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M.TECH - POWER ELECTRONICS
Course Structure R-19

I YEAR – I SEMESTER

S. No	Course Code	Course Title	Int. Marks	Ext. Marks	L	P	C
1	B121PC1	Machine Modeling and Analysis	30	70	3	--	3
2	B121PC2	Modern Control Theory	30	70	3	--	3
3	B121PC3	Power Electronic Devices and Circuits	30	70	3	--	3
4	B121PE4	1. Special Machines 2. HVDC Transmission 3. Programmable Logic Controllers and their Applications	30	70	3	--	3
5	B121PE5	1. Microcontrollers and Applications 2. Embedded Systems 3. Digital Control Systems	30	70	3	--	3
6	B121PC6	Power Converters Simulation Lab	30	70	--	4	2
Total Credits					**15**	4	**17**

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M.TECH - POWER ELECTRONICS
Course Structure R-19

I YEAR – II SEMESTER

S. No	Course Code	Course Title	Int. Marks	Ext. Marks	L	P	C
1	B122PC1	Advanced Power Electronic Converters	30	70	3	--	3
2	B122PE2	1. Power Quality 2. Power Electronic Control of DC Drives 3. Switched Mode Power Supplies(SMPS)	30	70	3	--	3
3	B122PE3	1. Flexible AC Transmission Systems 2. Industrial Load Modeling and Control 3. Dynamics of Electrical Machines	30	70	3	--	3
4	B122PE4	1. Power Electronic Control of AC Drives. 2. Advanced Digital Signal Processing 3. Reliability Engineering	30	70	3	--	3
5	B122PC5	Electrical Drives Lab	30	70	--	4	2
6	B122PC6	Machine Modeling Analysis Lab	30	70	--	4	2
7	B122PC7	Advanced Power Electronic Converters Lab	30	70	--	4	2
8	Audit-I	Audit-I	--	--	2	--	0
Total Credits					**14**	**12**	**18**

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M.TECH - POWER ELECTRONICS
Course Structure R-19

II YEAR – I SEMESTER

S. No	Course Code	Course Title	Int. Marks	Ext. Marks	L	P	C
1	B223OE1	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects 5. Composite Materials 6. Energy from Waste	30	70	3	--	3
2	B223RM2	Research Methodology and IPR	30	70	2	--	2
3	Audit-II	Audit-II			2		0
4	Mini Project with Seminar		100	--	--	6	3
5	Major Project	Phase-I Dissertation	100	--	--	18	9
Total Credits					**7**	**24**	**17**

II YEAR – II SEMESTER

S. No	Course Code	Course Title	Int. Marks	Ext. Marks	L	P	C
1	Major Project	Phase-II Dissertation	---	100	---	32	16
Total Credits						**32**	**16**

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POWER ELECTRONICS

M.Tech I Semester **L/P/C**
3/0/3

MACHINE MODELLING AND ANALYSIS (B121PC1)

Course Objectives:

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

Course Outcomes:

1. Develop the mathematical models of various machines like machines like dc machine.
2. Induction motor and Synchronous machines using modeling equations.
3. Models have to be used for analysis using simulation study.
4. 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 - VedamSubranmanyam, Add Publisher.
5. Power System Stability and Control – PrabhaKundur, EPRI.

REFERENCE BOOKS:

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, MuhammedRafeek, Dr. Babu Paul. International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 8, February 2013.

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POWER ELECTRONICS

M.Tech I Semester **L/P/C**
3/0/3

MODERN CONTROL THEORY (B121PC2)

Course Objectives:

The objective of the course is to

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

Course Outcomes:

After completion of the course, the student acquires knowledge to

1. Represent a system in state space form and analyze controllability and Observability concepts.
2. Define the stability of a non linear system using lyapunov stability method.
3. Linear and non linear systems in state model.
4. 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.

REFERENCE BOOK:

1. Optimal control by kircks.

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POWER ELECTRONICS

M.Tech I Semester **L/P/C**
3/0/3

POWER ELECTRONIC DEVICES AND CIRCUITS (B121PC3)

Course Objectives:

1. To understand the characteristics and principle of operation of modern power semi conductor devices.
2. To comprehend the concept of different power converters and their applications.
3. Students will be able to analyze and design switched mode regulator for various industrial applications.

