TKR COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)
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M. TECH- POWER ELECTRONICS
(Applicable for the Batch admitted from the Academic Year 2022-23 onwards)

(R22) COURSE STRUCTURE AND SYLLABUS

I YEAR I SEMESTER

			L	T	P	Credits
Sr.No	**Core/Elective**	**Course Name**				
1.	D121PC1	Advanced Power Electronic Converters-I	3	0	0	3
2.	D121PC2	Electrical Drives	3	0	0	3
3.	D121PE3	1. Machine Modelling and Analysis 2. Microcontroller Applications to Power Electronics 3. Smart Grid Technologies 4. Modern Control Theory	3	0	0	3
4.	D121PE4	1. Power Semiconductor Devices and Modelling 2. Reactive Power Compensation and Management 3. High Frequency Magnetic Components 4. Electric Vehicles and Design	3	0	0	3
5.	D121RM5	Research Methodology & IPR	2	0	0	2
6.	D121PC6	Advanced Power Electronic Converters Lab-I	0	0	4	2
7.	D121PC7	Electrical Drives Lab	0	0	4	2
8.	Audit-I	Audit Course-I	2	0	0	0
		Total Credits	**16**	**0**	**8**	**18**

I YEAR II SEMESTER

			L	T	P	Credits
Sr.No	**Core/Elective**	**Course Name**				
1.	D122PC1	Advanced Power Electronic Converters-II	3	0	0	3
2.	D122PC2	Power Electronics Application to Power Systems	3	0	0	3
3.	D122PE3	1. Industrial Load Modelling and Control 2. Advanced Digital Signal Processing 3. Power Quality Improvement Techniques 4. Power Electronics for Renewable Energy Systems	3	0	0	3
4.	D122PE4	1. DSP based Drive Control 2. Distributed Generation 3. Electric Vehicle Charging Techniques 4. Electromagnetic interference and compatibility	3	0	0	3
5.	MPWS	Mini Project with Seminar	0	0	4	2
6.	D122PC6	Advanced Power Electronic Converters Lab-II	0	0	4	2
7.	D122PC7	Power Electronics Application to Power Systems Lab	0	0	4	2
8.	Audit-II	Audit Course-II	2	0	0	0
		Total Credits	**14**	**0**	**12**	**18**

II YEAR I SEMESTER

			L	T	P	Credits
Sr.No	**Core/Elective**	**Course Name**				
1.	D223PE1	1. Reliability Engineering 2. Dynamics of Electrical Machines 3. Energy Storage Technologies 4. SCADA Systems and Applications	3	0	0	3
2.	D223OE2	1. Business Analytics 2. Operations Research 3. Cost Management of Engineering Projects 4. Photovoltaic Systems	3	0	0	3
3.	Dissertation	Dissertation Stage-I	0	0	12	6
		Total Credits	**6**	**0**	**12**	**12**

II YEAR II SEMESTER

			L	T	P	Credits
Sr.No	**Core/Elective**	**Course Name**				
1.	Dissertation	Dissertation Stage-II	0	0	12	6
2.	Dissertation	Dissertation Viva-Voce	0	0	28	14
		Total Credits	**0**	**0**	**40**	**20**

***For Dissertation Work Review - I, please refer 7.10 in R22 Academic Regulations.**

Open Elective

1. Business Analytics (Offered by **CSE** Department)
2. Operations Research (Offered by **Mechanical Engineering** Department)
3. Cost Management of Engineering Projects (Offered by **Civil Engineering** Department)
4. Photovoltaic Systems (Offered by **EEE** Department)

Audit Course I & II

1. English for Research Paper Writing.
2. Disaster Management.
3. Sanskrit for Technical Knowledge.
4. Value Education.
5. Constitution of India.
6. Pedagogy Studies.
7. Stress Management by Yoga.
8. Personality Development through Life Enlightenment Skills.

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L	T	P	C
3	0	0	3

ADVANCED POWER ELECTRONIC CONVERTERS-I

(D121PC1**)**

Prerequisite: Power Electronics

Course Objectives:

- To understand various advanced power electronic devices.
- To comprehend the design of rectifiers and inverters.
- To understand the operation of multi-level inverters with switching strategies for high power applications.

Course Outcomes: After completion of the course, students will be able to:

- Develop and analyze various converter topologies.
- Use power electronic simulation packages for analyzing and designing power converters.

UNIT-I:

MODERN POWER SEMICONDUCTOR DEVICES

Modern power semiconductor devices: Symbol, Structure and equivalent circuit ofInsulated Gate Bipolar Transistor (IGBT), MOSFET, MOS Turn off Thyristor (MTO), Emitter Turn off Thyristor (ETO), Integrated Gate-Commutated Thyristor (IGCTs), MOS-controlled thyristors (MCTs), Power Integrated Circuits (PICs). Comparison of their features.

UNIT-II:

SINGLE PHASE & 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 Techniques, Extinction angle control, Symmetrical angle control, Single phase sinusoidal PWM, Single phase series converters, Overlap analysis, Applications & Problems.

Three phase converters: Half controlled and fully controlled converters, Evaluation of input power factor and harmonic factor, Continuous and Discontinuous load current, Three phase dual converters, Power factor Improvements Techniques, Three phase PWM, Twelve pulse converters, Applications &Problems.

UNIT-III:

PULSE WIDTH MODULATED INVERTERS

Principle of operation, Performance parameters, Single phase bridge inverter, Evaluation of output voltage and current with resistive, inductive and capacitive loads, Voltage control of single phase inverters, Single PWM, Multiple PWM, Sinusoidal PWM, Modified PWM, Phase displacement Control, Advanced modulation techniques for improved performance, Trapezoidal, Staircase, Stepped, Harmonic injection and Delta modulation, Advantages, Applications & Problems.

UNIT-IV

THREE PHASE INVERTERS

Introduction to Three phase inverter, Analysis of 180 degree conduction for output voltage And current with resistive, inductive loads, Analysis of 120 degree Conduction, Voltage control of three phase inverters, Sinusoidal PWM, Third Harmonic PWM, 60 degree PWM, Space vector modulation, Comparison of PWM techniques, Harmonic reductions, Problems.

UNIT-V

MULTILEVEL INVERTERS

Multilevel concept, Classification of multilevel inverters, Principle of operation, main features and comparison of Diode clamped, Improved diode Clamped, Flying capacitors, Cascaded multilevel inverters, Multilevel inverter applications, Reactive power compensation, Back to back intertie system, Adjustable drives, Switching device currents, DC link capacitor voltage balancing.

TEXTBOOKS:

1. Mohammed H. Rashid, “Power Electronics”, Pearson Education, 3rd Edition, 1st Indian reprint2004.
2. Ned Mohan Tore M. Undeland and William P. Robbins, “Power Electronics”, John Wiley & Sons, 2nd Edition.

REFERENCES:

1. Milliman Shepherd and Lizang, "Power converters circuits", Chapter 14 (Matrix converter) PP-415-444,
2. M.H.Rashid, "Power Electronics hand book".
3. Marian P. Kaźmierkowski, Ramu Krishnan, Frede Blabjerg Edition, "Control in Power electronics", Published by Academic Press, 2002.

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3	0	0	3

ELECTRICAL DRIVES
(D121PC2**)**

Prerequisite: Power Electronic Converters, Electrical Machines

Course Objectives:

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

Course Outcomes: After completion of the course, students will be able to:

- Develop induction motor for variable speed operations using scalar and vector control techniques.
- Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.
- Develop controllers for synchronous motor and variable reluctance motor.

UNIT–I:

RECTIFIER CONTROLLED DC MOTOR

Separately excited DC motors and DC series motors with single phase semi converter and single phase full converter, 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, load and converter.

CLOSED LOOP CONTROL OF DC DRIVE

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 flowchart for simulation, Harmonics and associated problems, Sixth harmonics torque.

UNIT–II:

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.

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–III:

CONTROL OF INDUCTION MOTOR

Introduction to motor drive, Torque production, Equivalent circuit analysis, Speed – Torque characteristics with Variable voltage, Variable frequency, Constant v/f, Variable stator current operation, Induction motor characteristics in constant torque and field weakening regions.

STATOR SIDE CONTROL

Scalar control, Voltage fed inverter control, Open loop v/f control, Speed control slip regulation, Speed control with torque and flux control, Current controlled voltage fed inverter drive.

ROTOR SIDE CONTROL OF INDUCTION MOTOR DRIVES

Slip power recovery drives, Static Kramer Drive, Phasor diagram, Torque expression, Speed control of Kramer Drive, Static Scheribus Drive, and Modes of operation.

UNIT–IV:

VECTOR CONTROL OF INDUCTION MOTOR DRIVES

Principles of Vector control, Direct and Indirect methods of vector control, Adaptive control principles, Self tuning regulator Model referencing control, Direct torque control of AC motors.

UNIT–V:

CONTROL OF PERMENANT MAGNET SYNCHRONOUS MOTOR DRIVES

Synchronous motor and its characteristic, Control strategies, Constant torque angle control, Unity power factor control, Constant mutual flux linkage control, Closed loop operation.

