UNIT-V:

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 – Multi-output boost converters – Advantages - Applications.

TEXT BOOKS:

1. Power Electronics – Mohammed H. Rashid – Pearson Education Third Edition – First Indian reprint 2004.
2. Power Electronics – Daniel W. Hart, McGraw Hill Publications.
3. Power Electronics Devices, Circuits and Industrial applications, V. R. Moorthi, Oxford University Press.

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

REFERENCE BOOKS:

1. Power Electronics, Dr. P. S. Bimbhra, Khanna Pubishers.
2. Elements of Power Electronics, Philip T. Krein, Oxford University Press.
3. Power Electronics, M. S. Jamil Asghar, PHI Private Limited.
4. Principles of Power Electronics, John G. Kassakian, Martin F. Schlect, Geroge C. Verghese, Pearson Education.
5. Fundamentals of Power Electronics, Robert W. Erickson, Dragan and Maksimobic, Springer.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

SPECIAL MACHINES
(Elective–I)

Course Objectives: The course will enable the students to:
(i) Learn the constructional features, principle of operation, methods of control and applications of stepper motors.
(ii) Understand the constructional features, principle of operation, methods of control and applications of Switched reluctance motors.
(iii) Have an insight into the constructional features, principle of operation, methods of control and applications of PMBLDC motors.
(iv) Have a clear picture of the types, the constructional features, principle of operation, methods of control and applications of PMSM.
(v) Gain knowledge in the types, the constructional features, principle of operation, methods of control and applications of SyRM.

Learning Outcomes: After completion of the course, the students are expected to
(i) Realize the need for stepper motors and the various applications in industries.
(ii) Get a clear picture of the operational characteristics and the applications of SRM.
(iii) Know the various types of PMBLDC motors, rotor position sensors , methods of control and their applications.
(iv) Get a clear idea of the features , control and the applications of PMSM.
(v) Get a clear picture of the operational characteristics and the applications of SyRM.

UNIT–I:
Stepper Motors: Introduction-synchronous inductor (or hybrid stepper motor), Hybrid stepping motor, construction, principles of operation, energization with two phase at a time- essential conditions for the satisfactory operation of a 2-phase hybrid step motor - very slow - speed synchronous motor for servo control-different configurations for switching the phase windings-control circuits for stepping motors-an open-loop controller for a 2-phase stepping motor.

UNIT-II:
Variable Reluctance Stepping Motors: Variable reluctance (VR) Stepping motors, single-stack VR step motors, Multiple stack VR motors-Open-loop control of 3-phase VR step motor-closed-Loop control of step motor, discriminator (or rotor position sensor) transilator, major loop-characteristics of step motor in open-loop drive – comparison between open-loop position control with step motor and a position control servo using a conventional (dc or ac) servo motor- Suitability and areas of application of stepping motors-5- phase hybrid stepping motor - single phase - stepping motor, the construction, operating principle torque developed in the motor.
Switched Reluctance Motor: Introduction – improvements in the design of conventional reluctance motors- Some distinctive differences between SR and conventional reluctance motors-principle of operation of SRM- Some design aspects of stator and rotor pole arcs, design of stator and rotor and pole arcs in SR motor-determination of L(θ)-θ profile - power converter for SR motor-A numerical example –Rotor sensing mechanism and logic control, drive and power circuits, position sensing of rotor with Hall problems-derivation of torque expression, general linear case.

UNIT–III:
Permanent Magnet Materials and PM DC Machines: Introduction, Hysteresis loops and recoil line-stator frames (pole and yoke - part) of conventional PM dc Motors, Equivalent circuit of PM Generator and Motor-Development of Electronically commutated dc motor from conventional dc motor.
Brushless DC Motor: Types of construction – principle of operation of BLDM- sensing and switching logic scheme, sensing logic controller, lockout pulses –drive and power circuits, Base drive circuits, power converter circuit-Theoretical analysis and performance prediction, modeling and magnet circuit d-q analysis of BLDM -transient analysis formulation in terms of flux linkages as state variables-Approximate solution for current and torque under steady state –Theory of BLDM as variable speed synchronous motor (assuming sinusoidal flux distribution)- Methods or reducing Torque Pulsations, 180 degrees pole arc and 120 degree current sheet.

UNIT-IV:

Linear Induction Motor: Development of a double sided LIM from rotary type IM- A schematic of LIM drive for electric traction development of one sided LIM with back iron-field analysis of a DSLIM fundamental assumptions.

UNIT-V:

Permanent Magnet Axial Flux (Pmaf) Machines: Construction, Armature windings – Toroidal Stator and Trapezoidal Stator Windings, Torque and EMF equations, Phasor diagram and output equation.

TEXT BOOKS:

1. Special electrical machines, K. Venkataratnam, - University press.
2. Special electrical machines, E. G. Janardanan, - PHI.
3. R. K. Rajput ,"Electrical machines"-5th edition.
4. V. V. Athani," Stepper motor : Fundamentals , Applications and Design"- New age International pub.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

HVDC TRANSMISSION
(Elective-I)

UNIT-I:
Introduction: General consideration, Power Handling Capabilities of HVDC Lines Basic Conversion principles, static converter configuration.

UNIT-II:
Static Power Converters: 3-pulse, 6-pulse, and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters. VSC based HVDC and Hybrid HVDC systems. Back to back thyristor converter system.

UNIT-III:
Control of HVDC Converters and Systems: Constant current, constant extinction angle and constant ignition angle control Individual phase control and equidistant firing angle control DC power flow control. Interaction between HV AC and DC systems – Voltage interaction Harmonic instability problems and DC power modulation.

UNIT-IV:
MTDC Systems & Over Voltages: Series parallel and series parallel systems their operation and control.Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

UNIT-V:
Converter Faults & Protection: Converter faults, over current protection – valve group, and DC line protection over voltage protection of converters, surge arresters.

REFERENCE BOOKS:

1. E.W. Kimbark: Direct current Transmission, Wiely Inter Science – New York.
2. J. Arillaga HVDC Transmission Peter Peregrinus ltd. London UK 1983
3. KR Padiyar : High Voltage Direct current Transmission Wiely Esatern Ltd New Delhi – 1992.
4. E. Uhlman : Power Transmission by Direct Current , Springer Verlag, Berlin Helberg. 1985.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS
(Elective–I)

Course Objectives:

- To understand the generic architecture and constituent components of a Programmable Logic Controller.
- To develop a software program using modern engineering tools and technique for PLC.
- To apply knowledge gained about PLCs to identify few real life industrial applications

Learning Outcomes: Students will be able to

- Develop and explain the working of PLC with the help of a block diagram.
- Execute, debug and test the programs developed for digital and analog operations.
- Reproduce block diagram representation on industrial applications using PLC.