Course Outcomes:

1. Students will be able to choose appropriate device for a particular converter topology.
2. 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, KhannaPubishers.
2. Elements of Power Electronics, Philip T. Krein, Oxford University Press.
3. Power Electronics, M. S. JamilAsghar, PHI Private Limited.
4. Principles of Power Electronics, John G. Kassakian, Martin F. Schlect, Geroge C. Verghese,
5. Pearson Education.
6. Fundamentals of Power Electronics, Robert W. Erickson, Dragan and Maksimobic, Springer.

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POWER ELECTRONICS

M.Tech I Semester **L/P/C 3/0/3**

SPECIAL MACHINES (PE–I) (B121PE4)

Course Objectives:

The course will enable the students to:

1. Learn the constructional features, principle of operation, methods of control and application of stepper motors.
2. Understand the constructional features, principle of operation, methods of control and applications of Switched reluctance motors.
3. Have an insight into the constructional features, principle of operation, methods of control and applications of PMBLDC motors.
4. Have a clear picture of the types, the constructional features, principle of operation, and methods of control and applications of PMSM.
5. Gain knowledge in the types, the constructional features, principle of operation, methods of control and applications of SyRM.

Course Outcomes:

After completion of the course, the students are expected to

1. Realize the need for stepper motors and the various applications in industries.
2. Get a clear picture of the operational characteristics and the applications of SRM.
3. Know the various types of PMBLDC motors, rotor position sensors, methods of control and their applications.
4. Get a clear idea of the features, control and the applications of PMSM.
5. Get a clear picture of the operational characteristics and the applications of SyRM.
6. 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(θ)-θ profile - power converter for SR motor-A numerical example Rotor sensing mechanism and logic control, drive and power circuits, position sensing of rotor with Hall problems-derivation of torque expression, general linear case.

UNIT III

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

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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M.Tech I Semester **L/P/C**
3/0/3

2. HVDC TRANSMISSION (PE–I) (B121PE4)

Course Objectives:

1. To Comprehend the conversion principles of HVDC Transmission.
2. 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.
3. To comprehend interaction between HVAC and DC systems in various aspects.
4. To appreciate the reliable MTDC systems and protection of HVDC system.

Course Outcomes:

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

1. To find the applications of HVDC transmission in the power system with the acquired knowledge.
2. To analyze different converter topologies viz. 3, 6 and 12 Pulse converters and understand it's control aspects.
3. To understand the filter configuration for Harmonics in HVDC systems.
4. To appreciate the reliable Multi terminal HVDC system.
5. 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-in feed 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

REFERENCE BOOKS:

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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M.Tech I Semester **L/P/C**
3/0/3

3.PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS (PE–I) (B121PE4)

Course Objectives:

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

Course Outcomes:

Students will be able to

1. Develop and explain the working of PLC with the help of a block diagram.
2. Execute, debug and test the programs developed for digital and analog operations.
3. 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 WWebb 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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M.Tech I Semester **L/P/C**
3/0/3

1. MICROCONTROLLERS AND APPLICATIONS (PE–II) (B121PE5)

Course Objectives:

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

Course Outcomes:

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

1. A solid understanding of the fundamental hardware layout of a microprocessor and Microcontroller.
2. Working knowledge in ports and interrupts.
3. 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 – 8051microcontroller – 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 Key boardinterfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – AlphanumericDevices – Display Systems and its interfaces – Printer interfaces – Programmable instrumentsinterface using IEEE 488 Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to HighPower Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders– Industrial control – Industrial process control system – Prototype MCU based Measuringinstruments – 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"– PearsonEducation, 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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M.Tech I Semester **L/P/C 3/0/3**

2. EMBEDDED SYSTEMS (PE–II) (B121PE5)

Prerequisite: Microprocessors and Interfacing Devices
Course Objectives:

1. To emphasize the general embedded system concepts, design of embedded hardware and software development tools.
2. To explain the basics of real time operating and embedded systems.
3. 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