TEXTBOOKS:

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

REFERENCES:

1. MD Murthy and FG Turn, "Power Electronics and Control of AC Motors", Bull Pergman Press 1stEdition.
2. BK Bose, "Power Electronics and AC Drives", Prentice Hall Eagle wood diffs New Jersey, 1st Edition.
3. M H Rashid, "Power Electronic circuits Deices and Applications", PHI, 1995.
4. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa publications, 1995.

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L	T	P	C
3	0	0	3

MACHINE MODELLING AND ANALYSIS

(D121PE3**)**

Prerequisite: Electrical Machines

Course Objectives:

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

Course Outcomes: After completion of the course, students will be able to:

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

UNIT-I:

Basic Two-pole DC machine, Primitive 2-axis machine, Voltage and Current relationship, Torque equation. 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-II:

Linear 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, "d-q" model based DOL starting of induction motors.

UNIT-III:

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-IV:

Circuit model of a 3-phase Synchronous motor, two- axis representation of Synchronous Motor. Voltage and current Equations in state – space variable form, Torque equation, and "dq" model based short circuit fault analysis, Emphasis on voltage, Frequency and recovery time.

UNIT-V:

Modeling of Permanent Magnet Synchronous motor, Modeling of Brushless DC Motor.

TEXTBOOKS:

1. P.S. Bimbhra, "Generalized Machine theory", Khanna Publishers.
2. Paul C. Krause, Oleg wasynezuk, Scott D. Sudhoff, "Analysis of electric machinery and Drives systems".

REFERENCES:

1. Vedam Subranmanyam, "Thyristor control of Electric Drives".
2. Prabha Kundur, "Power System Stability and Control", EPRI.
3. Article in IEEE Transactions on Energy Conversion, "Performance optimization of induction motors during Voltage-controlled soft starting", July, 2004.
4. Nithin K.S, Dr.Bos Mathew Jos, Muhammed Rafeek, Dr.Babu Paul, "A Novel Method for Starting of Induction Motor with Improved Transient Torque Pulsations", International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 8, February 2013.

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3	0	0	3

MICROCONTROLLER APPLICATIONS TO POWER ELECTRONICS
(D121PE3**)**

Prerequisite: Power Electronics and Renewable Energy Systems

Course Objectives:

- To study the internal structure and operation of PIC 16F876 microcontroller and 8051 microcontrollers
- To know assembly language program for the generation of firing and control signals employing these microcontrollers.

Course Outcomes: After completion of the course, students will be able to:

- Understand the architecture of 8051 and 16F876 microcontrollers.
- Develop assembly language programs employing 8051 & 16F876 microcontrollers.
- Analyze the microcontroller programming using MPLAB and develop typical programs for power converter applications.

UNIT-I

8051 microcontrollers: Architecture, Addressing modes, I/O ports, Instruction sets, Simple assembly language programming.

UNIT-II

Use of microcontrollers for pulse generation in power converters, Overview of Zero-Crossing Detectors, Typical firing/gate-drive circuits, Firing/gate pulses for typical single-phase and three-phase power converters.

UNIT III

PIC16F876 Micro-controller: Device overview, Pin diagrams, Memory organization, Special Function Registers, I/O ports, Timers, Capture/ Compare/ PWM modules (CCP).

UNIT-IV

Analog to Digital Converter module, Instruction set, Instruction description, Introduction to PIC microcontroller programming, Oscillator selection, Reset, Interrupts, Watch dog timer.

UNIT-V

Introduction to MPLAB IDE and PICSTART plus, Device Programming using MPLAB and PICSTART plus, Generation of firing / gating pulses for typical power converters.

TEXTBOOKS:

1. S. N. Bhadra, D.Kastha, S.Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.
2. B.H.Khan, “Non-conventional Energy sources”, Tata McGraw-hill Publishing Company, New Delhi, 2009.

REFERENCES:

1. Rashid .M. H, “Power electronics Hand book”, Academic press, 2001.
2. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
3. Rai. G.D, “Non-conventional energy sources”, Khanna Publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, Prentice Hall linc, 1995.
5. Andrzej M. Trzynnadlowski, “Introduction to Modern Power Electronics”, 2nd Edition, Wiley India Pvt. Ltd, 2012.

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SMART GRID TECHNOLOGIES
(D121PE3**)**

Prerequisite: Power Systems

Course Objectives:

- To understand concept of smart grid and its advantages over conventional grid
- To know smart metering techniques
- To learn wide area measurement techniques
- To understand the problems associated with integration of distributed generation & its solutionthrough smart grid.

Course Outcomes: After completion of the course, students will be able to:

- Appreciate the difference between smart grid & conventional grid
- Apply smart metering concepts to industrial and commercial installations
- Formulate solutions in the areas of smart substations, distributed generation and wide area measurements
- Come up with smart grid solutions using modern communication technologies

UNIT-I:

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid Present development & International policies in Smart Grid

UNIT-II:

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation.

UNIT-III:

Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).

UNIT-IV:

Concept of micro-grid, Need& applications of micro-grid, Formation of micro-grid, Issues of interconnection, Protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, Fuel-cells, micro-turbines, Captive power plants, Integration of renewable energy sources.

UNIT-V:

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. Advanced Metering Infrastructure (AMI) and Various Communication means and IP based Protocols.

TEXTBOOKS:

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE, 2011.
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press, 2009.

REFERENCES:

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, “Smart Grid: Technology and Applications”,Wiley, 2012.
2. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions”, CRC Press.
3. A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer.

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3	0	0	3

MODERN CONTROL THEORY
(D121PE3**)**

Prerequisite: Control Systems

Course Objectives:

- To explain the concepts of basics and modern control system for the real time analysis and design of control systems.
- To explain the concepts of state variables analysis.
- To study and analyze nonlinear systems.
- To analyze the concept of stability for nonlinear systems and their categorization.

Course Outcomes: After completion of the course, students will be able to:

- Know various terms of basic and modern control system for the real time analysis and design of control systems.
- Perform state variables analysis for any real time system.
- Examine a system for its stability, controllability and observability.
- Implement basic principles and techniques in designing linear control systems.
- Apply knowledge of control theory for practical implementations in engineering and network analysis.

UNIT I:
MATHEMATICAL PRELIMINARIES AND STATE VARIABLE ANALYSIS

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 systems, The concept of state, State space model of Dynamic systems, Time invariance and Linearity, Non uniqueness of state model, State diagrams for Continuous-Time State models, Existence and Uniqueness of Solutions to Continuous-Time State Equations, Solutions of Linear Time Invariant Continuous-Time State Equations, State transition matrix and it's properties.

Complete solution of state space model due to zero input and due to zero state.

UNIT II:
CONTROLLABILITY AND OBSERVABILITY

General concept of controllability, Controllability tests, Different state transformations such as diagonalization, Jordon canonical forms and Controllability canonical forms for Continuous-Time Invariant Systems, General concept of Observability, Observability tests for Continuous-Time Invariant Systems, Observability of different State transformation forms.

UNIT III:
STATE FEEDBACK CONTROLLERS AND OBSERVERS

State feedback controller design through Pole Assignment, using Ackkermans formula.

State observers: Full order and Reduced order observers.

UNIT IV:
NON-LINEAR SYSTEMS

Introduction to Non-Linear Systems, Types of Non-Linearities, Saturation, Dead-Zone, Backlash, Jump Phenomenon etc., Linearization of nonlinear systems, Singular Points and its types, Describing function, Describing function of different types of nonlinear elements, Stability analysis of Non-Linear systems through describing functions.

Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

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.

TEXTBOOKS:

1. M.Gopal, “Modern Control System Theory”, New Age International, 1984.
2. Ogata. K, “Modern Control Engineering”, Prentice Hall, 1997.

REFERENCES:

1. N K Sinha, “Control Systems”, New Age International, 3rd Edition.
2. Donald E.Kirk, “Optimal Control Theory an Introduction”, Prentice Hall Network series, 1stEdition.

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POWER SEMICONDUCTOR DEVCES AND MODELLING
(D121PE4**)**

Prerequisite: Power Electronics

Course Objectives:

- To improve power semiconductor device structures for adjustable speed motor control applications.
- To understand the static and dynamic characteristics of current controlled power semiconductor devices.
- To understand the static and dynamic characteristics of voltage- controlled power semiconductor devices.
- To enable for the selection of devices for different power electronic applications.
- To understand the control and firing circuit for different devices.

Course Outcomes: After completion of the course, students will be able to:

- Know the operating characteristics of various basic semiconductor devices and switches
- Understand the advanced power semiconductor devices operation.
- Know the modeling of basic and advanced semiconductor devices and switches through simulation.
- Analyze the applications of various power semiconductor switches.

UNIT-I:

POWER DIODES

Basic structure and V-I characteristics, Breakdown voltages and control, On-state losses, switching characteristics, Turn-on, Turn off and reverse recovery transient, Schottky diodes, Snubber requirements for diodes, Diode snubber, Modelling and simulation of Power diodes.

