TKR COLLEGE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)

M.TECH (POWERELECTRONICS)

COURSE STRUCTURE AND SYLLABUS

IYear–ISemester

Category	CourseTitle	Int. marks	Ext. marks	L	P	C
CoreCourse I	Machine Modeling and Analysis	30	70	4	--	4
Core Course II	Modern Control Theory	30	70	4	--	4
Core Course III	PowerElectronicDevicesand Circuits	30	70	4	--	4
Core ElectiveI	1. Special Machines 2. HVDC Transmission 3. Programmable LogicControllers and their Applications	30	70	4	--	4
Core ElectiveII	1. Microcontrollers and Applications 2. Embedded Systems 3. DigitalControlSystems	30	70	4	--	4
Open ElectiveI	1. Optimization Techniques 2.Renewable energysystems 3. Solar energy and applications 4. Analysisofpowerconverters	30	70	4	--	4
LaboratoryI	PowerConvertersSimulationLab	30	70	--	4	2
SeminarI	Seminar-I	50	--	--	4	2
Total Credits				**24**	**8**	**28**

IYear–II Semester

Category	CourseTitle	Int. marks	Ext. Marks	L	P	C
Core Course IV	PowerElectronicConverters	30	70	4	--	4
Core Course V	PowerElectronicControlofDC Drives	30	70	4	--	4
Core Course VI	PowerElectronicControlofAC Drives	30	70	4	--	4
Core ElectiveIII	1. PowerQuality 2. Advanced DigitalSignal Processing 3. SwitchedMode PowerSupplies(SMPS)	30	70	4	--	4
Core ElectiveIV	1. Flexible ACTransmission Systems 2. High-FrequencyMagneticComponents 3. DynamicsofElectricalMachines	30	70	4	--	4
Open ElectiveII	1. Smartgridtechnologies 2. AI Techniquesin Electrical Engineering 3. ReliabilityEngineering 4. EnergyAuditing, Conservation&Management	30	70	4	--	4
LaboratoryII	PowerConvertersand DrivesLab	30	70	--	4	2
SeminarII	Seminar-II	50	--	--	4	2
Total Credits				**24**	**8**	**28**

IIYear-I Semester

CourseTitle	Int. marks	Ext. marks	L	P	C
ComprehensiveViva-Voce	--	100	--	--	4
ProjectworkReviewI	50	--	--	24	12
Total Credits			--	24	**16**

IIYear- IISemester

CourseTitle	Int. marks	Ext. marks	L	P	C
ProjectworkReviewII	50	--	--	8	4
ProjectEvaluation(Viva-Voce)	--	150	--	16	12
Total Credits			**--**	**24**	**16**

M.Tech: I Year – I Sem. **L T P C**

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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.
- A Harmonic modeling of Synchronous machine can be studied

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.

UNIT-IV:
Voltage and current Equations in stator reference frame – equation in Rotor reference frame – equations in a synchronously rotating frame – Torque equation - Equations In 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. Harmonic Modeling of Synchronous Machine.

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. “Power Quality in power systems and electrical Machines” by Md.A.S.Masoum, CRC Press.
4. Thyristor control of Electric Drives - Vedam Subranmanyam, Add Publisher.
5. 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.

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MODERN CONTROL THEORY

Course Objectives: The objective of the course is to

- Understand state space representation of systems and study controllability and Observability tests for continuous time-invariant systems.
- Understand the problem formulation of non linear systems and study the performance.
- Understand different types of optimal control techniques and its applications

Learning Outcomes: After completion of the course, the student acquires knowledge to

- Represent a system in state space form and analyze controllability and Observability concepts.
- Define the stability of a non linear system using lyapunov stability method.
- linear and non linear systems in state model
- stability analysis of linear and non linear systems through describing functions

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– Non Linear Models- 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.

UNIT-IV:

Phase-Plane Analysis: Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points phase-plane analysis of nonlinear control systems

UNIT-V:

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.

TEXT BOOKS:

1.Modern Control System Theory by M.Gopal – New Age International -1984

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

N.K.Sinha, control systems, New Age International, 3rd edition.