1. To analyze and design embedded systems and real-time systems
2. Define the unique design problems and challenges of real-time systems
3. Identify the unique characteristics of real-time operating systems and evaluate the need for real-time operating system
4. Explain the general structure of a real-time system and Understand and use RTOS to build an embedded real-time system
5. 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: Dream Tech Software Team-John Wiley -2002

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M.Tech I Semester **L/P/C 3/0/3**

3.DIGITAL CONTROL SYSTEMS (PE-II) (B121PE5)

Course Objective:

The objective of the course is to

1. Understand difference between the Discrete control systems and Digital control systems and z-transforms.
2. Understand conversion of A/D and D/A of the control system, sample and hold, data conversion and quantization.
3. Understand the state space modeling of digital systems and computation of state transition matrix. Understand Stability tests and second method of lyapunov.
4. Understand the transient and study state analysis of digital control systems and controllability and Observability.

Course Outcomes:

After completion of the course, the student acquires knowledge on

1. Converting an A/D and D/A control system, sampling theorem, reconstruction of sampled signals.
2. Mapping between s-plane and z-plane, theorems and limitations of Z-transforms.
3. Transient and study state analysis of digital control systems and controllability and Observability.
4. 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 Lyapunov

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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POWER ELECTRONICS

M.Tech I Semester **L/P/C 0/4/2**

POWER CONVERTERS SIMULATION LAB (B121PC6)

Course Objectives:

1. To Simulate Single phase, Three phase full converter using RLE loads
2. To simulate Single phase AC Voltage controller using RL load.
3. To develop the model of DC-DC Converters, Separately Excited DC Motor.
4. To design a PID controller based on Bode plot.

Course Outcomes:

At the end of the course, the student should be able to:

1. Simulate Single phase, Three phase full converter using RLE loads
2. Simulate Single phase AC Voltage controller using RL load.
3. Simulate DC-DC Converters
4. Identify stability methods and various controllers

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
   iii. 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.

Note: 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.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

ADVANCED POWER ELECTRONIC CONVERTERS (B122PC1)

Course Objectives:

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

Course Outcomes:

1. Students will be able to develop various converter topologies and analyze it and can identify the corresponding T.H.D.
2. 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.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C 3/0/3**

1. POWER QUALITY (PE – III) (B122PE2)

Course Objectives:

The course should enable the students to

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

Course Outcomes:

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

1. Know the different characteristics of electric power quality in power systems.
2. One can learn about the applications of non-linear loads.
3. Know the applications of Hartley and Wavelet Transforms.
4. One can learn to mitigate the power quality problems.
5. One can learn about the application of FACTS device on DG side.
6. 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.

TEXT BOOKS:

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. SastryVedamMulukutlaS.Sarma, CRC Press.
4. Power Quality, C. Sankaran, CRC Presss.
5. Electrical Power Systems Quality, Roger C. Dugan , Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, Tata McGraw Hill Education Private Ltd.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

2.POWER ELECTRONIC CONTROL OF DC DRIVES (PE-III) (B122PE2)

Course Objectives:

1. Introduction of drive system and characteristics of drive ,operating modes of drive .
2. Comprehend the principle operation of phase control and Chopper controlled of dc drives.
3. Design a current and speed controllers to achieve closed loop operation of dc drive.

Course Outcomes:

1. Students will be able to perform simulations of phase or chopper controlled dc drive both for open loop and closed loop operations.
2. Student can choose proper gain values for speed and current controllers.
3. 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.

REFERENCE BOOKS:

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

M.Tech II Semester **L/P/C**
3/0/3

3.SWITCHED MODE POWER SUPPLIES (SMPS) (PE–III) (B122PE2)

Course Objectives:

1. To apply the basic concepts of power electronics for designing converters.
2. Design and implement practical circuits for UPS, SMPS etc.
3. To get awareness on Heat sink calculations.