POWER BJT'S

Basic structure and V-I characteristics, Breakdown voltages and control, Secondary breakdown and its control, FBSOA and RBSOA curves, On-state losses, switching characteristics, Resistive switching specifications, clamped inductive switching specifications, Turn-on and turn off transient, Storage time, Base drive requirements, switching losses, device protection, Snubber requirements for BJT's and snubber design, Switching aids, Modeling and simulation of power BJT'S.

UNIT-II:

SILICON CONTROLLED RECTIFIERS (THYRISTORS)

Basic structure, V-I characteristics, Turn-on process, On-state operation, Turn-off process, Switching characteristics, Turn-on transient and di/dt limitations, Turn-off transient, Turnoff time and re-applied dv/dt limitations, Gate drive requirements, Ratings of thyristors, Snubber requirements and snubber design, Modelling and simulation of Thyristor.

TRIACS

Basic structure and operation, V-I characteristics, Ratings, Snubber requirements, Modelling and simulation of triacs.

UNIT-III:

GATE TURNOFF THYRISTOR (GTO)

Basic structure and operation, GTO switching characteristics, GTO turn-on transient, GTO turn-off transient, Minimum on and off state times, Gate drive requirements, Maximum controllable anode current, Overcurrent protection of GTO'S, Modelling and simulation of GTO'S.

POWER MOSFET's

Basic structure, V-I characteristics, Turn-on process, On state operation, Turnoff process, Switching characteristics, Resistive switching specifications, Clamped inductive switching specifications, Turn-on transient and di/dt limitations, Turn-off transient, Turn off time, Switching losses, Effect of reverse recovery transients on switching stresses and losses, dv/dt limitations, Gating requirements, Gate charge, Ratings of MOSFET'S, FBSOA and RBSOA curves, Device protection, Snubber requirements, Modeling and simulation of Power MOSFET'S.

UNIT-IV:

INSULATED GATE BIPOLAR TRANSISTOR's (IGBT's)

Basic structure and operation, latch up IGBT, switching characteristics, Resistive switching specifications, clamped inductive switching specification, IGBT turn-on and turn off transient, Current tailing, Gating requirements, Ratings of IGBT'S, FBSOA and RBSOA curves, switching losses, Minimum on and off state times, Switching frequency capability, Overcurrent protection of IGBT'S, Short circuit protection, Snubber requirements and snubber design.

UNIT-V:

ADVANCED POWER SEMICONDUCTOR DEVICES

MOS gated thyristors, MOS controlled thyristors or MOS GTO'S, Base resistance-controlled thyristors, Emitter switched thyristor, Thermal design of power electronic equipment, Modelling and simulation, Heat transfer by conduction, Transient thermal impedance, Heat sinks, Heat transfer by radiation and convection, Heat sink selection for power semiconductor devices.

TEXTBOOKS:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition, Wiley India Pvt Ltd, 2011.
2. G. Massobrio, P. Antognetti, "Semiconductor Device Modeling with Spice", McGrawHill, 2nd Edition, 2010.

REFERENCES:

1. B. Jayant Baliga, "Power Semiconductor Devices", 1st Edition, International Thompson Computer Press, 1995.
2. V. Benda, J. Gowar, and D. A. Grant, "Discrete and Integrated Power Semiconductor Devices: Theory and Applications", John Wiley & Sons, 1999.

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3	0	0	3

REACTIVE POWER COMPENSATION AND MANAGEMENT

(D121PE4**)**

Prerequisite: Power Systems

Course Objectives:

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management.

Course Outcomes: After completion of the course, students will be able to:

- Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads
- Work out on various compensation methods in transmission lines
- Construct models for reactive power coordination
- Distinguish demand side reactive power management & user side reactive power management

UNIT-I:

LOAD COMPENSATION

Objectives and specifications, Reactive power characteristics, Inductive and capacitive approximate biasing, Load compensator as a voltage regulator, Phase balancing and power factor correction of unsymmetrical loads, Examples.

UNIT-II:

STEADY–STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS

Uncompensated line, Types of compensation, Passive shunt and series and dynamic shunt compensation, Examples.

TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS

Characteristic time periods, Passive shunt compensation, Static compensation, Series capacitor compensation, Compensation using synchronous condenser, Examples.

UNIT-III:

REACTIVE POWER COORDINATION

Objective, Mathematical modeling, Operation planning, Transmission benefits, Basic concepts of quality of power supply, Disturbances, Steady–state variations, Effect of under-voltages, Frequency, Harmonics, Radio frequency and electromagnetic interference.

UNIT-IV:

DEMAND SIDE MANAGEMENT

Load patterns, Basic methods load shaping, Power tariffs, KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.

DISTRIBUTION SIDE REACTIVE POWER MANAGEMENT

System losses, Loss reduction methods, Examples, Reactive power planning, Objectives, Economics Planning capacitor placement, Retrofitting of capacitor banks.

UNIT-V:

USER SIDE REACTIVE POWER MANAGEMENT

KVAR requirements for domestic appliances, Purpose of using capacitors, Selection of capacitors, Deciding factors, Types of available capacitor, Characteristics and Limitations.

REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES

Typical layout of traction systems, Reactive power control requirements, Distribution transformers, Electric arc furnaces, Basic operation, Furnaces transformer, Filter requirements, Remedial measures, Power factor of an arc furnace.

TEXTBOOKS:

1. T.J.E.Miller, “Reactive power control in Electric power systems”, John Wiley and sons, 1982.
2. D.M. Tagare,” Reactive power Management”, Tata McGraw Hill, 2004.

REFERENCES:

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just, “Reactive Power Compensation: A Practical Guide”, Wiley Publication, April2012.

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M. Tech – I Semester

L	T	P	C
3	0	0	3

HIGH FREQUENCY MAGNETIC COMPONENTS
(D121PE4**)**

Prerequisite: None

Course Objectives:

- To have a knowledge on magnetic circuits
- To know the skin effect and proximity effect

Course Outcomes: After completion of the course, students will be able to:

- Design of magnetic components (i.e., inductor and transformer) in a converter.
- Perform steady-state analysis of switched mode power supply.
- Understand core loss in an electromagnetic device, recognize& describe its effect.
- Describe the engineering uses of electromagnetic waves, by frequency band, and the respective hazards associated with them.

UNIT-I:

FUNDAMENTALS OF MAGNETIC DEVICES

Introduction, Magnetic Relationships, Magnetic Circuits, Magnetic Laws, Eddy Currents, Core Saturation, Volt-Second Balance, Inductance, Inductance Factor, Magnetic Energy, Self-Resonant Frequency, Classification of Power Losses in Magnetic Components, Non-inductive Coils.

MAGNETIC CORES

Introduction, Properties of Core Materials, Magnetic Dipoles, Magnetic Domains, Curie Temperature, Magnetization, Magnetic Materials, Hysteresis, Core Permeability, Core Geometries, Iron Alloy Cores, Amorphous Alloy Cores, Nickel–Iron and Cobalt–Iron Cores, Ferrite Cores, Powder Cores, Nano-crystalline Cores, Superconductors, Hysteresis Core Loss, Eddy-Current Core Loss, Total Core Loss, Complex Permeability.

UNIT-II:

SKIN EFFECT & PROXIMITY EFFECT

Introduction, Magnet Wire, Wire Insulation, Skin Depth, Ratio of AC-to-DC Winding Resistance, Skin Effect in Long Single Round Conductor, Current Density in Single Round Conductor, Impedance of Round Conductor, Magnetic Field Intensity for Round Wire, Other Methods of Determining the Round Wire Inductance, Power Density in Round Conductor, Skin Effect on Single Rectangular Plate. Proximity and Skin Effects in Two Parallel Plates, Anti-proximity and Skin Effects in Two Parallel Plates, Proximity Effect in Multiple-Layer Inductor, Appendix: Derivation of Proximity Power Loss.

WINDING RESISTANCE AT HIGH FREQUENCIES

Introduction, Winding Resistance, Square and Round Conductors, Winding Resistance of Rectangular Conductor, Winding Resistance of Square Wire, Winding Resistance of Round Wire, Leakage Inductance, Solution for Round Conductor Winding in Cylindrical Coordinates, Litz Wire, Winding Power Loss for Inductor Current with Harmonics, Effective Winding Resistance for Non-sinusoidal Inductor Current, Thermal Model of Inductors.

UNIT-III:

TRANSFORMERS

Introduction, Neumann's Formula for Mutual Inductance, Mutual Inductance, Energy Stored in Coupled Inductors, Magnetizing Inductance, Leakage Inductance, Measurement of Transformer Inductances, Stray Capacitance, High-Frequency Transformer Model, Non-interleaved Windings, Interleaved Windings, AC Current Transformers, Winding Power Losses with Harmonics, Thermal Model of Transformers.

DESIGN OF TRANSFORMERS

Introduction, Area Product Method, Optimum Flux Density, Transformer Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in DCM.