REFERENCES:

Optimal control by kircks

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POWER ELECTRONIC DEVICES AND CIRCUITS

Course Objectives:
- To understand the characteristics and principle of operation of modern power semi conductor devices.
- To comprehend the concept of 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 – SIT, SITH, and COOLMOS 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.

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SPECIAL MACHINES

(Core Elective–I)

Course Objectives: The course will enable the students to:

- Learn the constructional features, principle of operation, methods of control and application of stepper motors.
- Understand the constructional features, principle of operation, methods of control and applications of Switched reluctance motors.
- Have an insight into the constructional features, principle of operation, methods of control and applications of PMBLDC motors.
- Have a clear picture of the types, the constructional features, principle of operation, and methods of control and applications of PMSM.
- 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

- Realize the need for stepper motors and the various applications in industries.
- Get a clear picture of the operational characteristics and the applications of SRM.
- Know the various types of PMBLDC motors, rotor position sensors, methods of control and their applications.
- Get a clear idea of the features, control and the applications of PMSM.
- Get a clear picture of the operational characteristics and the applications of SyRM.
- Get a clear picture of the operational characteristics and the applications of Induction Machines.

UNIT–I:

Stepper Motors: Introduction-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 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-

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 $L(\theta)$-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.

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.

Linear Synchronous Machines: Construction, Operation and types, Applications.

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.

Induction generators- self excitation requirements, voltage regulation, different methods of voltage control, application to mini and micro hydel systems.

Doubly fed induction machines- control via static converter, power flow, voltage/frequency control (generation mode), and application to grid connected wind and mini/micro hydel systems.

TEXT BOOKS:

1. Special electrical machines, K. Venkataratnam, - University press.
2. Special electrical machines, E. G. Janardanan, - PHI.
3. Alternative Energy Systems:Design and Analysis of Induction Generators, M. Godoy Simoes and F.A. Farret, C.R.C.Press.
4. V. V. Athani,“ Stepper motor : Fundamentals , Applications and Design”- New age International pub.

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HVDC TRANSMISSION
(Core Elective - I)

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

Learning 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, Modern trends in HVDC Technology.

UNIT-II: Static Power Converters: static converter configuration,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.

UNIT-III: HVDC Converter System Control : 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: Converter Faults & Protection: Types of Converter faults, over current protection–Over voltages on DC side, over voltages due to AC disturbances, Transients in DC system, Insulation co-ordination, Smoothing reactors, DC Breakers, Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

UNIT-V:Multi Terminal Dc Systems: Applications of MTDC systems, Types of MTDC systems, Comparison of series and parallel MTDC systems, Control of MTDC systems, Protection of MTDC systems, Multi-infeed DC systems.

TEXT BOOKS:

1. E.W. Kimbark: Direct current Transmission, Wiely Inter Science – New York
2. KR Padiyar : High Voltage Direct current Transmission WielyEsatern Ltd New Delhi – 1992.
3. S.Kamakshaiah,V.Kamaraju,'HVDC Transmission',Tata McGraw-Hill EducationPvt. Ltd., 2011

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.

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PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS
(Core 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 and various industrial applications.

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.

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MICROCONTROLLERS AND APPLICATIONS
(Core 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 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 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.

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EMBEDDED SYSTEMS
(Core Elective-II)

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, 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

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DIGITAL CONTROL SYSTEMS

(Core Elective-II)

Course Objective: The objective of the course is to
- Understand difference between the Discrete control systems and Digital control systems and z-transforms
- Understand conversion of A/D and D/A of the control system, sample and hold, data conversion and quantization.
- Understand the state space modeling of digital systems and computation of state transition matrix. Understand Stability tests and second method of lyapunov.
- Understand the transient and study state analysis of digital control systems and controllability and Observability.

Learning Outcomes: After completion of the course, the student acquires knowledge on
- Converting an A/D and D/A control system, sampling theorem, reconstruction of sampled signals.
- Mapping between s-plane and z-plane, theorems and limitations of Z-transforms.
- Transient and study state analysis of digital control systems and controllability and Observability.
- Designing digital PID ,full order observer and reduced order observer, discrete Euler Lagrance equation and maximum principle.

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-modified z-transforms-theorems of the Z-transforms-limitations of z-transforms-pulse transfer function- pulse transfer function 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 invariant systems-solution of time invariant 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- 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-Nyquists 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 2003.