Course Outcomes:

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

1. Ability to design converter system for electrical applications.
2. Ability to understand and design SMPS.
3. 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 Converter: 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.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

1. FLEXIBLE AC TRANSMISSION SYSTEMS (PE–IV) (B122PE3)

Course Objectives:

The course will enable the students

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

Course Outcomes:

After completion of the course the students are expected to be able to

1. Explain the basic compensators used in power systems.
2. Explain how a series compensation is done in power system
3. Explain the working of Unified Power Flow Controller.
4. Design variable structure of FACTS controllers for power system
5. 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 BOOK:

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

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POWER ELECTRONICS

M.Tech II Semester **L/P/C 3/0/3**

2. INDUSTRIAL LOAD MODELLING AND CONTROL (PE-IV) (B122PE3)

Prerequisite: Power Systems

Course Objectives:

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models
4. Study Reactive power management in Industries

Course Outcomes:

After taking this course, student will be able to:

1. Knowledge about load control techniques in industries and its application.
2. Different types of industrial processes and optimize the process using tools like LINDO and LINGO.
3. Apply load management to reduce demand of electricity during peak time.
4. Apply different energy saving opportunities in industries.

UNIT I

Electric Energy Scenario-Demand Side Management-Industrial Load Management, Load Curves- Load Shaping Objectives-Methodologies, Barriers; Classification of Industrial Loads-Continuous and Batch processes -Load Modeling.

UNIT II

Electricity Pricing – Dynamic and spot pricing –Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of load models- Optimization and control algorithms - Case studies.

UNIT III

Reactive power management in industries-controls-power quality impacts application of filters Energy saving in industries. Cooling and heating loads- load profiling- Modeling, Cool storage-Types- Control strategies, optimal operation-Problem formulation- Case studies.

UNIT IV

Captive Power Units- Operating and control strategies- Power Pooling- Operation models, Energy banking-Industrial Cogeneration

UNIT V

Selection of Schemes Optimal Operating Strategies, Peak load saving-Constraints-Problem formulation- Case study, Integrated Load management for Industries

TEXT BOOKS:

1. C.O. Bjork “Industrial Load Management - Theory, Practice and Simulations", Elsevier, theNetherlands,1989.
2. C.W. Gellings and S.N. Talukdar, “Load management concepts,” IEEE Press, New York, 1986,pp. 3-28.

REFERENCE BOOKS:

1. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. On PAS,April 1981.
2. H. G. Stoll, "Least cost Electricity Utility Planning”, Wiley Interscience Publication, USA,1989.
3. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGrawHillpublishers, New Delhi, 1995.
4. IEEE Bronze Book- “Recommended Practice for Energy Conservation and costeffectiveplanningin Industrial facilities”, IEEE Inc, USA.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

3. DYNAMICS OF ELECTRICAL MACHINES (PE-IV) (B122PE3)

Course Objective:

1. This course deals with generalized modeling and analysis of different electrical machines used for industrial drive applications.

Course Outcomes:

After completion of the course the students are expected to be able to

1. Basic mathematical analysis of electrical machines and its characteristics.
2. Behavior of electrical machines under steady state and transient state.
3. Dynamic modeling of electrical machines.
4. 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.

TEXT 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.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

1. POWER ELECTRONIC CONTROL OF AC DRIVES (PE-V) (B122PE4)

Course Objectives:

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

Course Outcomes:

1. Students will be able to develop induction motor for variable speed operations using scalar and vector control techniques.
2. To identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives .
3. 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 loopvolts/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

REFERENCE BOOKS:

1. Power Electronics and Control of AC Motors – MD Murthy and FG Turn Bull Pergman Press 1stedition
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.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

2. ADVANCED DIGITAL SIGNAL PROCESSING (PE–V) (B122PE4)

Course Objectives:

The course will enable the students to:

1. Know the basics of discrete random processes
2. Know the basics of various Spectrum estimation methods
3. Know the basics of linear estimators & predictors
4. Know the basics of various adaptive filters along with their applications
5. Know the fundamentals of multirate digital signal processing

Course Outcomes:

At the end of the course the students should be able to

1. Understand the various theorems & processing that are done on discrete random processes
2. Understand the different parametric & non-parametric spectrum estimation methods
3. Understand the linear predictors & Wiener filters
4. Understand the adaptive filters & their various applications
5. Understand the importance of multirate digital signal processing

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

TEXT 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 RebinarandBernold.
6. Digital Filter Analysis and Design Auntoniam – TMH.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
3/0/3

3. RELIABILITY ENGINEERING (PE–V) (B122PE4)

Prerequisite: Mathematics

Course Objectives:

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

Course Outcomes:

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

1. Apply fundamental knowledge of Reliability to modeling and analysis of series parallel and Non-series parallel systems.
2. Solve some practical problems related
3. Understand or become aware of various failures, causes of failures and remedies for failures in practical systems.