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

REFERENCE BOOKS:

1. Programmable Logic Controllers – Principle and Applications by John W Webb and Ronald A Reiss Fifth edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR Hackworth and F.D Hackworth – Jr- Pearson, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PE/PEED/PID)

MICROCONTROLLERS AND APPLICATIONS
(Elective-II)

Course Objectives:

- The aim of this course is to introduce Microcontroller Intel 8051,Controller 68HCII, PIC Microcontrollers and their applications,
- To study the architecture of 8051, 68HCII, 16C74, their addressing modes and Instruction sets,
- To introduce the need and use of Interrupt structure, timers and to be acquainted with the applications.

Learning Outcomes: At the end of the course, the student is expected to possess knowledge and achieve skills on the following.

- A solid understanding of the fundamental hardware layout of a microprocessor and a microcontroller.
- Working knowledge in ports and interrupts.
- A comfort level in assembly language and C programming for 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.

REFERENCE BOOKS:

1. A.V. Deshmuk, “Microcontrollers (Theory & Applications)” – WTMH, 2005.
2. John B. Peatman, “Design with PIC Microcontrollers” – Pearson Education, 2005.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

EMBEDDED SYSTEMS
(Elective-II)

UNIT- I:
Overview of Embedded System: Embedded System, types of Embedded System, Requirements of Embedded System, and Issues in Embedded software development, Applications.

UNIT-II:
Processor & Memory Organization: Structural units in a processor, Processor selection, Memory devices, Memory selection, Memory Allocation & Map, Interfacing.

UNIT-III:
Devices, Device Drivers & Buses For Device Networks: I/O devices, Timer & Counter devices, Serial Communication, Communication between devices using different buses. Device drives, Parallel and serial port device drives in a system, Interrupt servicing mechanism, context and periods for context switching, Deadline and Interrupt Latency.

UNIT-IV:
Programming & Modeling Concepts : Program elements, Modeling Processes for Software Analysis, Programming Models, Modeling of Multiprocessor Systems, Software algorithm Concepts, design, implementation, testing, validating, debugging, Management and maintenance, Necessicity of RTOS.

UNIT-V:
Hardware and Software Co-Design: Embedded system design and co design issues in software development, design cycle in development phase for Embedded System, Use of ICE & Software tools for development of **ES, Issues in embedded system design.**

REFERENCE BOOKS:

1. Embedded Systems: Architecture, Programming and Design – Rajkamal, TMH 2003.
2. Programming for Embedded System: DreamTech Software Team-John Wiley -2002

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

DIGITAL CONTROL SYSTEMS
(Elective-II)

UNIT – I:
Introduction: Block Diagram of typical control system- advantages of sampling in control systems – examples of discrete data and digital systems – data conversion and quantization – sample and hold devices – D/A and A/D conversion – sampling theorem – reconstruction of sampled signals –ZOH.
Z-transform: Definition and evaluation of Z-transforms – mapping between s-plane and z-plane – inverse z-plane transform – theorems of the Z-transforms –limitations of z-transforms –pulse transfer function –pulse transfer function of ZOH –relation between G(s) and G(z) – signal flow graph method applied to digital systems.

UNIT- II:
State Space Analysis: State space modeling of digital systems with sample and hold – state transition equation of digital time in variant systems – solution of time in variant discrete state equations by the Z-Transformation – transfer function from the state model – Eigen values – Eigen vector and diagonalisation of the A-matrix – Jordan canonical form. Computation of state transition matrix-Transformation to phase to variable canonical form-The state diagram – decomposition of digital system – Response of sample data system between sampling instants using state approach.
Stability: Definition of stability – stability tests – The second method of Liapunov.

UNIT- III:
Time Domain Analysis : Comparison of time response of continuous data and digital control systems-correlation between time response and root locus j the s-plane and z-plane – effect of pole-zero configuration in the z-plane upon the maximum overshoot and peak time of transient response – Root loci for digital control systems – steady state error analysis of digital control systems – Nyquits plot – Bode plot-G.M and P.M.

UNIT- IV:
Design: The digital control design with digital controller with bilinear transformation – Digital PID controller-Design with deadbeat response-Pole placement through state feedback-Design of full order state observer-Discrete Euler Lagrance Equation – Discrete maximum principle.

UNIT-V:
Digital State Observer: Design of - Full order and reduced order observers. Design by max.principle: Discrete Euler language equation-discrete maximum principle.

TEXT BOOKS:
1. Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition.
2. Digital Control and State Variable Methods by M.Gopal, TMH.

REFERENCE BOOKS:
1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.
2. Digital Control Engineering, M.Gopal

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

OPTIMIZATION TECHNIQUES
(Open Elective - I)

Course Objectives:

- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
- To develop an interest in applying optimization techniques in problems of Engineering and Technology
- To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

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

- Know basic theoretical principles in optimization
- formulate optimization models and obtain solutions for optimization;
- apply methods of sensitivity analysis and analyze post processing of results

UNIT – I
Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.
Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.
Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II
Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

UNIT – III
Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.
Unconstrained Nonlinear Programming: One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method

U**NIT – IV**
Unconstrained Optimization Techniques: Univariate method, Powell's method and steepest descent method.
Constrained Nonlinear Programming: Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.

UNIT – V
Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

TEXT BOOKS:

1. "Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2. "Introductory Operations Research" by H.S. Kasene & K.D. Kumar, Springer(India), Pvt .LTd.

REFERENCES:

1 "Optimization Methods in Operations Research and systems Analysis" – by K.V. Mital and C. Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
2. Operations Research – by Dr. S.D.Sharma.
3. "Operations Research: An Introduction" by H.A. Taha, PHI Pvt. Ltd., 6th edition
4. Linear Programming by G. Hadley

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

DIGITAL CONTROL SYSTEMS
(Open Elective - I)

Course Objectives:
- To explain basic and digital control system for the real time analysis and design of control systems.
- To apply the knowledge state variable analysis in the design of discrete systems.
- To explain the concept of stability analysis and design of discrete time systems.

Course Outcomes: Upon the completion of this course, the student will be able to
- Apply the concepts of Digital control systems.
- Analyze and design of discrete systems in state variable analysis.
- To relate the concepts of stability analysis and design of discrete time systems.

UNIT – I:
Concept & Representation of Discrete time Systems: Block Diagram of typical control system- advantages of sampling in control systems – examples of discrete data and digital systems – data conversion and quantization – sample and hold devices – D/A and A/D conversion – sampling theorem – reconstruction of sampled signals.
Z-transform: Definition of Z-transforms – mapping between s-plane and z-plane – inverse z- transform – properties of z-transforms - ROC of z-transforms –pulse transfer function –relation between G(s) and G(z) – signal flow graph method applied to digital control systems.