2. Digital control and state variable methods by M.Gopal,TMH.

3. Digital control systems by v.i.George, C.P.Kurian, cengage learning.

REFERENCE BOOKS:

1.Digital control systems by Kuo, oxford University Press, 2nd edition, 2003

2. Digital control Engineering by M.Gopal.

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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.

Learning 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

UNIT–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

Sequencing Models: Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

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.
3. "Operations Research" by S.D.SHARMA, Kedar Nath Ram Nath & Co.

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

M.Tech: I Year – I Sem.

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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, H2-O 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, 2Nd 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.

M.Tech: I Year – I Sem. **L T P C**

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SOLAR ENERGY AND APPLICATIONS
(Open Elective-I)

UNIT-I:Principles Of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, solar radiation data. Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT-II:Storage And Applications: Different methods of solar energy storage, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating /cooling technique, solar distillation and drying MPPT Algorithms and flow charts of the algorithms Fundamentals of solar cells, types of solar cells, semiconducting materials, band gap theory, absorption of photons, excitations and photo emission of electrons, band engineering.

UNIT – III P-V And I-V Cell Applications: Solar cell properties and design, p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, output power. I-V and P-V cell interconnection, module structure and module fabrication, Equivalent circuits, load matching, efficiency, fill factor and optimization for maximum power, Design of stand-alone I-V, P-V systems, system sizing, device structures, device construction,

UNIT – IV Cost Analysis And Environmental Issues: Cost analysis and pay back calculations for different types of solar panels and collectors, installation and operating costs, Environmental and safety issues, protection systems, performance monitoring.

UNIT - V Hybrid Energy Sources: Wind Energy, Availability, Wind Devices, Wind Characteristics, Performance of Turbines and systems. Tidal Energy: Types of devices for Tidal Energy Collection, Control Systems, wind-solar system and Fuel cells.

TEXT BOOKS:
1. G. D. Rai (2009), *Non-Conventional Energy Sources*, 4th edition, Khanna Publishers, New Delhi.
2. Martin A. Green (2008), *Solar Cells: Operating Principles, Technology and system Applications*, 1st edition, Prentice Hall, New Delhi.

REFERENCES BOOKS:
1. Sukatme (2008), Solar Energy, 3rd Edition, McGraw Hill Companies, New Delhi.
2. D. Yogi gosuami, Frank Kreith, Jan F. Kreider (2000), Principles of Solar Engineering, 2nd edition, Taylor &Francis, USA.

TKR COLLEGE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)
POWER ELECTRONICS

M.Tech: I Year – I Sem. **L T P C**

4 0 0 4

ANALYSIS OF POWER ELECTRONIC CONVERTER
(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 PWM Control - Effects of source and load inductances - Synchronous tap changers-Applications - numerical problems.

UNIT- II
Three Phase AC Voltage Controllers: Three phase AC voltage controllers - Analysis of controllers with star and delta Connected Resistive, Resistive-inductive loads - Effects of source and load Inductances - applications - numerical problems.
Cyclo-converters: Single phase to single phase cyclo-converters - analysis of midpoint and bridge Configurations - Three phase to three phase cyclo-converters - 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 - Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap. 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 - performance parameters – effect of source impedance and overlap. power factor Improvements - three phase PWM - twelve pulse converters - applications -Numerical problems.

UNIT-IV

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 - 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

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POWER ELECTRONICS

M.Tech: I Year – I Sem. **L T P C**

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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. Resonant pulse commutation circuit.

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.
    - a. Root locus
    - b. Bode plot
    - c. Nyquist plot
    - d. 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.

I Year–II Semester

Category	CourseTitle	Int. marks	Ext. Marks	L	P	C
Core Course IV	PowerElectronicConverters	30	70	4	--	4
Core Course V	PowerElectronicControlofDC Drives	30	70	4	--	4
Core Course VI	PowerElectronicControlofAC Drives	30	70	4	--	4
Core ElectiveIII	1. PowerQuality 2. Advanced DigitalSignal Processing 3. SwitchedMode PowerSupplies(SMPS)	30	70	4	--	4
Core ElectiveIV	1. Flexible ACTransmission Systems 2. High-FrequencyMagneticComponents 3. DynamicsofElectricalMachines	30	70	4	--	4
Open ElectiveII	1. Smartgridtechnologies 2. AI Techniquesin Electrical Engineering 3. ReliabilityEngineering 4. EnergyAuditing, Conservation&Management	30	70	4	--	4
LaboratoryII	PowerConvertersand DrivesLab	30	70	--	4	2
SeminarII	Seminar-II	50	--	--	4	2
Total Credits				**24**	**8**	**28**

M.Tech: I Year – II Sem.