UNIT I

Reliability and Probability: 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, exponential 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: meantime 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

Frequency and Duration Techniques: Frequency and duration concepts, application to multi state problems, Frequency balance approach. Approximate System Reliability Evaluation: Series systems – Parallel systems- Network reduction techniques- Cut set approach- Common mode failures modeling and evaluation techniques- Examples.

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.

REFERENCE BOOKS:

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.

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M.Tech II Semester **L/P/C**
0/4/2

ELECTRICAL DRIVES LAB (B122PC5)

Course Objectives:

1. To understand principle operation of scalar control of ac motor and corresponding speed torque characteristics
2. To comprehend the vector control for ac motor drive (IM and SM)
3. To explain the static resistance control and Slip power recovery drive
4. To explain the Characteristics of solar PV Systems and Maximum Power Point Tracking Charge Controllers.
5. To understand the Inverter control for Solar PV based systems.

Course Outcomes:

After taking this course, student will be able to:

1. Develop induction motor for variable speed operations using scalar and vector control Techniques.
2. Identify the difference between the rotor resistance control and static rotor resistance Control method and significance of slip power recovery drives.
3. Develop controllers for PV systems.

Note: Any ten experiments can be conducted.

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.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
0/4/2

MACHINE MODELING ANALYSIS LAB (B122PC6)

Prerequisite: Electrical Machines, Machine Modeling Analysis

Course Objectives:

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

Course Outcomes:

At the end of the course, the student is able to:

1. Develop the mathematical models of various machines like, induction motor and Synchronous machines, permanent magnet synchronous motor, brushless DC motor using Modeling equations.
2. Analyze the developed models in various reference frames.

Note: Conduct any 10 experiments from the above using any simulation tool

1. Develop a dynamic model of open loop controlled dc motor.
2. Develop a dynamic model of closed loop controlled dc motor.
3. Convert ABC voltages into stationary frame.
4. Convert ABC voltages into synchronous frames.
5. Convert ABC voltages into rotor reference frames.
6. Develop dynamic model of 3-phase Induction motor and generator.
7. Develop a mathematical model for V/f controlled 3-phase Induction motor.
8. Develop a mathematical model for 3-phase Synchronous motor.
9. Develop a mathematical model for3-phase Permanent Magnet Synchronous motor.
10. Develop a mathematical model for Brushless DC Motor.
11. Develop a dynamic model for closed loop control of Induction Motor.
12. Develop a dynamic model for closed loop control of Synchronous motor.

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POWER ELECTRONICS

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ADVANCED POWER ELECTRONIC CONVERTERS LAB (B122PC7)

Prerequisite: Power Electronic Converters

Course Objectives:

1. Gate drive circuit configurations for converter circuits
2. Advanced converter topologies
3. Simulation and hardware implementation of various AC-DC, AC-AC, DC-DC converter topologies

Course Outcomes:

At the end of the course, the student should be able to:

1. Know the different converter strategies of AC to DC, AC-AC and DC-DC
2. Analysis of various topologies developed
3. Get the knowledge on multi-level inverter/converter topologies
4. Use power electronic simulation packages to develop the power converter topologies

List of Experiments:

1. To study Single phase diode clamped multilevel inverter.
2. To study Single phase flying capacitor multilevel inverter.
3. To study Single phase cascaded multilevel inverter.
4. To study Push pull converter.
5. To study Fly back converter.
6. To study Forward converter.
7. To study Series resonant converter.
8. To study ZVS.
9. Experimental study of Single Phase full converter using R, RL and E loads.
10. Experimental study of Three Phase full converter using R, RL and E loads.
11. Experimental study of Three Phase semi converter using R, RL and E loads.
12. Experimental study of Single phase AC Voltage controller using R and RL loads.
13. Experimental study of Single Phase Cyclo-converter using RL load.
14. Experimental study of Buck and Boost regulators.