UNIT-IV:

INTEGRATED INDUCTORS

Introduction, Resistance of Rectangular Trace, Inductance of Straight Rectangular Trace, Construction of Integrated Inductors, Meander Inductors, Inductance of Straight Round Conductor, Inductance of Circular Round Wire Loop, Inductance of Two-Parallel Wire Loop, Inductance of Rectangle of Round Wire, Inductance of Polygon Round Wire Loop, Bond-wire Inductors, Single-Turn Planar Inductor, Inductance of Planar Square Loop, Planar Spiral Inductors, Multi-metal Spiral Inductors, Planar Transformers, MEMS Inductors, Inductance of Coaxial Cable, Inductance of Two-Wire Transmission Line, Eddy Currents in Integrated Inductors, Model of RF Integrated Inductors, PCB Inductors.

DESIGN OF INDUCTORS

Introduction, Restrictions on Inductors, Window Utilization Factor, Temperature Rise of Inductors, Mean Turn Length of Inductors, Area Product Method, AC Inductor Design, Inductor Design for Buck Converter in CCM, Inductor Design for Buck Converter in DCM method.

UNIT-V:

SELF-CAPACITANCE

Introduction, High-Frequency Inductor Model, Self-Capacitance Components, Capacitance of Parallel-Plate Capacitor, Self-Capacitance of Foil Winding Inductors, Capacitance of Two Parallel Round Conductors, Capacitance of Round Conductor and Conducting Plane, Self-Capacitance of Single-Layer Inductors, Self-Capacitance of Multi-layer Inductors, Capacitance of Coaxial Cable.

TEXTBOOKS:

1. Umanand L, Bhat, S.R, “Design of Magnetic Components for Switched Mode Power Converters”, ISBN: 978-81-224-0339-8, Wiley Eastern Publication, 1992.
2. Marian K. Kazimierczuk, “High-Frequency Magnetic Components”, ISBN: 978-0-470-71453-9, John Wiley& Sons, Inc.

REFERENCES:

1. G.C. Chryssis, “High frequency switching power supplies”, McGraw Hill, 1989 (2nd Edition.)
2. Eric Lowdon, “Practical Transformer Design Handbook”, Howard W. Sams & Co., Inc., 1980
3. Thompson, “Electrodynamic Magnetic Suspension.pdf”
4. Witulski, “Introduction to modeling of transformers and coupled inductors”
5. Beattie,“Inductance 101.pdf”
6. P. L. Dowell, “Effects of eddy currents in transformer windings.pdf”
7. Dixon, “Eddy current losses in transformer windings.pdf”
8. J J Ding, J S Buckkeridge, “Design Considerations for A Sustainable Hybrid Energy System” IPENZ Transactions, 2000, Vol. 27, No. 1/EMCh.
9. Texas Instruments, “Windings.pdf”
10. Texas Instruments, “Magnetic core characteristics.pdf”.
11. Ferroxcube, “3f3 ferrite datasheet.pdf”.
12. Ferroxcube, “Ferrite selection guide.pdf”, Magnetics, Inc., Ferrite Cores (www.mag-inc.com).

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3	0	0	3

ELECTRIC VEHICLES AND DESIGN
(D121PE4**)**

Prerequisite: Power Semiconductor Drives, Electrical Drives and Control, Utilization of Electric Energy

Course Objectives:

- To understand the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
- To know the various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used energy storage devices, etc.

Course Outcomes: After completion of the course, students will be able to:

- Understand the models to describe hybrid vehicles and their performance.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

UNIT-I:
INTRODUCTION
Conventional Vehicles: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance.

UNIT-II:
INTRODUCTION TO HYBRID ELECTRIC VEHICLES
History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies.
Hybrid Electric Drive-Trains: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

UNIT-III:
ELECTRIC TRAINS
Electric Drive-Trains: Basic concept of electric traction, introduction to various electric drive train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis.
Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, Drive system efficiency.

UNIT-IV:
ENERGY STORAGE
Energy Storage: Introduction to Energy Storage, Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, Sizing the power electronics, selecting the energy storage technology, Communications, Supporting subsystems.

UNIT-V:
ENERGY MANAGEMENT STRATEGIES
Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, Classification of different energy management strategies, Comparison of different energy management strategies, Implementation issues of energy management strategies.
Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

TEXT BOOKS:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

REFERENCES:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

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2	0	0	2

RESEARCH METHODOLOGY & IPR

(D121RM5)

Prerequisite:

Course Objectives:

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know about the patent rights

Course Outcomes: After completion of the course, students will be able to:

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept and creativity.
- 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 Right to be promoted among students in general & engineering in particular.
- 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.

UNIT-II:

Effective literature studies approaches, Analysis, Plagiarism, Research ethics.

UNIT-III:

Effective technical writing, how to write a report, paper in developing a research proposal, Format of research proposal, A presentation and assessment by a review committee.

UNIT-IV:

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 grant of patents, Patenting under PCT.

UNIT-V:

Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

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".

REFERENCES:

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 TechnologicalAge", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

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L	T	P	C
0	0	4	2

ADVANCED POWER ELECTRONIC CONVERTERS LAB-I
(D121PC6)

Prerequisite: Power Electronic Converters

Course Objectives:

- To simulate various AC-AC, AC-DC, DC-AC converter topologies

Course Outcomes: After completion of the course, students will be able to:

- Design controlled rectifiers
- Design conventional multi-level inverters for industrial applications.

List of Experiments

1. Characteristics of IGBT, MTO, ETO, IGCT, MCT
2. Single phase and three-phase fully controlled converter.
3. Single phase and three-phase Half controlled converter.
4. Single phase Extinction angle control.
5. Single phase symmetrical angle control.
6. Single phase PWM controlled full converter.
7. Sinusoidal pulse width modulated single phase inverter.
8. Sinusoidal pulse width modulated three phase inverter.
9. Space vector modulated three phase inverter.
10. Single phase diode clamped Multi-level inverter.
11. Single phase flying capacitor Multi-level inverter.
12. Single phase cascaded Multi-level inverter.

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

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L	T	P	C
0	0	4	2

ELECTRICAL DRIVES LAB
(D121PC7)

Prerequisite: Power Electronic Devices and Circuits and Electrical Machines

Course Objectives:

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

Course Outcomes: After completion of the course, students will be able to:

- Develop induction motor for variable speed operations using scalar and vector control techniques.
- Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.
- Develop controllers for synchronous motor and variable reluctance motor.

List of Experiments:

1. Speed control of separately excited DC Motor Drive with 1 quadrant chopper
2. Speed control of separately excited DC Motor Drive with 4 quadrant chopper.
3. Speed control of BLDC Motor Drive.
4. Multi-level inverter-based AC Induction Motor Drive control equipment.
5. Speed control of 3-phase wound rotor Induction Motor Drive.
6. Speed control of 3-phase doubly fed Induction Motor Drive.
7. Speed control of 5-phase Induction Motor Drive.
8. Speed control of 3-phase Induction Motor Drive using V/F control.
9. Speed control of 3-phase Induction Motor Drive using Vector Control technique.
10. Speed Measurement and closed loop control using PMDC Motor Drive.
11. Speed measurement and closed loop control of PMDC Motor Drive with thyristor circuit.
12. Matrix Converter
13. Speed measurement and closed loop control of IGBT used single 4 quadrant chopper for PMDC Motor Drive.
14. Isolated Gate Drive circuits for MOSFET / IGBT based circuits.

Note: From the above list, minimum of 10 experiments are to be conducted

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L	T	P	C
3	0	0	3

ADVANCED POWER ELECTRONIC CONVERTERS-II
(D122PC1**)**

Prerequisite: Power Electronics, Power Electronic Converters

Course Objectives:

- To comprehend the concepts of different power converters and their applications
- To analyze and design switched mode regulators for various industrial applications.
- To develop resonant power converters with better performance

Course Outcomes: After completion of the course, students will be able to:

- Select an appropriate power semiconductor device and design a power converter for the required application
- Model existing and modified power converters based on real time applications
- Analyze and design power converters and feedback loops.

UNIT-I:
NON-ISOLATED 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, Problems, State space analysis of regulators.

UNIT-II:
ISOLATED D.C. TO D.C. CONVERTERS
Classification, switched mode dc power supplies, Fly back Converter, Forward converter, Push-pull converter, Half bridge converter, Full bridge converter, Control circuits, Magnetic design considerations, Applications.

UNIT-III:
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, Parallel resonant, Series loaded, Parallel loaded, Series and Parallel loaded inverters, Voltage control of resonant inverters, Class-E resonant inverter, Class-E resonant rectifier, Evaluation of values of 'C' and 'L' for Class-E inverter and Class-E rectifier, Numerical problems.

UNIT-IV:
ZCS & ZVS RESONANT CONVERTERS
Resonant converters, zero current switching resonant converters, L-type and M-type ZCS resonant converter, zero voltage switching resonant converters, Comparison between ZCS and ZVS resonant converters, Two quadrant ZVS resonant converters, Resonant dc-link inverters, Evaluation of 'L' and 'C' for a zero current switching inverter, Numerical problems.