UNIT- II:
State Space Analysis: State space modeling of discrete time systems – state transition equation of discrete time invariant systems – solution of time invariant discrete state equations: recursive method and the Z-Transformation method – conversion of pulse transfer function to the state model & vice-versa – Eigen values – Eigen vectors of discrete time system-matrix (A) – Realization of pulse transformation in state space form, discretization of continuous time systems, Computation of state transition matrix and its properties. Response of sample data system between sampling instants.

UNIT – III:
Controllability, Observability & Stability Tests: Concept of controllability, stabilizability, observability and reachability - Controllability and observability tests, Transformation of discrete time systems into controllable and observable forms.
Stability: Definition of stability – stability tests – The second method of Liapunov.

UNIT- IV:
Design of discrete time Controllers and observers: Design of discrete time controller with bilinear transformation – Realizatiion of digital PID controller-Design of deadbeat controller; Pole placement through state feedback.

UNIT-V:
State Observers: Design of - Full order and reduced order observers. Study of observer based control design

TEXT BOOKS:

1. K. Ogata , Discrete-Time Control systems, Pearson Education/PHI, 2nd Edition.
2. V. I. George, C. P. Kurian, Digital Control Systems, Cengage Learning.
3. M.Gopal, Digital Control Engineering, New Age Int. Pvt. Ltd., 2014

REFERENCES:

1. Kuo, Digital Control Systems, Oxford University Press, 2nd Edition, 2003.
2. M.Gopal , Digital Control and State Variable Methods, TMH.
3. M. Sami Fadali Antonio Visioli, Digital Control Engineering Analysis and Design, Academic Press

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PE/PEED/PID)

RENEWABLE ENERGY SYSTEMS
(Open Elective - I)

Course Objectives:

- To recognize the awareness of energy conservation in students
- To identify the use of renewable energy sources for electrical power generation
- To collect different energy storage methods
- To detect about environmental effects of energy conversion

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

- find different renewable energy sources to produce electrical power
- estimate the use of conventional energy sources to produce electrical energy
- role-play the fact that the conventional energy resources are depleted
- arrange Store energy and to avoid the environmental pollution

UNIT-I:

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-II:

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

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

UNIT-III:

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-IV:

Miscellaneous energy conversion systems: coal gasification and liquefaction, biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, description of fuel cells, Co-generation and energy storage, combined cycle co-generation, energy storage.

Global energy position and environmental effects: energy units, global energy position.

UNIT-V:

Types of fuel cells, H_2-O_2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power. 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, 2^{nd} Edition, Fspon & Co.

REFERENCES:

1. “Understanding Renewable Energy Systems” , by Volker Quaschning, 2005, UK.
2. “Renewable Energy Systems-Advanced Conversion, Technologies & Applications” by Faner Lin Luo Honer Ye, CRC press, Taylor & Francis group.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

HVDC TRANSMISSION
(Open Elective - I)

Prerequisite: Power Electronics and Power Systems
Course Objectives:

- To Comprehend the conversion principles of HVDC Transmission
- Analysis of 3, 6, 12 pulse converters, rectifier and inverter operations of HVDC converters
- To identify the different types of Harmonics and reduction by using Filters
- To comprehend interaction between HVAC and DC systems in various aspects
- To appreciate the reliable MTDC systems and protection of HVDC system

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

- To find the applications of HVDC transmission in the power system with the acquired knowledge.
- To analyze different converter topologies viz. 3, 6 and 12 Pulse converters and understand it's control aspects.
- To understand the filter configuration for Harmonics in HVDC systems.
- To appreciate the reliable Multi terminal HVDC system.
- To have knowledge on the Protection of HVDC systems against Transient over voltages and over currents.

UNIT-I:
Introduction: General consideration, Power Handling Capabilities of HVDC Lines Basic Conversion principles, static converter configuration.

UNIT-II:
Static Power Converters: 3-pulse, 6-pulse, and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

UNIT-III:
Control of HVDC Converters and Systems: Constant current, constant extinction angle and constant ignition angle control Individual phase control and equidistant firing angle control DC power flow control. Interaction between HV AC and DC systems – Voltage interaction Harmonic instability problems and DC power modulation.

UNIT-IV:
MTDC Systems & Over Voltages: Series parallel and series parallel systems their operation and control.
Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

UNIT-V:
Converter Faults & Protection: Converter faults, over current protection – valve group, and DC line protection over voltage protection of converters, surge arresters.

TEXT BOOKS:

1. E.W. Kimbark: Direct current Transmission, Wiely Inter Science – New York
2. KR Padiyar : High Voltage Direct current Transmission Wiely Esatern Ltd New Delhi – 1992.

REFERENCES:

1. J. Arillaga HVDC Transmission Peter Peregrinus ltd. London UK 1983
2. E. Uhlman : Power Transmission by Direct Current , Springer Verlag, Berlin Helberg. 1985.
3. S. Rao "EHVAC and HVDC Transmission Engg. Practice" Khanna publishers.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

ANALYSIS OF POWER ELECTRONIC CONVERTERS
(Open Elective - I)

Prerequisite: Power Electronics
Course Objectives:

- To comprehend the concepts of power converters and their applications.
- To describe the importance of AC voltage controllers and cyclo converters for various industrial applications
- To analyze and design switch mode power electronic converters for various applications including microprocessor power supplies, renewable energy systems, and motor drives.
- To analyze pulse width modulated inverters which are used in variable speed drives

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

- To understand of the basic principles of switch mode power conversion.
- To understand the operating principles and models of different types of power electronic converters including dc-dc converters, PWM rectifiers and inverters
- To choose appropriate power converter topologies and design the power stage and feedback controllers for various applications

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 PW 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.
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 III
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.
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 V
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.

Pulse 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 and Sons - Second Edition.

REFERENCES:

1. Power Electronics Daniel W. Hart
2. Fundamentals of Power Electronis, 2nd Edition. R.W. Erickson
3. The power electronics Hand Book Timothy, L. Skvarenina, Purdue University

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

EMBEDDED SYSTEMS
(Open Elective - I)

Prerequisite: Microprocessors and Interfacing Devices
Course Objectives:

- To emphasize the general embedded system concepts, design of embedded hardware and software development tools
- To explain the basics of real time operating and embedded systems
- To describe key issues such as CPU scheduling, memory management, task synchronization, and file system in the context of real-time embedded systems.