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POWER ELECTRONICS

M.Tech II Semester **L/P/C**
2/0/0

ENGLISH FOR RESEARCH PAPER WRITING (AUDIT-I)

Course Objectives:

To make the students

1. understand how to improve their writing skills and level of readability.
2. learn about what to write in each section.
3. understand the skills needed when writing a Title and ensure the good quality of paper at the time of the first submission itself.

Course outcomes:

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

1. To structure sentences and paragraph with grammatical accuracy
2. To prepare abstracts and introductions, review literature ,incorporate data ,sight references ,and prepare bibliography according to the requirements of their thesis or research paper
3. To avoid plagiarism and and ambiguity and use techniques like hedging while improvising their research papers.

UNIT I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

TEXT BOOKS:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

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M.Tech II Semester **L/P/C**
2/0/0

DISASTER MANAGEMENT (AUDIT-I)

Course Objectives:

1. To provide basic conceptual understanding of disasters and its relationships with development.
2. To gain understand approaches of Disaster Risk Reduction (DRR) and the relationship between vulnerability, disasters, disaster prevention and risk reduction.
3. To enhance awareness of Disaster Risk Management institutional processes in India
4. To build skills to respond to disasters.

Course Outcomes:

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

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches.
5. planning and planning and programming in different countries, particularly their home country or the countries they work in.

UNIT I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II

Repercussions of Disasters and Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Eco system. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III

Disaster Prone Areas in India: Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post- Disaster Diseases and Epidemics

UNIT IV

Disaster Preparedness and Management: Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.
Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.

TEXT BOOKS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

REFERENCE BOOK:

1. Goel S. L. Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

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M.Tech II Semester **L/P/C**
2/0/0

SANSKRIT FOR TECHNICAL KNOWLEDGE (AUDIT-I)

Course Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes:

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

1. Understanding basic Sanskrit language.
2. Ancient Sanskrit literature about science & technology can be understood.
3. Being a logical language will help to develop logic in students.

UNIT I

Alphabets in Sanskrit.

UNIT II

Past/Present/Future Tense, Simple Sentences.

UNIT III

Order, Introduction of roots.

UNIT IV

Technical information about Sanskrit Literature.

UNIT V

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

TEXT BOOKS:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

REFERENCE BOOK:

1. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

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M.Tech II Semester **L/P/C**
2/0/0

VALUE EDUCATION (AUDIT-I)

Course Objectives:

1. Understand value of education and self- development.
2. Imbibe good values in students.
3. Let the should know about the importance of character.

Course Outcomes:

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

1. Knowledge of self-development.
2. Learn the importance of Human values.
3. Developing the overall personality.

UNIT I

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments.

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature ,Discipline.

UNIT III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

UNIT IV

Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

UNIT V

Character and Competence –Holy books vs. Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence ,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TEXT BOOKS:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

REFERENCE BOOKS:

1. “Value Education The Indian Tradition” , by D.P.Mukharjee, Bhavans Book University.
2. “Value Education ”, by Jagadish C.

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POWER ELECTRONICS

M.Tech III Semester **L/P/C 3/0/3**

1. BUSINESS ANALYTICS (OE) (B223OE1)

Course Objectives:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes:

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

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT I

Business Analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

UNIT II

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, News vendor Model, Overbooking Model, Cash Budget Model.

UNIT V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TEXT BOOKS:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G.Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

REFERENCE BOOKS:

1. Business Analytics with Management Science Models and Methods by Arbeen Asllani,Pearson
2. Business Analytics: Data Analysis And Decision Making, by Albright and Winston 5th Edn, Cingage.
3. R for Business Analytics, by A.Ohri.