UNIT-V
POWER CONDITIONERS
Power line disturbances, Power conditioners, Uninterruptible Power supplies, Applications
ADVANCED CONVERTERS
Principle of operation of SEPIC converter, Matrix Converter, Luo Converter, Interleaved Converter.

TEXTBOOKS:

1. Mohammed H. Rashid, "Power Electronics", Pearson Education, 3rd Edition, 1st Indian reprint, 2004.
2. Ned Mohan Tore M. Undeland and William P. Robbins, "Power Electronics", John Wiley & Sons, 2nd Edition.

REFERENCES:

1. Milliman Shepherd and Lizang, “Power converters circuits”, Chapter 14 (Matrix converter) pp.415-444.
2. M.H.Rashid,”Power Electronics Hand Book”.
3. Marian P. Kaźmierkowski, Ramu Krishnan, Frede Blabjerg Edition, “Control in Power Electronics”,Published by Academic Press, 2002.

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L	T	P	C
3	0	0	3

POWER ELECTRONICS APPLICATION TO POWER SYSTEMS
(D122PC2)

Prerequisite: Power System, Power Electronics

Course Objectives:

- Understand the basics of formation of bus admittance matrix, modeling of transmission line, and analyze the load flow.
- Teach the analysis of sensitivity and the basics of power system security.
- Explain the voltage stability, proximity indicators and participation factors.
- Familiarize with FACT systems for controlling the power and configuration of various FACT devices.
- Introduce the thyristor-controlled series capacitor, its analysis, different modes of operation and various models.

Course Outcomes: After completion of the course, students will be able to:

- Create the bus admittance matrix, describe the reactive power of transmission line, model the transmission line, define the model of OLTC and analyze the load flow of lines.
- Analyze the sensitivity of different distribution factors, explain the power system security, and select and evaluate the contingency.
- Determine the voltage stability, proximity indicators and participation factor based on model analysis.
- Describe the FACT's controllers for power system and configure various FACT devices.

UNIT-I:
Power System components models formation of bus admittance matrix, algorithm for formation of bus impedance matrix, Reactive power capability of an alternator, transmission line model and loadability, Reactive power transmission and associated difficulties, regulated shunt compensation, Models of OLTC and Phase shifting transformer, load flow study.

UNIT-II:
Sensitivity analysis: Generation shift distribution factors, line outage distribution factors, Compensated shift factors. Power system security levels, contingency selection and evaluation, security constrained economic dispatch. Pre-contingency corrective rescheduling.

UNIT-III:
Voltage stability: Proximity indicators e.g., slope of PV-curve, Minimum Eigen value of reduced load flow Jacobian, participation factors based on modal analysis and application.

UNIT-IV:
Flexible ac transmission systems, Reactive power control, Brief description and definition of FACT's controllers, Shunt compensators, Configuration and operating characteristics of TCR, FC-TCR, TSC, Comparison of SVCs.

UNIT-V:
The Thyristor-controlled series capacitor (TCSC), Advantages of the TCSC, Basic principle and different mode of operation, Analysis, Variable-reactance model and transient stability model of TCSC.

TEXTBOOKS:

1. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill 2011.
2. A. J. Wood and B. F. Wollenberg, "Power generation, operation and control", second edition John Wiley and Sons 1996.
3. N. G. Hingorani and L. Gyugyi, "Understanding facts: Concepts and Technology of flexible AC transmission systems", Wiley Press 2000.

REFERENCES:

1. P. Kundur, "Power System Stability and control", McGraw-Hill edition 2008.
2. R. M. Mathur and R. K. Varma, "Thyristor Based FACTS Controllers for electrical Transmission systems", John Wiley and sons 2002.

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3	0	0	3

INDUSTRIAL LOAD MODELLING AND CONTROL

(D122PE3**)**

Prerequisite: Power Systems

Course Objectives:

- To understand the energy demand scenario
- To understand the modeling of load and its ease to study load demand industrially
- To know electricity pricing models
- To study reactive power management in Industries

Course Outcomes: After completion of the course, students will be able to:

- Acquire knowledge about load control techniques in industries and its application.
- Understand different types of industrial processes and optimize the process using tools like LINDO and LINGO.
- Apply load management to reduce demand of electricity during peak time.
- Apply different energy saving opportunities in industries.

UNIT-I:

Electric Energy Scenario, Demand Side Management, Industrial Load Management. Load Curve, Load Shaping Objective, Methodologies.
Barriers: Classification of Industrial Loads, Continuous and Batch processes, Load Modeling.

UNIT-II:

Direct load control, Interruptible load control. Bottom- u p approach, Scheduling, Formulation of load models, Optimization and control algorithms, Case studies. Reactive power management in industry, Controls, Power quality impacts, Application of filters, Energy saving in industries.

UNIT-III:

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.

TEXTBOOKS:

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

REFERENCES:

1. Y. Manichaikul and F.C. Schweppe, “Physically based Industrial load”, IEEE Trans. on PAS, April1981.
2. H. G. Stoll, “Least cost Electricity Utility Planning”, Wiley Inter science Publication, USA, 1989.
3. I.J.Nagarath and D.P.Kothari,”Modern Power System Engineering”, Tata McGraw Hill Publishers, New Delhi, 1995.
4. IEEE Bronze Book, “Recommended Practice for Energy Conservation and cost-e f fe ct i ve planning inIndustrial facilities”, IEEE Inc, USA.

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ADVANCED DIGITAL SIGNAL PROCESSING
(D122PE3**)**

Prerequisite: Digital Signal Processing

Course Objectives:

- To understand the difference between discrete-time and continuous-time signals
- To understand and apply Discrete Fourier Transforms (DFT)

Course Outcomes: After completion of the course, students will be able to:

- Acquire knowledge about the time domain and frequency domain representations as well analysis of discrete-time signals and systems
- Study the design techniques for IIR and FIR filters and their realization structures.
- Acquire knowledge about the finite word length effects in implementation of digital filters.
- Gain knowledge about the various linear signal models and estimation of power spectrum of stationary Random signals
- Design of optimum FIR and IIR filters

UNIT-I:
Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signal, Discrete time Fourier transforms, Discrete Fourier series, Discrete Fourier transform, Z-transforms, Properties of different transforms.

UNIT-II:
Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bi-linear transformation method.

UNIT-III:
FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations, Quantization process and errors, Coefficient quantization effects in IIR and FIR filters.

UNIT-IV:
A/D conversion noise, Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zero Input limit cycles in IIR filters, Linear Signal Models.

UNIT-V:
All pole, All zero and Pole-zero models, Power spectrum estimation, Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals, Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters.

TEXTBOOKS:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ", TMH Edition, 1998.
2. Dimitris G.Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", TMH International Editions, 2000.

REFERENCES:

1. S Salivahanan. A. Vallavaraj C. Gnanapriya, "Digital Signal Processing", TMH, 2nd reprint 2001.
2. Lourens R Rebinarand Bernold, "Theory and Applications of Digital Signal Processing".
3. Auntoniam, "Digital Filter Analysis and Design", TMH.

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POWER QUALITY IMPROVEMENT TECHNIQUES
(D122PE3**)**

Prerequisite: Power Systems and Power Electronics

Course Objectives:

- To know different terms of power quality.
- To illustrate power quality issues for short and long interruptions.
- To study of characterization of voltage sag magnitude and three-phase unbalanced voltage sag.
- To know the behavior of power electronics loads, induction motors, synchronous motor etc. by the power quality issues
- To know mitigation of power quality problems by using VSI converters.

Course Outcomes: After completion of the course, students will be able to:

- Know the severity of power quality problems in distribution system
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
- Compute the power quality improvement by using various mitigating custom power devices.

UNIT-I:
INTRODUCTION AND POWER QUALITY STANDARDS
Introduction, Classification of Power Quality Problems, Causes, Effects and Mitigation Techniques of Power Quality Problems, Power Quality Terminology, Standards, Definitions, Monitoring and Numerical Problems.

UNIT-II:
CAUSES OF POWER QUALITY PROBLEMS
Introduction to Non-Linear Loads, Power Quality Problems caused by Non-Linear Loads, Analysis of Non-Linear Loads, Numerical Problems.

UNIT-III:
PASSIVE SHUNT AND SERIES COMPENSATION
Introduction, Classification and Principle of operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators for Single-Phase System, Three-Phase Three Wire System and Three-Phase Four Wire System.

UNIT-IV:
ACTIVE SHUNT AND SERIES COMPENSATION
Introduction to Shunt compensators: Classification of DSTATCOM's, Principle of Operation of DSTATCOM.
Different Control Algorithms of DSTATCOM: PI Controller, I-Cosφ Control Algorithm, Synchronous Reference Frame Theory, Single-Phase PQ theory and DQ Theory Based Control Algorithms, Analysis and Design of Shunt Compensators, Numerical Problems.

Introduction to Series Compensators: Classification of Series Compensators, Principle of Operation of DVR.
Different Control Algorithms of DVR: Synchronous Reference Frame Theory-Based Control of DVR, Analysis and Design of Active Series Compensators, Numerical Problems.