L	T	P	C
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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.

Learning 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 – 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.

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.

Protection of devices and circuits: Introduction cooling and heat sinks- Thermal modeling of power switching devices-snubber circuits-reverse recovery transients-voltage protection by selenium diodes and metal oxide varistors-current protection-electromagnetic interference.

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.

M.Tech: I Year – II Sem. **L T P C**
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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

Learning 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 Freewheeling 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

SIMULATION OF DC MOTOR DRIVES: Dynamic simulation of the speed controlled DC motor drives, Speed feedback speed controller, and command current generator current controller.

TEXT BOOKS:

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.

REFERENCES:

1. Power Electronics circuits, Devices and Applications – MH Rashid – PHI – 1 Edition 1995.
2. Fundamentals of Electric Drives – GK Dubey, Narosa Publishers 1995
3. Power Semiconductor drives – SB Dewan and A Straughen -1975.

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POWER ELECTRONICS

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POWER ELECTRONIC CONTROL OF AC DRIVES

Course 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.

Learning 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:

Traction drives: Motors employed in railway traction and road-vehicles, control of railway traction dc motors using ac-dc converters, control of railway traction ac motors using ac-dc and dc-ac converters, power electronic control circuits of electric vehicles and hybrid electric vehicles**.**

Text Books:

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

References:

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

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

M.Tech: I Year – II Sem.

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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.
- One can be able to know the PQ issues in RES.

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 – 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:

Power Quality Solutions for Renewable energy sources: Energy conservation and efficiency, Photovoltaic and thermal solar (power) systems , Horizontal – and vertical-axes wind power (WP) plants, Complementary control of renewable plants with energy storage plants, AC transmission lines versus DC lines, Fast-charging stations for electric cars, Off-shore renewable plants, Metering, Other renewable energy plants, Production of automotive fuel from wind, water, and CO2 , Water efficiency.

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.8

REFERENCE BOOK:

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

M.Tech: I Year – II Sem.

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ADVANCED DIGITAL SIGNAL PROCESSING
(Core Elective–III)

Course Objectives: The course will enable the students to:
- Know the basics of discrete random processes
- Know the basics of various Spectrum estimation methods
- Know the basics of linear estimators & predictors
- Know the basics of various adaptive filters along with their applications
- Know the fundamentals of multirate digital signal processing

Learning Outcomes: At the end of the course the students should be able to
- Understand the various theorems & processing that are done on discrete random processes
- Understand the different parametric & non-parametric spectrum estimation methods
- Understand the linear predictors & Wiener filters
- Understand the adaptive filters & their various applications
- 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- Nonparametric 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 1 Edition reprint
3. Digital Signal Processing principles – algorithms and Applications- john G. Proakis – PHI – 3 edition 2002.
4. Digital Signal Processing – S Salivahanan. A. Vallavaraj C. Gnanapriya – TMH – 2 reprint2001.
5. Theory and Applications of Digital Signal Processing –Lourens R Rebinarand Bernold.
6. Digital Filter Analysis and Design Auntoniam – TMH.

M.Tech: I Year – II Sem.

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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.
- To get awareness on Heat sink calculations

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
- To analyze dc-dc converter in thermal point of view.

UNIT – I

Basic Converter Circuits: Buck Regulator, Buck- Boost Regulator, Boost Regulator, Cuk Converters and Resonant Converters & SEPIC converter.

UNIT–II

Isolated :

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

Thermal Model:

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

Applications:

DC/DC converter as Power Factor Corrector (active shaping of the line current) Offline Computer Power Supply System, Uninterruptible AC Power Supplies, Space Craft Power Supply etc

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

M.Tech: I Year – II Sem.