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M.Tech III Semester **L/P/C 3/0/3**

2. INDUSTRIAL SAFETY (OE) (B223OE1)

Course Objectives:

1. Analyze the safety measures in industry
2. Identifying the corrosion and their prevention techniques
3. Different types of faults associated in industry and their prevention

Course Outcomes:

At the end of the course, the student should be able to

1. Classify types of hazards and safety measures
2. Practice of maintenance measures
3. Analyze corrosion and prevention techniques
4. Find the problems and their importance

UNIT I

Industrial Safety: Accident, causes, types, results and control, mechanical and Electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

UNIT II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear Reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need And applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

TEXT BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

REFERENCE BOOKS:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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3/0/3

3. OPERATIONAL RESEARCH (OE) (B223OE1)

Course Objectives:

1. .To impart knowledge in concepts and tools of Operations Research.
2. To understand mathematical models used in Operations Research.
3. To apply these techniques constructively to make effective business decision.

Course Outcomes:

At the end of the course, the student should be able to
1. Solve Linear Programming Problems.
2. Solve Transportation and Assignment Problems.
3. Understand the usage of game theory and Simulation for Solving Business Problems.

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory – dual simplex method - sensitivity analysis - parametric programming.

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem – max flow problem - CPM/PERT.

UNIT IV

Scheduling and sequencing - single server and multiple server models – deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

TEXT BOOKS:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

REFERENCE BOOKS:

1. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
2. Hitler Libermann Operations Research: McGraw Hill Pub. 2009.
3. Pannerselvam, Operations Research: Prentice Hall of India 2010.
4. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

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M.Tech III Semester **L/P/C**
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4. COST MANAGEMENT OF ENGINEERING PROJECTS (OE) (B2230E1)

Course Objectives:

1. To apply modern software packages to conduct analysis of real world data.
2. To understand the technical underpinning of engineering economic analysis.
3. The ability to apply the appropriate analytical techniques to a wide variety of real world problems and data sets.
4. To summarize and present the analysis results in a clear and coherent manner.

Course Outcomes:

At the end of the course, the student should be able to

1. Understand project characteristics and various stages of a project.
2. Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
3. Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
4. Apply the risk management plan and analyse the role of stakeholders.
5. Understand the contract management, Project Procurement, Service level Agreements and productivity.
6. Understand the How Subcontract Administration and Control are practiced in the Industry.

UNIT I

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of aCosting System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT III

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT IV

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

TEXT BOOKS:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi.
2. Charles T. Horngren and George Foster, Advanced Management Accounting.

REFERENCE BOOKS:

1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.
3. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

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5. COMPOSITE MATERIALS (OE) (B223OE1)

Course Objectives:

1. Explain the behavior of constituents in the composite materials.
2. Enlighten the students in different types of reinforcement.
3. Develop the student's skills in understanding the different manufacturing methods available for composite material.
4. Illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.

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

1. Explain the mechanical behavior of layered composites compared to isotropic materials.
2. Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.
3. Determine stresses and strains relation in composites materials.

UNIT I

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT III

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding –Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs– hand layup method – Autoclave method – Filament winding method – Compression moulding –Reaction injection moulding. Properties and applications.

UNIT V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCE BOOKS:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W.Tasi.

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6. ENERGY FROM WASTE (OE) (B223OE1)

Course Objectives:

1. To enable students to understand of the concept of Waste to Energy.
2. To link legal, technical and management principles for production of energy form waste.
3. To learn about the best available technologies for waste to energy.
4. To analyze of case studies for understanding success and failures.
5. To facilitate the students in developing skills in the decision making process

Course Outcomes:

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

1. Apply the knowledge about the operations of Waste to Energy Plants.
2. Analyse the various aspects of Waste to Energy Management Systems.
3. Carry out Techno-economic feasibility for Waste to Energy Plants.
4. Apply the knowledge in planning and operations of Waste to Energy plants.

UNIT I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yieldsand application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidizedbed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and Their classification - Biomass conversion processes - Thermo chemical conversion – Direct combustion -biomass gasification - pyrolysis and liquefaction - biochemical conversion -anaerobic digestion Types of biogas Plants – Applications - Alcohol production from biomass -Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TEXT BOOKS:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

REFERENCE BOOKS:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. Were Ko-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

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RESEARCH METHODOLOGY AND IPR (B223RM2)

Course Objectives:

1. To understand the research problem.
2. To know the literature studies, plagiarism and ethics.
3. To get the knowledge about technical writing.
4. To analyze the nature of intellectual property rights and new developments.
5. To know the patent rights.