UNIT-V:
UNIFIED POWER QUALITY COMPENSATORS
Introduction to Unified Power Quality Compensators (UPQC), Classification of UPQCs, Principle of Operation of UPQC.
Control of UPQCs: Synchronous Reference Frame Theory-Based UPQC, Analysis and Design of UPQCs, Numerical Problems.

TEXTBOOKS:

1. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality Problems and Mitigation Techniques", Wiley Publications, 2015.
2. Math H J Bollen, "Understanding Power Quality Problems", IEEE Press, 2000.

REFERENCES:

1. R.C. Dugan, M.F. McGranaghan and H.W. Beaty, "Electric Power Systems Quality", New York, McGraw-Hill, 1996.
2. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007.
3. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000.
4. G.T. Heydt," Electric Power Quality", 2ndEdition, West Lafayette, IN, Stars in Circle Publications,1994.
5. R. SastryVedamMulukutlaS.Sarma, "Power Quality VAR Compensation in Power Systems", CRC Press.
6. A Ghosh, G. Ledwich," Power Quality Enhancement Using Custom Power Devices", Kluwer Academic, 2002.

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M. Tech – II Semester

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POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS
(D122PE3**)**

Prerequisite: Power Electronics, Renewable Energy Sources

Course Objectives:

- To impart knowledge on different types of renewable energy systems.
- To analyze the operation of electrical generators used for the wind energy conversion Systems.
- To know the operation of AC-DC, DC-DC and AC-AC power converters used in renewable energy systems.
- To know the principles of standalone, grid connected and hybrid operation in renewable energy systems.

Course Outcomes: After completion of the course, students will be able to:

- Demonstrate the various types of renewable energy technologies that are used to harness electrical power.
- Demonstrate the operating principle and analysis of various types of Wind generators.
- Identify a suitable converter such as AC-DC, DC-DC and AC-AC converters for renewableenergy systems.
- Demonstrate and analyze the various types of wind and PV systems.
- Interpret the stand alone, grid connected and hybrid renewable energy systems

UNIT-I:

Solar cell characteristics and their measurement, PV Module, PV array, Partial shading of a solar cell and a module, The diode, Power conditioning unit, maximum power point tracker, Implementation of Perturb and Observe Method, Incremental Conductance Method, Battery charger/discharge controller.

UNIT-II:

Centralized Inverters, String Inverters, Multi-string Inverters, Module Integrated Inverter/Micro-inverters, Inverter Topology, Model of Inverter, Sizing Batteries and Inverters for a Solar PV System.
Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System.

UNIT-III:

Introduction to wind: Characteristics, Wind Turbine, Fixed and Variable-Speed Wind Turbines, Components of WECS, Description of Components, Types of Wind Turbine Generators, Economics of Wind Energy Conversion Systems, Linking Wind Turbines onto the Grid, Power Converter Topologies for Wind Turbine Generators.

UNIT-IV:

Modeling of Permanent Magnet Synchronous Generators, Doubly Fed Induction Generators, Squirrel cage Induction Generators wind turbine, Control of Power converters for WECS.

UNIT-V:

Hybrid Energy Systems, Need for Hybrid Energy Systems, Range and types of Hybrid systems, Hybrid Solar PV/Wind Energy System, Architecture of Solar-Wind Hybrid System and Grid connected issues.

TEXTBOOKS:

1. S. N. Bhadra, D.Kastha, S.Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.

REFERENCE BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
2. Rashid .M. H, “Power Electronics Hand book”, Academic Press, 2001.
3. Rai. G.D, “Non-conventional energy sources”, Khanna Publishers, 1993.
4. Rai. G.D,” Solar energy utilization”, Khanna Publishes, 1993.
5. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 1995.
6. B.H.Khan "Non-conventional Energy sources", Mc Graw-hill, 2nd Edition, 2009.

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DSP BASED DRIVE CONTROL
(D122PE4**)**

Prerequisite: Signals and Systems, Digital Signal Processing

Course Objectives:

- To enrich the learner with digital controller concepts and its application in the field of Power Electronic drives

Course Outcomes: After completion of the course, students will be able to:

- Understand the architecture of DSP core and its functionalities.
- Acquire knowledge on operation of interrupts and peripherals
- Explore the possibilities of hardware implementation using PLDs and FPGAs.
- Design controllers for power electronic drives.

UNIT-I

Introduction to the C2xx DSP core and code generation, the components of the C2xx DSP core, mapping external devices to the C2xx core, Peripherals and Peripheral Interface, System configuration registers, Memory, Types of Physical Memory, Memory addressing Modes, Assembly Programming using C2xx DSP, Instruction Set, Software Tools.

UNIT II

Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers, Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.

UNIT III

ADC Overview, Operation of the ADC in the DSP, Overview of the Event manager (EV), Event Manager Interrupts, General Purpose (GP) Timers, Compare Units, Capture Units and Quadrature Enclosed Pulse (QEP) Circuitry, General Event Manager Information.

UNIT IV

Introduction to Field Programmable Gate Arrays (FPGA), CPLD Vs FPGA, Types of FPGA, Xilinx XC3000 series, Configurable logic Blocks (CLB), Input/output Block (IOB), Programmable Interconnect Point (PIP), Xilinx 4000 series, HDL programming, Overview of Spartan 3E and Virtex II pro FPGAboards case study.

UNIT V

Control of DC motor, Permanent magnet Brushless DC motor, Permanent magnet synchronous motor.

TEXTBOOKS:

1. John.F.Wakerly, “Microcomputer Architecture and Programming”, John Wiley and Sons, 1981.
2. Ramesh S.Gaonker, “Microprocessor Architecture, Programming and Applications with the8085”, Penram International Publishing (India), 1994.

REFERENCE BOOKS:

1. Hamid.A.Toliyat and Steven G.Campbell, “DSP Based Electro Mechanical Motion Control”, CRC Press New York, 2004.
2. XC 3000 series datasheets (version 3.1). Xilinx, Inc., USA, 1998.
3. XC 4000 series datasheets (version 1.6). Xilinx, Inc., USA, 1999.
4. Wayne Wolf, “FPGA based system design, Prentice Hall, 2004.

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DISTRIBUTED GENERATION
(D122PE4**)**

Prerequisite: Power Systems, Power Electronics

Course Objectives:

- To understand renewable energy sources.
- To explore the working of off-grid and grid-connected renewable energy generation schemes.

Course Outcomes: After completion of the course, students will be able to:

- Understand the planning and operational issues related to Distributed Generation.
- Acquire knowledge about Distributed Generation Learn Micro-Grids

UNIT-I:

Need for Distributed generation, Renewable sources in distributed generation and current scenario in Distributed Generation.

UNIT-II:

Planning of DGs, Sitting and sizing of DGs optimal placement of DG sources in distribution systems, Grid integration of DG's, Different types of interfaces, Inverter based DG's and rotating machine- b a s e d interfaces, Aggregation of multiple DG units.

UNIT-III:

Technical impacts of DG' on Transmission systems and Distribution Systems, De-regulation, Impact of DGs upon protective relaying, Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.

UNIT-IV:

Economic and control aspects of DG's Market facts, Issues and challenges, Limitations of DG's, Voltage control techniques, Reactive power control, Harmonics, Power quality issues, Reliability of DG based systems.

UNIT-V:

Introduction to micro-grids, Types of micro-grids, Autonomous and non-autonomous grids, Sizing of micro-grids, Modeling & analysis of Micro-grids with multiple DG's, Micro-grids with power electronic interfacing units, Transients in micro-grids, Protection of micro-grids, Case studies, Advanced topics.

TEXTBOOKS:

1. H. Lee Willis, Walter G. Scott, "Distributed Power Generation-Planning and Evaluation", MarcelDecker Press.
2. M.Godoy Simoes, Felix A.Farret, "Renewable Energy Systems-Design and Analysis with Induction Generators", CRC press.

REFERENCES:

1. Stuart Borlase, "Smart Grid: Infrastructure Technology Solutions", CRC Press.

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ELECTRIC VEHICLE CHARGING TECHNIQUES
(D122PE4**)**

Prerequisite: Electric and Hybrid Vehicles, Power Electronics, Smart Grid Technologies

Course Objectives:

- To understand the charging infrastructure for EV's
- To explore the working of grid connected with EV's.

Course Outcomes: After completion of the course, students will be able to:

- Understand the planning and operational issues related to EV's charging.
- Acquire knowledge about EV's charging implementation models.

UNIT-I:
AN OVERVIEW OF EV CHARGING INFRASTRUCTURE:
Orients the reader to EV charging infrastructure, providing a brief introduction to technical concepts of electric vehicle supply equipment, AC and DC charging, power ratings, and charging standards.

UNIT-II:
LOCATION PLANNING AND LAND ALLOCATION:
Covers the location and site planning aspects for EV charging, by framing the principles of location planning and demonstrating a methodology for spatial allocation of charging demand, and identifies enabling processes and policies to integrate public charging in urban planning.