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

- To analyze and design embedded systems and real-time systems
- Define the unique design problems and challenges of real-time systems
- Identify the unique characteristics of real-time operating systems and evaluate the need for real-time operating system
- Explain the general structure of a real-time system and Understand and use RTOS to build an embedded real-time system
- Gain knowledge and skills necessary to design and develop embedded applications based on real-time operating systems.

UNIT- I:
Overview Of Embedded System: Embedded System, types of Embedded System, Requirements of Embedded System, and Issues in Embedded software development, Applications.

UNIT-II:
Processor & Memory Organization: Structural units in a processor, Processor selection, Memory devices, Memory selection, Memory Allocation & Map, Interfacing.

UNIT-III:
Devices, Device Drivers & Buses for Device Networks: I/O devices, Timer & Counter devices, Serial Communication, Communication between devices using different buses. Device drives, Parallel and serial port device drives in a system, Interrupt servicing mechanism, context and periods for context switching, Deadline and Interrupt Latency.

UNIT-IV:
Programming & Modeling Concepts : Program elements, Modeling Processes for Software Analysis, Programming Models, Modeling of Multiprocessor Systems, Software algorithm Concepts, design, implementation, testing, validating, debugging, Management and maintenance, Necessity of RTOS.

UNIT-V:
Hardware and Software Co-Design: Embedded system design and co-design issues in software development, design cycle in development phase for Embedded System, Use of ICE & Software tools for development of ES, Issues in embedded system design.

TEXTBOOKS:

1. Embedded systems: Architecture, programming and design by Rajkamal, TMH
2. Embedded system design by Arnold S Burger, CMP

REFERENCES:

1. An embedded software primer by David Simon, PEA
2. Embedded systems design:Real world design be Steve Heath; Butterworth Heinenann, Newton mass USA 2002
3. Data communication by Hayt.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PE/PEED/PID)

POWER CONVERTERS SIMULATION LAB

PART A:

1. Single phase full converter using RL and E loads.
2. Three phase full converter using RL and E loads.
3. Single phase AC Voltage controller using RL load.
4. Three-phase inverter with PWM controller.
5. DC-DC Converters.
6. Modeling of Separately Excited DC Motor.
7. Modeling of Three Phase Induction Motor.

PART B:

8. Write program and simulate dynamical system of following models:
   i. I/O Model
   ii. State variable model
   Also identify time domain specifications of each.
9. Obtain frequency response of a given system by using various methods:
   i. General method of finding the frequency domain specifications.
   ii. Polar plot
   iii. Bode plot
   iv. Also obtain the Gain margin and Phase margin.
10. Determine stability of a given dynamical system using following methods.
    i. Root locus
    ii. Bode plot
    iii. Nyquist plot
    iv. Liapunov stability criteria
11. Transform a given dynamical system from I/O model to state variable model and vice versa.
12. Design a compensator for a given systems for required specifications.
13. Design a PID controller based on Bode plot.
14. Develop a program to solve Swing Equation.

Notes: Use the suitable software for each simulation.
Any ten experiments, Six from PART A and Four from PART B, can be selected from the above list.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH (POWER ELECTRONICS/
POWER AND INDUSTRIAL DRIVES/POWER ELECTRONICS AND ELECTRIC DRIVES)
COURSE STRUCTURE AND SYLLABUS

I Year – II Semester

Category	Course Title	Int. marks	Ext. marks	L	P	C
Core Course IV	Power Electronic Converters	25	75	4	--	4
Core Course V	Power Electronic Control of DC Drives	25	75	4	--	4
Core Course VI	Power Electronic Control of AC Drives	25	75	4	--	4
Core Elective III	1. Power Quality 2. Advanced Digital Signal Processing 3. Switched Mode Power Supplies (SMPS)	25	75	4	--	4
Core Elective IV	1. Flexible AC Transmission Systems 2. High-Frequency Magnetic Components 3. Dynamics of Electrical Machines	25	75	4	--	4
Open Elective II	1. Instrumentation & Control 2. Intelligent Control 3. Smart grid technologies 4. AI Techniques in Electrical Engineering 5. Reliability Engineering 6. Energy Auditing, Conservation & Management	25	75	4	--	4
Laboratory II	Power Converters and Drives Lab	25	75	--	4	2
Seminar II	Seminar-II	50	--	--	4	2
Total Credits				**24**	**8**	**28**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PE/PEED/PID)

POWER ELECTRONIC CONVERTERS

Course Objectives

- To understand various PWM techniques for inverters and corresponding T.H.D
- To describe the operation of multi level inverters with switching strategies for high power
- applications
- To appreciate the design of resonant converters and switch mode power supplies.

Outcomes:

- Students will be able to develop various converter topologies and analyze it and can identify the corresponding T.H.D.
- AC or DC switched mode power supplies can be designed.

UNIT-I:
PWM Inverters (Single-Phase & Three-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 modulations – Advantage – application.
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 DC link inverter – buck and boost inverter – inverter circuit design – advantage applications.

UNIT-II:
Resonant Pulse Inverters: Resonant pulse inverters – series resonant inverters – series resonant inverters with unidirectional switches – series resonant inverters with bidirectional Switches – analysis of half bridge resonant inverter - evaluation of currents and Voltages of a simple resonant inverter – analysis of half bridge and full bridge resonant inverter with bidirectional switches – Frequency response of series resonant inverters – for series loaded inverter – for parallel loaded inverter – For series and parallel loaded inverters – parallel resonant inverters – Voltage control of resonant inverters – class E inverter and Class E rectifier.
Resonant converters: Resonant converters – Zero current switching resonant converters – L type ZCS resonant converter – M type ZCS resonant converter – zero voltage Switching resonant converters – comparison between ZCS and ZVS resonant Converters – Two quadrant ZVS resonant converters – resonant de-link Inverters – evaluation of L and C for a zero current switching inverter.

UNIT-III:
Multilevel Inverters: Multilevel concept – Classification of multilevel inverters – Diode clamped multilevel inverter – principle of operation – main features – improved diode Clamped inverter – principle of operation – Flying capacitors multilevel inverter – principle of operation – main features. Cascaded multilevel inverter – principle of operation – main features – Multilevel inverter applications – reactive power compensation – back to back intertie system – adjustable drives – Switching device currents – de link capacitor voltage balancing – features of Multilevel inverters – comparisons of multilevel converters.

UNIT-IV:
DC Power Supplies: DC power supplies – classification – switched mode dc power supplies – fly back Converter – forward converter – push-pull converter – half bridge converter – Full bridge converter – Resonant dc power supplies – bidirectional power supplies – Applications.