Course Outcomes:

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information.
3. Follow research ethics.
4. Understand that today's world is controlled by Computer, Information Technology, But tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals &nation, it is needless to emphasis the need of information about Intellectual Property
6. Right to be promoted among students in general & engineering in particular.
7. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations. Effective literature studies approaches, analysis Plagiarism, Research ethics

UNIT II

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and data bases. Geographical Indications.

UNIT V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction.

REFERENCE BOOKS:

1. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall , "Industrial Design", McGraw Hill, 1992.
4. Niebel , "Product Design", McGraw Hill, 1974.
5. Asimov , "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

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CONSTITUTION OF INDIA (AUDIT-II)

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes:

At the end of this course, students will be able to

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the Conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

UNIT I

History of Making of The Indian Constitution: History Drafting Committee, (Composition& Working).
Philosophy of The Indian Constitution: Preamble, Salient Features.

UNIT II

Contours of Constitutional Rights & Duties: Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

UNIT IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

TEXT BOOKS:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

REFERENCE BOOKS:

1. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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PEDAGOGY STUDIES (AUDIT-II)

Course Objectives:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes:

At the end of this course, students will be able to

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

UNIT II

Thematic Overview: Pedagogical practices are being used by teachers informal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT III

Evidence on the Effectiveness of Pedagogical Practices, Methodology for the in Depth Stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the schocurriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers attitudes and beliefs and Pedagogic strategies.

UNIT IV

Professional Development: alignment with classroom practices and follow up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

UNIT V

Research Gaps and Future Directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

TEXT BOOKS:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

REFERENCE BOOKS:

1. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
3. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
4. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
5. www.pratham.org/images/resource%20working%20paper%202.pdf.

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STRESS MANGEMENT BY YOGA (AUDIT- II)

Course Objectives:

1. To achieve overall health of body and mind.
2. To overcome stress.

Course Outcomes:

Students will be able to
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

UNIT I

Definitions of Eight parts of yog.(Ashtanga).

UNIT II

Yam and Niyam.

UNIT III

Do`s and Dont's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT IV

Asan and Pranayam

UNIT V

i) Various yog poses and their benefits for mind & body
ii)Regularization of breathing techniques and its effects-Types of pranayam

TEXT BOOKS:
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami YogabhyasiMandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

REFERENCE BOOKS:
1. ' Stress and Its Mangaement by Yoga": by K. N. Udupa and R.C Prasad.

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PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (AUDIT- II)

Course Objectives:

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.

Course Outcomes:

At the end of this course, students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
3. Study of Neetishatakam will help in developing versatile personality of students.

UNIT I

Neetisatakam-Holistic development of personality

1. Verses- 19,20,21,22 (wisdom)
2. Verses- 29,31,32 (pride & heroism)
3. Verses- 26,28,63,65 (virtue)

UNIT II

Neetisatakam-Holistic development of personality

1. Verses- 52,53,59 (dont's)
2. Verses- 71,73,75,78 (do's)

UNIT III

Approach to day to day work and duties.

1. ShrimadBhagwadGeeta : Chapter 2-Verses 41, 47,48,
2. Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
3. Chapter 18-Verses 45, 46, 48.

UNIT IV

Statements of basic knowledge.

1. ShrimadBhagwadGeeta: Chapter2-Verses 56, 62, 68.
2. Chapter 12 -Verses 13, 14, 15, 16, 17, 18.
3. Personality of Role model. Shrimad Bhagwad Geeta:

UNIT V

1. Chapter2-Verses 17, Chapter 3-Verses 36, 37, 42.
2. Chapter 4-Verses 18, 38, 39.
3. Chapter18 – Verses 37, 38, 63.

TEXT BOOKS:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

REFERENCE BOOKS:

1. "Personality Development and soft skills" by Barun K. Mitra, 2nd Edition, Oxford Publishers.