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FLEXIBLE AC TRANSMISSION SYSTEMS
(Core Elective–IV)

Course Objectives: The course will enable the students

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

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

- Explain the basic compensators used in power systems.
- Explain how a series compensation is done in power system
- Explain the working of Unified Power Flow Controller.
- Design variable structure of FACTS controllers for power system
- 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 & applications 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.Unified power flow control(UPFC), Interline Power flow control(IPFC)

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.

REFERENCE:

1. Xiao-Ping Zhang, Christian Rehtanz, Bikash Pal, Flexible AC Transmission Systems: Modelling and Control, Springer,2006

M.Tech: I Year – II Sem.

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HIGH-FREQUENCY MAGNETIC COMPONENTS

(Core Elective-IV)

Course Objective:

- The course is aimed to give a comprehensive knowledge of Different magnetic material and their properties and application in electrical Engineering.

Learning Outcomes:

- Knowledge of Magnetic components like Inductors ,Magnetic Cores
- Knowledge of Skin effect and Proximity effect on Electrical Conductors
- Overview of High frequency effects on conductor resistance
- Overview of Self-Capacitance and its effects
- Study of Magnetic components used in Power Electronics

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.
Magnetic Cores: Introduction, Properties of Core Materials, Magnetic Dipoles, Magnetic Domains, Curie Temperature, Magnetization, Magnetic Materials, Hysteresis, Core Permeability, Core Geometries: Toroidal Cores, CC and UU Cores, Pot Cores, PQ and RM Cores, EE and EDT Cores, Planar 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, 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, 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, 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 AC Current Transformers, Winding Power Losses with Harmonics, Saturable Reactors, 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, Inductance of Coaxial Cable, Inductance of Two-Wire Transmission Line, Eddy Currents in 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. Core Geometry Coefficient *Kg* Method, General Expression for Core Geometry Coefficient *Kg*, AC Inductor with Sinusoidal Current and Voltage, Inductor for PWM Converter in CCM, Inductor for PWM Converter in DCM, Inductor Design for Buck Converter in CCM Using *Kg* Method, Inductor Design for Buck Converter in DCM Using *Kg* 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, Capacitance of Coaxial Cable.
Magnetic Components for Power Electronics: Soft Ferrites for Power Electronics, Ferrite Power Inductor Materials, Magnetic Properties of Metallic Strip Materials, Amorphous Metal Magnetic Materials, Nanocrystalline Materials, Powder Core Materials-Output Chokes, EMI and PFC, Commercially-Available Components for Power Electronics.

TEXT BOOKS:

1. High-Frequency Magnetic Components, Marian K. Kazimierczuk, ISBN: 978-0-470- 71453-9, John Wiley & Sons, Inc.
2. Magnetic Components for Power Electronics**,** Alex Goldman, ISBN: 978-1-461-50871-7, Springer Science & Business Media, 2012

REFERENCES:

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.
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”

M.Tech: I Year – II Sem.

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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.
- Dynamic modeling of Transformers.

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:
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-III:
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-IV:
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.

UNIT-V:
Transformer Transients:
Excitation phenomena–Harmonics in single –phase transformers, Over current transients–Qualitative and Analytical approaches.- Estimation of inrush current, External and Internal over voltages – Transformer equivalent circuit with over voltages-Initial voltage distribution for solidly grounded neutral and isolated neutral.

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.
3. Nagrath I.J. & Kothari D.P, Electric Machines, Tata McGraw Hill Publishers, 2004.

M.Tech: I Year – II Sem.

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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.

Learning 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.

Power Quality Management in Smart Grid-Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid.

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
3. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley

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.
3. Tony Flick and Justin Morehouse, “Securing the Smart Grid”, Elsevier Inc. (ISBN: 978-1-59749-570 7)

M.Tech: I Year – II Sem.

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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.

Learning 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, Neural network Architecture – Rosenblatt's perception- ADALINE network-MADALINE 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-Applications

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- Applications-Advances in GA.

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:

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

REFERENCE BOOKS:

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

M.Tech: I Year – II Sem. **L T P C**
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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 cut sets 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.

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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.

Learning 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 , and their Application.

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
4.Turner W.C., 'Energy Management Handbook', 1982.

M.Tech: I Year – II Sem.

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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.