UNIT-V:
AC Power Supplies: AC power supplies – classification – switched mode ac power supplies – Resonant AC power supplies – bidirectional ac power supplies – multistage conversions – control circuits – applications. Introduction – power line disturbances – power conditioners – uninterruptible Power supplies – applications.

TEXT BOOKS:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition.
2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons – Second Edition.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PE/PEED/PID)

POWER ELECTRONIC CONTROL OF DC DRIVES

Course Objectives

- Introduction of drive system and characteristics of drive ,operating modes of drive
- Comprehend the principle o p e r a t i o n of phase control and Chopper controlled of dc drives
- Design a current and speed controllers to achieve closed loop operation of dc drive

Outcomes

- Students will be able to perform simulations of phase or chopper controlled dc drive both for open loop and closed loop operations.
- Student can choose proper gain values for speed and current controllers.
- To Comprehend the difference between pwm controller and hysteresis controller

UNIT–I:

Single-Phase Rectifiers Controlled DC Motor: Separately excited DC motors with rectified single – phase supply – single-phase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor.

UNIT–II:

Three-Phase Rectifiers Controlled DC Motor: Three-phase semi-converter and Three phase full converter for continuous and discontinuous modes of operations – power and power factor - Addition of Free wheeling diode – Three phase double converter.
Three phase controlled bridge rectifier with passive load impedance, resistive load and ideal supply – Highly inductive load and ideal supply for load side and supply side quantities, shunt capacitor compensation, three phase controlled bridge rectifier inverter.

UNIT–III:

Phase, Current & Speed Controlled DC Drive: Three-phase controlled converter, control circuit, control modeling of three phase converter – Steady state analysis of three phase converter control DC motor drive – Two quadrant, Three phase converter controlled DC motor drive – DC motor and load, converter.
Current and speed controllers - Current and speed feedback – Design of controllers – Current and speed controllers – Motor equations – filter in the speed feedback loop speed controller – current reference generator – current controller and flow chart for simulation – Harmonics and associated problems – sixth harmonics torque.

UNIT–IV:

Chopper Controlled DC Motor Drives: Principle of operation of the chopper – Chopper with other power devices – model of the chopper – input to the chopper – steady state analysis of chopper controlled DC motor drives – rating of the devices – Pulsating torque.
Closed loop operation: Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller.

UNIT–V: FOUR QUADRANT OPERATION OF DC DRIVES

Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic and Regenerative Braking operations. Four quadrant operation of D.C motors by single phase, three phase dual converters and Choppers – Closed loop operation of DC motor.

REFERENCES:

1. Power Electronics and motor control – Shepherd, Hulley, Liang – II Edition Cambridge University Press.
2. Electronic motor drives modeling Analysis and control – R. Krishnan – I Edition Prentice Hall India.
3. Power Electronics circuits, Devices and Applications – MH Rashid – PHI – 1 Edition 1995.
4. Fundamentals of Electric Drives – GK Dubey, Narosa Publishers 1995
5. Power Semiconductor drives – SB Dewan and A Straughen -1975.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PE/PEED/PID)

POWER ELECTRONIC CONTROL OF AC DRIVES

Objectives
- To understand principle operation of scalar control of ac motor and corresponding speed-torque-slip characteristics
- To comprehend the vector control for ac motor drive (IM and SM)
- To explain the static resistance control and Slip power recovery drive
- To explain synchronous motor drive characteristics and its control strategies
- To Comprehend the brushless dc motor principle of operation.

Outcomes
- Students will be able to develop induction motor for variable speed operations using scalar and vector control techniques.
- To identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives
- Controllers for synchronous motor and variable reluctance motor can be developed

UNIT-I:
Introduction : Introduction to motor drives – Torque production – Equivalent circuit analysis – Speed – Torque Characteristics with variable voltage operation Variable frequency operation constant v/t operation – Variable stator current operation – Induction motor characteristics in constant torque and field weakening regions.

UNIT-II:
Stator Side Control of Induction Drives: Scalar control – Voltage fed inverter control – Open loop volts/Hz control – speed control slip regulation – speed control with torque and flux control – current controlled voltage fed inverter drive – current – fed inverter control – Independent current and frequency control – Speed and flux control in Current –Fed inverter drive – Volts/Hz control of Current –fed inverter drive – Efficiency optimization control by flux program.

UNIT–III:
Rotor Side Control of Induction Drives : Slip power recovery drives – Static Kramer Drive – Phasor diagram – Torque expression – speed control of Kramer Drive – Static Scheribus Drive – modes of operation.
Vector control of Induction Motor Drives: Principles of Vector control – Vector control methods – Direct methods of vector control – Indirect methods of vector control – Adaptive control principles – Self tuning regulator Model referencing control.

UNIT–IV:
Control of Synchronous Motor Drives: Synchronous motor and its characteristics – Control strategies – Constant torque angle control – Unity power factor control – Constant mutual flux linkage control.
Controllers: Flux weakening operation – Maximum speed – Direct flux weakening algorithm – Constant Torque mode controller – Flux Weakening controller – indirect flux weakening – Maximum permissible torque – speed control scheme – Implementation strategy speed controller design.

UNIT–V:
Variable Reluctance Motor Drive: Variable Reluctance motor drive – Torque production in the variable reluctance motor Drive characteristics and control principles – Current control variable reluctance motor service drive.
Brushless DC Motor Drives: Three phase full wave Brushless dc motor – Sinusoidal type of Brushless dc motor- current controlled Brushless dc motor Servo drive.

REFERENCES:

1. Electric Motor Drives Pearson Modeling, Analysis and control – R. Krishnan – Publications – 1st edition – 2002.
2. Modern Power Electronics and AC Drives B K Bose – Pearson Publications 1st edition

3. Power Electronics and Control of AC Motors – MD Murthy and FG Turn Bull Pergman Press 1st edition
4. Power Electronics and AC Drives – BK Bose – Prentice Hall Eagle wood diffs New Jersey - 1st edition
5. Power Electronic circuits Deices and Applications – M H Rashid – PHI – 1995.
6. Fundamentals of Electrical Drives – G. K. Dubey – Narora publications – 1995.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (PE/PEED/PID)

POWER QUALITY
(Core Elective – III)

Course Objectives: The course should enable the students to

- Study the basics of power quality , power quality problems and power quality standards,
- Study about the characteristics of non-linear loads ,
- Study Voltage, Current, Power and Energy measurements and analysis methods of Laplace's, Fourier and Hartley and Wavelet Transforms ,
- Study the analysis and conventional mitigation methods,
- Study about various devices used to enhance power quality.