UNIT-III:
CONNECTING EVs TO THE ELECTRICITY GRID:
Focuses on supply of electricity for charging infrastructure, familiarizing readers with the regulations that govern electricity supply for EV charging, the role of DISCOMs in provision of EV charging connections, and the three methods of arranging for power supply for charging infrastructure.

UNIT-IV:
ACHIEVING EFFECTIVE EV-GRID INTEGRATION:
Zooms out from site-level considerations for supply of electricity to assess grid-level impacts, and then highlights the need for smart charging to minimize adverse impacts of EV charging loads on the grid.

UNIT-V:
MODELS OF EV CHARGING IMPLEMENTATION
Defines the typical roles within an implementation model for EV charging infrastructure and identifies three models in India – the government-driven model, the consumer-driven model and the charge point operator-driven model – for charging infrastructure implementation.

TEXTBOOKS:

1. Sulabh Sachan, P. Sanjeevikumar, Sanchari Deb, "Smart Charging Solutions for Hybrid and Electric Vehicles",Wiley Publications, March 2022.
2. Handbook of Electric Vehicle Charging Infrastructure Implementation Version-1

REFERENCES:

1. Vahid Vahidinasab, Behnam Mohammadi-Ivatloo, "Electric Vehicle Integration via Smart Charging, Springer, 2022.
2. Alam, Mohammad Saad, Pillai, Reji Kumar, Murugesan, N, "Developing Charging Infrastructure and Technologies for Electric Vehicles", IGI Global Publisher, December 2021,

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3	0	0	3

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY
((D122PE4**)**

Prerequisite: Power Systems, Power Electronics
Course Objectives:

- To enumerate sources of Electromagnetic interferences
- To design EMI Filter for insertion loss and for switch mode power supplies
- To understand concept of Faraday screens for EMI Prevention

Course Outcomes: After completion of the course, students will be able to:

- Recognize the sources of Conducted and radiated EMI in Power Electronic Converters and consumer appliances and suggest remedial measures to mitigate the problems.
- Assess the insertion loss and design EMI filters to reduce the loss
- Design EMI filters, common-mode chokes and RC-snubber circuits measures to keep the interference within tolerable limits

UNIT-I:
INTRODUCTION:
Sources of conducted and radiated EMI, EMC standardization and description, measuring instruments, conducted EMI references, EMI in power electronic equipment: EMI from power semiconductors circuits.

UNIT-II:
NOISE SUPPRESSION IN RELAY SYSTEMS:
AC switching relays, shielded transformers, capacitor filters, EMI generation and reduction at source, influence of layout and control of parasites.

UNIT-III:
EMI FILTER ELEMENTS:
Capacitors, choke coils, resistors, EMI filter circuits. Ferrite breeds, feed through filters, bifilar wound choke filter, EMI filters at source, EMI filter at output.

UNIT-IV:
EMI IN SWITCH MODE POWER SUPPLIES:
EMI propagation modes, power line conducted-mode inference, safety regulations (ground return currents), Power line filters, suppressing EMI at sources, Line impedance stabilization network (LISN), line filter design, common-mode line filter inductors- design& example, series –mode inductors and problems, EMI measurements.

UNIT-V:
FARADAY SCREENS FOR EMI PREVENTION:
Faraday Screens for EMI prevention in switching devices, transformers, safety screens, faraday screens on output components, reducing radiated EMI on gapped transformer cores, metal screens, electrostatic screens in transformers.

TEXTBOOKS:

1. Electromagnetic Compatibility in Power Electronics, Laszlo Tihanyi, IEEE Press
2. EMI Filter Design, Pullen Timotty. M. Ozenbaugh, N. Richard Lee, CRC Press, Taylor & Francis
3. Practical Design for Electromagnetic Compatibility, R. F. Ficchi Hayden Book Co.

REFERENCES:

1. Stuart Borlase, “Smart Grid: Infrastructure Technology Solutions”, CRC Press.
2. Handbook on Switch-Mode Power Supplies, Keith H. Billings, McGraw-Hill Publisher, 1989
3. https://www.ee.iitb.ac.in/web/academics/courses/EE785

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ADVANCED POWER ELECTRONIC CONVERTERS LAB-II
(D122PC6)

Prerequisite: Power Electronic Converters

Course Objectives:

- To know gate drive circuit configurations for converter circuits
- To analyze advanced converter topologies

Course Outcomes: After completion of the course, students will be able to.

- Design the gate driver circuits for converter topologies.
- Design concern topologies based on industrial applications

List of Experiments:

1. Buck Converter
2. Boost Converter
3. Cuk converter
4. Push pull converter
5. Fly back converter
6. Forward converter
7. Series resonant converter
8. Parallel resonant converter
9. ZVS
10. ZCS
11. UPS
12. SEPIC Converter

Note: From the above list, minimum of 10 experiments are to be conducted using any simulation tool

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L	T	P	C
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POWER ELECTRONICS APPLICATION TO POWER SYSTEMS LAB
(D122PC7**)**

Prerequisite: Power Electronic Converters, Power Systems, FACTS

Course Objectives:

- To understand the various power electronic devices simulation used in power systems
- To analyze advanced converter topologies for power system applications

Course Outcomes: After completion of the course, students will be able to.

- Model the different power converters for power system applications.
- Simulate and test the various designs of converter topologies based on needs of power and energy requirements.

List of Experiments:

1. Simulation of Thyristor Controlled Series Capacitor (TCSC) (Phasor Model)
2. Simulation of Steady-state and transient performance of a simple 6-Pulse HVDC Transmission System (Phasor Model)
3. Simulation of Unified Power Flow Controller (UPFC) (Phasor Model)
4. Simulation of Static Synchronous Compensator (STATCOM) used for midpoint voltage regulation on a transmission line (Phasor Model)
5. Simulation of Distribution STATCOM (D-STATCOM) (Average Model)
6. Simulation of Static Synchronous Series Compensator (SSSC) used for power oscillation damping (Phasor Model)
7. Simulation of Steady-state and dynamic performance of the static var compensator model SVC (Phasor Model)
8. Simulation of Shunt active harmonic filter (Three-Phase Active Harmonic Filter) to minimize the harmonic content propagated to the source from a non-linear load
9. Simulation of a typical transformer-less photovoltaic (PV) residential system connected to the electrical utility grid (Grid-Connected PV Array)
10. Simulation of Steady-state and transient performance of a 12-pulse, HVDC transmission system (Thyristor-Based HVDC Transmission System (Detailed Model))
11. Simulation of Thyristor Controlled Series Capacitor (TCSC) (Detailed Model).
12. Simulation of 48-Pulse, GTO-based unified power flow controller UPFC (Detailed Model)
13. Simulation of Static Synchronous Compensator using 22 power modules per phase STATCOM (Detailed MMC Model with 22 Power Modules per Phase)
14. Simulation of VSC-Based HVDC Transmission System (Detailed Model)
15. Simulation of A 48-pulse GTO based STATCOM (Detailed Model)
16. Simulation of Distribution STATCOM. D-STATCOM (Detailed Model)
17. Simulation of Static Var Compensator (SVC) (Detailed Model)
18. Simulation of Transient stability of a two-machine transmission system with Power System Stabilizers (PSS) and Static Var Compensator (SVC) SVC and PSS (Phasor Model).

Note: From the above list, minimum of 10 experiments are to be conducted using any simulation tool

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RELIABILITY ENGINEERING
(D223PE1)

Prerequisite: Mathematics

Course Objectives:

- To comprehend the concept of Reliability and Unreliability.
- To derive the expressions for probability of failure, expected value and standard deviation of Binominal distribution, Poisson distribution, Normal distribution and Weibull distributions.
- To formulate expressions for reliability analysis of series-parallel and non-series parallel systems.
- To derive expressions for time dependent and limiting state probabilities using Markov models.

Course Outcomes: After completion of the course, students will be able to:

- Apply fundamental knowledge of Reliability to modeling and analysis of series-parallel and non-series parallel systems.
- Solve some practical problems.
- 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 distribution, 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, Mean time to failure and Mean time between failures.

UNIT-III:
CLASSIFICATION OF ENGINEERING SYSTEMS

Series, Parallel and Series-Parallel systems, Expressions for the reliability of the basic configurations. **Reliability evaluation of non-series-parallel configurations:** Decomposition, Path based and cutest based methods, Deduction of the Paths and cut-sets from Event tree.

UNIT-IV:
DISCRETE MARKOV CHAINS

General modeling concepts, stochastic transitional probability matrix, Time dependent probability evaluation and limiting state probability evaluation of one component repairable model, Absorbing states. **Continuous Markov Processes:** Modeling concepts, State space diagrams, Stochastic Transitional Probability Matrix, evaluating time dependent and limiting state, Probabilities of one component repairable model. Evaluation of limiting state probabilities of two component repairable model.

UNIT-V:
FREQUENCY AND DURATION TECHNIQUES

Frequency and duration concepts, Application to multi-state problems, Frequency balance approach. **Approximate System Reliability Evaluation:** Series system, Parallel system, Network reduction techniques, Cut set approach, Common mode failures, modeling and evaluation techniques, Examples.