Learning Outcomes: At the end of the course the student should be able to:

- Know the different characteristics of electric power quality in power systems,
- One can learn about the applications of non-linear loads ,
- Know the applications of Hartley and Wavelet Transforms ,
- One can learn to mitigate the power quality problems
- One can learn about the application of FACTS device on DG side.

UNIT-I:

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

UNIT-II:

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

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

UNIT III:

Single and Three-Phase Voltage Sag Characterization : Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration.

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

UNIT-IV:

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

UNIT-V:

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

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

REFERENCE BOOK:

1. "Understanding Power Quality Problems" by Math H J Bollen. IEEE Press.
2. Power Quality VAR Compensation in Power Systems, R. SastryVedam Mulukutla S. Sarma,CRC Press.
3. Power Quality, C. Sankaran, CRC Presss.
4. Electrical Power Systems Quality, Roger C. Dugan , Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, Tata McGraw Hill Education Private Ltd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PE/PEED/PID)

ADVANCED DIGITAL SIGNAL PROCESSING
(Core Elective–III)

Course Objectives: The course will enable the students to:

(i) Know the basics of discrete random processes
(ii) Know the basics of various Spectrum estimation methods
(iii) Know the basics of linear estimators & predictors
(iv) Know the basics of various adaptive filters along with their applications
(v) Know the fundamentals of multirate digital signal processing

Learning Outcomes: At the end of the course the students should be able to

(i) Understand the various theorems & processing that are done on discrete random processes
(ii) Understand the different parametric & non-parametric spectrum estimation methods
(iii) Understand the linear predictors & Wiener filters
(iv) Understand the adaptive filters & their various applications
(v) Understand the importance of multirate digital signal processing

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 Implementation : 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.

REFERENCE BOOKS:

1. Digital signal processing –sanjit K. Mitra – TMH second edition
2. Discrete Time Signal Processing – Alan V. Oppenheim, Ronald W, Shafer – PHI 1996 1ST Edition reprint
3. Digital Signal Processing principles – algorithms and Applications- john G. Proakis – PHI – 3RD edition 2002.
4. Digital Signal Processing – S Salivahanan. A. Vallavaraj C. Gnanapriya – TMH – 2nd reprint 2001.
5. Theory and Applications of Digital Signal Processing –Lourens R Rebinarand Bernold.
6. Digital Filter Analysis and Design Auntoniam – TMH.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (PE/PEED/PID)

SWITCHED MODE POWER SUPPLIES (SMPS)
(Core Elective–III)

Course Objectives:
- To apply the basic concepts of power electronics for designing converters.
- Design and implement practical circuits for UPS, SMPS etc.

Learning Outcomes: At the end of the course, the student is expected to possess knowledge and achieve skills on the following:
- Ability to design converter system for electrical applications
- Ability to understand and design SMPS

UNIT – I

Basic Converter Circuits:

Buck Regulator, Buck- Boost Regulator, Boost Regulator, Cuk Converters and Resonant Converters. Choice of switching frequency.

UNIT – II

Isolated SMPS:

Fly back Converter, Forward Converter, Half-Bridge and Full Bridge Converters, Push-Pull Converter and SMPS with multiple outputs. Choice of switching frequency.

UNIT – III

Control Aspects

PWM Controllers, Isolation in feedback loop, Power Supplies with multiple output.
Stability analysis using Bode Diagrams.

UNIT – IV

Design Considerations

Selection of output filter capacitor, Selection of energy storage inductor, Design of High Frequency Inductor and High frequency Transformer, Selection of switches. Snubber circuit design, Design of driver circuits.

UNIT – V

Electro Magnetic Interference (EMI)

EMI Filter Components, Conducted EMI suppression, Radiated EMI suppression, Measurement.

Protection

Over current protection, Over voltage protection, Inrush current protection.

Thermal Model

Thermal Resistance, Cooling Considerations, Selection of Heat sinks, Simple Heat sink calculations.

TEXT BOOKS:

1) Switched Mode Power Supplies, Design and Construction, H. W. Whittington, B. W. Flynn and D. E. MacPherson, Universities Press, 2009 Edition.
2) Mohan N. Undeland . T & Robbins W., Power Electronics Converters, Application and Design. John Wiley, 3rd edition, 2002
3) Umanand L., Bhat S.R., Design of magnetic components for switched Mode Power Converters. , Wiley Eastern Ltd.,1992
4) Robert. W. Erickson, D. Maksimovic .Fundamentals of Power Electronics., Springer International Edition, 2005
5) Course Material on Switched Mode Power Conversion, V. Ramanarayanan.

REFERENCE BOOKS:

1) Krein P.T .Elements of Power Electronics., Oxford University Press
2) M.H.Rashid, Power Electronics. Prentice-Hall of India

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (PE/PEED/PID)

FLEXIBLE AC TRANSMISSION SYSTEMS
(Core Elective–IV)

Course Objectives: The course will enable the students

- (i) To get introduced to basic concepts of FACTS controllers.
- (ii) To familiar the students with the working of series compensation .
- (iii) To familiar the students with the working of Unified Power Flow Controller.
- (iv) To expose the students to the designing of FACTS controllers.
- (v) To familiarize the students with static VAR compensators

Learning Outcomes: After completion of the course the students are expected to be able to

- (i) Explain the basic compensators used in power systems.
- (ii) Explain how a series compensation is done in power system
- (iii) Explain the working of Unified Power Flow Controller.
- (iv) Design variable structure of FACTS controllers for power system
- (v) Explain the working of static VAR compensators and their applications in power system

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. "Understanding FACTS Devices" N.G. Hingorani and L. Guygi. IEEE Press Publications 2000.
2. Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
3. Mohan Mathur R. and Rajiv K.Varma , 'Thyristor - based FACTS controllers for Electrical transmission systems', IEEE press, Wiley Inter science , 2002.
4. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1 st Edition, 2007.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PE/PEED/PID)

HIGH-FREQUENCY MAGNETIC COMPONENTS
(Core Elective-IV)

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).

DYNAMICS OF ELECTRICAL MACHINES
(Core Elective-IV)

Course Objective: This course deals with generalized modeling and analysis of different electrical machines used for industrial drive applications.
Learning Outcomes: Students will be able to

- Basic mathematical analysis of electrical machines and its characteristics.
- Behavior of electrical machines under steady state and transient state.
- Dynamic modeling of electrical machines.

UNIT-I:
Basic Machine Theory:
Electromechanical Analogy – Magnetic Saturation – Rotating field theory – Operation of Inductor motor – equivalent circuit – Steady state equations of DC machines – operations of synchronous motor – Power angle characteristics

UNIT-II:
Electrodynamical Equation & Their Solutions
Spring and Plunger system - Rotational motion – mutually coupled coils – Lagrange's equation – Application of Lagrange's equation solution of Electro dynamical equations.

UNIT-III:
Dynamics of DC Machines
Separately excited d. c. generations – stead state analysis – transient analysis – Separately excited d. c. motors – stead state analysis – transient analysis – interconnection of machines – Ward Leonard system of speed control.

UNIT-IV:
Induction Machine Dynamics
Induction machine dynamics during starting and braking – accelerating time – induction machine dynamic during normal operation – Equation for dynamical response of the induction motor.

UNIT-V:
Synchronous Machine Dynamics
Electromechanical equation – motor operation – generator operation – small oscillations – general equations for small oscillations – representation of the oscillation equations in state variable form.

REFERENCE BOOKS:

1. Sen Gupta D.P. and J.W **"** Electrical Machine Dynamics "Macmillan Press Ltd 1980.
2. Bimbhra P.S. "Generalized Theory of Electrical Machines " Khanna Publishers 2002.

INSTRUMENTATION AND CONTROL
(Open Elective – II)

Course Objectives:

- To provide knowledge of Instrumentation systems and their applications.
- To provide knowledge of advanced control theory and its applications to engineering problems.
- To have a comprehensive idea about P,PI,PD,PID controllers

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

- to understand and analyze instrumentation systems and their applications to various industries.
- to apply advanced control theory to practical engineering problems.

Unit-I
Instrumentation: Introduction to mechanical systems and their structure and function, Performance Characteristics – Static and Dynamic, Fundamentals of signals acquisition, conditioning and processing,

Unit-II
Measurement of temperature, pressure, flow, position, velocity, acceleration, force, torque etc.

Unit-III
Control: Introduction to control systems, mathematical model of physical systems in transfer function and state space forms, response of dynamic systems, concept of pole & zero of a system,

Unit-IV
Realization of transfer functions, stability analysis. Introduction of discrete time system. Controllers: P, PI, PD, PID, Feed forward etc., tuning of controller parameters, disturbance rejection, implementation of controller using digital computer.

Unit-V
Control components: Actuator (ac & dc servomotors, valve), AC, DC tacho-generators, servo amplifier.

TEXT BOOKS:

1. John P Bently, “Principles of Measurement Systems” 3rd. Edition, Pearson
2. Alok Barua, “Fundamentals of Industrial Instrumentation’ Wiely India, 2011
3. William Bolton, “Instrumentation and Control Systems”, Elsevier, 2015

REFERENCES:

1.William Bolton, “Industrial Control and Instrumentation” University Press, 1991
2.Norman A Anderson,” Instrumentation for Process Measurement and Control” CRC, 1997
3.A. K, Ghosh, “ Introduction to Instrumentation and Control” Prentice Hall of India, 2005

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (PE/PEED/PID)

INTELLIGENT CONTROL
(Open Elective-II)

Course Objectives:

- Gaining an understanding of the functional operation of a variety of intelligent control techniques and their bio-foundations
- the study of control-theoretic foundations
- learning analytical approaches to study properties

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

- develop Neural Networks, Fuzzy Logic and Genetic algorithms.
- implement soft computing to solve real-world problems mainly pertaining to control system applications

Unit-I

Introduction and motivation. Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

Unit-II

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feedforward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis.

Unit-III

Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems.

Unit-IV

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

Unit-V

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Fuzzy logic control for nonlinear time-delay system. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

TEXT BOOKS:

a. Simon Haykins, Neural Networks: A comprehensive Foundation, Pearson Edition, 2003.
b. T.J.Ross, Fuzzy logic with Fuzzy Applications, Mc Graw Hill Inc, 1997.
c. David E Goldberg, “Genetic Algorithms”.
d. John Yen and Reza Langari, Fuzzy logic Intelligence, Control, and Information, Pearson Education, Indian Edition, 2003.

REFERENCES:

a. M.T.Hagan, H. B. Demuth and M. Beale, Neural Network Design, Indian reprint, 2008.
b. Fredric M.Ham and Ivica Kostanic, Principles of Neurocomputing for science and Engineering, McGraw Hill, 2001.
c. N.K. Bose and P.Liang, Neural Network Fundamentals with Graphs, Algorithms and Applications, Mc - Graw Hill, Inc. 1996.
d. Yung C. Shin and Chengying Xu, Intelligent System - Modeling, Optimization and Control, CRC Press, 2009.
e. N.K.Sinha and Madan M Gupta, Soft computing & Intelligent Systems - Theory & Applications, Indian Edition, Elsevier, 2007.
f. Witold Pedrycz, Fuzzy Control and Fuzzy Systms, Overseas Press, Indian Edition, 2008.

SMART GRID TECHNOLOGIES
(Open Elective–II)

Prerequisite: Electrical and Electronic Instrumentation
Course Objectives:
- To group various aspects of the smart grid,
- To defend smart grid design to meet the needs of a utility
- To select issues and challenges that remain to be solved
- To analyze basics of electricity, electricity generation, economics of supply and demand, and the various aspects of electricity market operations in both regulated and deregulated environment.

Course Outcomes: Upon the completion of this course, the student will be able to
- analyze the structure of an electricity market in either regulated or deregulated market conditions.
- know the advantages of DC distribution and developing technologies in distribution
- Discriminate the trade-off between economics and reliability of an electric power system.
- Differentiate various investment options (e.g. generation capacities, transmission, renewable, demand-side resources, etc) in electricity markets.
- Analyze the development of smart and intelligent domestic systems.

UNIT–I:
Introduction: Introduction to smart grid - Electricity network - Local energy networks- Electric transportation - Low carbon central generation - Attributes of the smart grid - Alternate views of a smart grid.
Smart Grid to Evolve A Perfect Power System: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

UNIT–II:
Dc Distribution and Smart Grid:AC Vs DC sources-Benefits of and drives of DC power delivery systems - Powering equipment and appliances with DC-Data centers and information technology loads - Future neighborhood-Potential future work and research.
Intelligrid Architecture for the Smartgrid: Introduction- Launching intelligrid -Intelligrid today - Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies.

UNIT–III:
Dynamic Energy Systems Concept: Smart energy efficient end use devices-Smart distributed energy resources - Advanced whole building control systems- Integrated communications architecture - Energy management-Role of technology in demand response- Current limitations to dynamic energy management-Distributed energy resources-Overview of a dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

UNIT–IV:
Energy Port as Part of the Smart Grid: Concept of energy - Port, generic features of the energy port.
Policies and Programs to Encourage End – Use Energy Efficiency: Policies and programs in action - multinational - national-state-city and corporate levels.
Market Implementation: Framework-factors influencing customer acceptance and response - program planning - monitoring and evaluation.

UNIT–V:
Efficient Electric End – Use Technology Alternatives: Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating - hyper efficient appliances - Ductless residential heat pumps and air conditioners - Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency- LED street and

area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

TEXT BOOKS:

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

REFERENCES:

1. JanakaEkanayake, KithsiriLiyanage, 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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (PE/PEED/PID)

AI TECHNIQUES IN ELECTRICAL ENGINEERING
(Open Elective-II)

Course Objectives:

- To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
- To observe the concepts of feed forward neural networks and about feedback neural networks.
- To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control
- To analyze genetic algorithm, genetic operations and genetic mutations.

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

- understand feed forward neural networks, feedback neural networks and learning techniques.
- understand fuzziness involved in various systems and fuzzy set theory.
- develop fuzzy logic control for applications in electrical engineering
- develop genetic algorithm for applications in electrical engineering.

UNIT – I:
Artificial Neural Networks: Introduction-Models of Neural Network - Architectures – Knowledge representation – Artificial Intelligence and Neural networks – Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzman learning – Supervised learning – Unsupervised learning – Reinforcement learning - learning tasks.

UNIT- II:
ANN Paradigms : Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map – Radial Basis Function Network – Functional link, network – Hopfield Network.

UNIT – III:
Fuzzy Logic: Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers - Fuzzy Inference - Fuzzy Rule based system - Defuzzification methods.

UNIT – IV:
Genetic Algorithms: Introduction-Encoding – Fitness Function-Reproduction operators - Genetic Modeling – Genetic operators - Crossover - Single–site crossover – Two-point crossover – Multi point crossover-Uniform crossover – Matrix crossover - Crossover Rate - Inversion & Deletion – Mutation operator –Mutation – Mutation Rate-Bit-wise operators - Generational cycle-convergence of Genetic Algorithm.

UNIT–V:
Applications of AI Techniques: Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability (Dynamic stability) Reactive power control – speed control of DC and AC Motors.

TEXT BOOK:

1. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithms”- PHI, New Delhi, 2003.

REFERENCES:

1. P.D.Wasserman,Van Nostrand Reinhold,”Neural Computing Theory & Practice” - New York,1989.
2. Bart Kosko,”Neural Network & Fuzzy System” Prentice Hall, 1992.
3. G.J.Klir and T.A.Folger,”Fuzzy sets,Uncertainty and Information”-PHI, Pvt.Ltd,1994.
4. D.E.Goldberg,” Genetic Algorithms”- Addison Wesley 1999.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (PE/PEED/PID)

RELIABILITY ENGINEERING
(Open Elective –II)

Course Objectives:

- To comprehend the concept of Reliability and Unreliability
- Derive the expressions for probability of failure, Expected value and standard deviation of Binominal distribution, Poisson distribution, normal distribution and weibull distributions.
- Formulating expressions for Reliability analysis of series-parallel and Non-series parallel systems
- Deriving expressions for Time dependent and Limiting State Probabilities using Markov models.

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

- Apply fundamental knowledge of Reliability to modeling and analysis of series-parallel and Non-series parallel systems.
- Solve some practical problems related with Generation, Transmission and Utilization of Electrical Energy.
- Understand or become aware of various failures, causes of failures and remedies for failures in practical systems.

Unit I:

Rules for combining probabilities of events, Definition of Reliability. Significance of the terms appearing in the definition. Probability distributions: Random variables, probability density and distribution functions. Mathematical expectation, Binominal distribution, Poisson distribution, normal distribution, weibull distribution.

Unit II:

Hazard rate, derivation of the reliability function in terms of the hazard rate. Failures: Causes of failures, types of failures (early failures, chance failures and wear-out failures). Bath tub curve. Preventive and corrective maintenance. Modes of failure. Measures of reliability: mean time to failure and mean time between failures.

Unit III:

Classification of engineering systems: series, parallel and series-parallel systems- Expressions for the reliability of the basic configurations.

Reliability evaluation of Non-series-parallel configurations: Decomposition, Path based and cutest based methods, Deduction of the Paths and cutsets from Event tree.

Unit IV:

Discrete Markov Chains: General modeling concepts, stochastic transitional probability matrix, time dependent probability evaluation and limiting state probability evaluation of one component repairable model. Absorbing states.

Continuous Markov Processes: Modeling concepts, State space diagrams, Stochastic Transitional Probability Matrix, Evaluating time dependent and limiting state Probabilities of one component repairable model. Evaluation of Limiting state probabilities of two component repairable model.

UNIT-V:

Approximate system Reliability analysis of Series systems, parallel systems with two and more than two components, Network reduction techniques. Minimal cutest/failure mode approach.

TEXT BOOKS:

1. “Reliability evaluation of Engineering systems”, Roy Billinton and Ronald N Allan, BS Publications.
2. “Reliability Engineering”, Elsayed A. Elsayed, Prentice Hall Publications.

REFERENCES:

1. “Reliability Engineering: Theory and Practice”, By Alessandro Birolini, Springer Publications.
2. “An Introduction to Reliability and Maintainability Engineering”, Charles Ebeling, TMH Publications.
3. “Reliability Engineering”, E. Balaguruswamy, TMH Publications.

M. Tech – I Year – II Sem. (PE/PEED/PID)

ENERGY AUDITING, CONSERVATION AND MANAGEMENT
(Open Elective –II)

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- booklet12-EEO

M. Tech – I Year – II Sem. (PE/PEED/PID)

POWER CONVERTERS AND DRIVES LAB

1. Speed Measurement and closed loop control using PMDC motor.

2. Thyristorised drive for PMDC Motor with speed measurement and closed Loop control.

3. IGBT used single 4 quadrant chopper drive for PMDC motor with speed measurement and closed loop control.

4. Thyristorised drive for 1Hp DC motor with closed loop control.

5. 3-Phase input, thyristorised drive, 3 Hp DC motor with closed loop

6. 3-Phase input IGBT, 4 quadrant chopper drive for DC motor with closed Loop control equipment.

7. Cyclo-converter based AC Induction motor control equipment.

8. Speed control of 3 phase wound rotor Induction motor.

9. Single-phase fully controlled converter with inductive load.

10. Single phase half wave controlled converter with inductive load.

11. Isolated Gate Drive circuits for MOSFET / IGBT based circuits.

12. Characteristics of solar PV Systems.

13. Maximum Power Point Tracking Charge Controllers.

14. Inverter control for Solar PV based systems.

Note: Any ten experiments can be conducted.