TEXTBOOKS:

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

REFERENCES:

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

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DYNAMICS OF ELECTRICAL MACHINES
(D223PE1)

Prerequisite: Machine Modeling and Analysis

Course Objectives:

- To introduce generalized modeling of electrical machines
- To analyze different electrical machines with dynamic modeling

Course Outcomes: After completion of the course, students will be able to:

- Understand the basic mathematical analysis of electrical machines and its characteristics.
- Understand behavior of electrical machines under steady state and transient state.
- Understand dynamic modeling of electrical machines.

UNIT-I:
BASIC MACHINE THEORY
Electromechanical Analogy, Magnetic Saturation, Rotating field theory, Operation of Inductor motor, Equivalent circuit, Steady state equation of DC machines, Operation of synchronous motor, Power angle characteristics.

UNIT-II:
ELECTRODYNAMICAL EQUATION & THEIR SOLUTIONS
Spring and Plunger system, Rotational motion, mutually coupled coils, Lagrange's equation, Application of Lagrange's equation, and Solution of Electro dynamical equations.

UNIT-III:
DYNAMICS OF DC MACHINES
Separately excited DC generator and motors, Steady-state and Transient analysis, Interconnection of machines, Ward Leonard system of speed control.

UNIT-IV:
INDUCTION MACHINE DYNAMICS
Induction machine dynamics during starting and braking, Accelerating time, Induction machine dynamic during normal operation, Equation for dynamical response of the induction motor.

UNIT-V:
SYNCHRONOUS MACHINE DYNAMICS
Electromechanical equation, Motor operation, Generator operation, small oscillations, General equations for small oscillations, Representation of the oscillation equations in state variable form.

TEXTBOOKS:

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

REFERENCES:

1. Vedam Subranmanyam, "Thyristor control of Electric Drives".
2. Article in IEEE Transactions on Energy Conversion, "Performance Optimization of Induction motors during Voltage-controlled soft starting", July 2004.

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ENERGY STORAGE TECHNOLOGIES
(D223PE1**)**

Prerequisite: -

Course Objectives:

- To introduce generalized storage techniques
- To analyze the different features of energy storage systems
- To know the management and application of energy storage technologies
- To have an idea about electrical energy storage market potential by different forecasting methods

Course Outcomes: After completion of the course, students will be able to:

- Understand the role of electrical energy storage technologies in electricity usage
- Know the behavior and features of electrical energy storage systems
- Analyze the applications of energy storage system
- Understand the hierarchy, demand for energy storage and valuation techniques.
- Get knowledge about energy storage forecasting methods

UNIT-I:

THE ROLES OF ELECTRICAL ENERGY STORAGE TECHNOLOGIES IN ELECTRICITY USE

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable, Emerging needs for EES, More renewable energy, Less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

UNIT-II:

TYPES AND FEATURES OF ENERGY STORAGE SYSTEMS

Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Lead-Acid Batteries, Lithium-Ion Batteries, Flow batteries, Other Batteries in Development, Chemical energy storage, Hydrogen (H2), Synthetic Natural Gas (SNG), Electrical storage systems, Double-Layer Capacitors (DLC), Superconducting Magnetic Energy Storage (SMES),Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

UNIT-III:

APPLICATIONS OF EES

Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), EES installed capacity worldwide, new trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles.

UNIT-IV:

MANAGEMENT AND CONTROL HIERARCHY OF EES

Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems and distributed generation (Virtual Power Plant), “Battery SCADA” aggregation of many dispersed batteries.

DEMAND FOR ENERGY STORAGE

Growth in Variable Energy Resources, Relationship between balancing services and variable energy resources, Energy Storage Alternatives, Variable Generator Control, Demand Management, Market Mechanisms, Longer Term Outlook.

VALUATION TECHNIQUES

Overview, Energy Storage Operational Optimization, Market Price Method, Power System Dispatch Model Method, Ancillary Service Representation, Energy Storage Representation, Survey of Valuation Results.

UNIT-V:

FORECAST OF EES MARKET POTENTIAL BY 2030

EES market potential for overall applications, EES market estimation by Sandia National Laboratory (SNL), EES market estimation by the Boston Consulting Group (BCG), EES market estimation for Li-ion batteries by the Panasonic Group, EES market potential estimation for broad introduction of renewable energies, EES market potential estimation for Germany by Fraunhofer, Storage of large amounts of energy in gas grids, EES market potential estimation for Europe by Siemens, EES market potential estimation by the IEA, Vehicle to grid concept, EES market potential in the future.

TEXTBOOKS:

1. Paul Breeze, "Power System Energy Storage Technologies", 1st Edition, Academic Press.
2. Alfred Rufer, "Energy Storage: Systems and Components", CRC Press, 2017.

REFERENCES:

1. Huggins and Robert, "Energy Storage Fundamentals, Materials and Applications", Springer.
2. andreasoberhofer@gmx.de
3. www.ecofys.com/com/publications
4. www.iec.ch.

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SCADA SYSTEMS AND APPLICATIONS
(D223PE1)

Prerequisite: -

Course Objectives:

- To understand what is meant by SCADA and its functions.
- To know SCADA communication.
- To get an insight into its application**.**

Course Outcomes: After completion of the course, students will be able to:

- Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical Applications.
- Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.
- Acquire knowledge about single unified standard architecture IEC 61850.
- Learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
- Learn and understand about SCADA applications in transmission and distribution sector, industries etc.

UNIT–I:

Introduction to SCADA, Data acquisition systems, Evolution of SCADA, Communication technologies. Monitoring and supervisory functions, SCADA applications in utility Automation, Industries SCADA.

UNIT–II:

Industries SCADA System Components, Schemes, Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.

UNIT–III:

SCADA Architecture**,** Various SCADA architectures, Advantages and disadvantages of each System, Single unified standard architecture -IEC 61850.

UNIT–IV:

SCADA Communication, Various industrial communication technologies, Wired and wireless methods and fiber optics, Open standard communication protocols.

UNIT–V:

SCADA Applications: Utility applications**,** Transmission and Distribution sector operations, Monitoring, analysis and improvement**.** Oil, gas and water industries case studies: Implementation, Simulation exercises.

TEXTBOOKS:

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

REFERENCES:

1. William T. Shaw, "Cyber Security for SCADA systems", PennWell Books, 2006.
2. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
3. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well, 1999.

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M. Tech – III Semester

L	T	P	C
3	0	0	3

BUSINESS ANALYTICS

(D223OE2

Prerequisite: None

Course objectives:

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

Course Outcomes: After completion of the course, students will be able to:

- Demonstrate knowledge of data analytics.
- Demonstrate the ability of think critically in making decisions based on data and deep analytics.
- Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
- 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 modelling, sampling and estimation methods overview.

UNIT-II:

Trendiness and Regression Analysis: Modelling 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 Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, 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, Newsvendor 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.

TEXTBOOKS:

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.

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M. Tech – III Semester

L	T	P	C
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OPERATIONS RESEARCH

(D223OE2)

Prerequisite: None

Course Outcomes: After completion of the course, students will be able to:

- Apply the dynamic programming to solve problems of discreet and continuous variables.
- Apply the concept of non-linear programming
- Carry out sensitivity analysis
- Model the real-world problem and simulate it.

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

TEXTBOOKS/ REFERENCES:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

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M. Tech – III Semester

L	T	P	C
3	0	0	3

COST MANAGEMENT OF ENGINEERING PROJECTS
(D223OE2**)**

Prerequisite: None

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 a Costing 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 centers, 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.

TEXTBOOKS/ REFERENCES:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techn

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L	T	P	C
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PHOTOVOLTAIC SYSTEMS
(D223OE2)

Prerequisite: None

Course Objectives:

- To introduce photovoltaic systems
- To deal with various technologies of solar PV cells
- To understand details about manufacture, sizing and operating techniques
- To have knowledge of design considerations.

Course Outcomes: After completion of the course, students will be able to:

- Identify photovoltaic system components and system types
- Calculate electrical energy and power
- Correctly size system components, design considerations of solar equipment
- Design a basic grid-tie PV system.

UNIT-I:
SOLAR ENERGY
Sun and Earth, Solar Spectrum, Solar Geometry, Solar radiation on horizontal and inclined planes, Instruments for measurement of solar radiation, Solar cell, Equivalent circuit, V-I characteristics, Performance improvement.

UNIT-II:
SOLAR CELLS
Manufacture of Solar Cells-Technologies, Design of Solar cells, Photovoltaic modules, Design requirements, Encapsulation systems, Manufacture, Power rating, Hotspot effect, Design qualifications.

UNIT-III:
PROTECTION AND MEASUREMENTS
Flat plate arrays, Support structures, Module interconnection and cabling, Lightning protection, Performance measurement using natural sun light and simulator, Determination of temperature coefficients, Internal series resistance, Curve correction factor.

UNIT-IV:
PHOTOVOLTAIC SYSTEMS
Photovoltaic systems, Types, General design considerations, System sizing, Battery sizing, Inverter sizing, Design examples, Balance of PV systems.

UNIT-V:
MAXIMUM POWER POINT TRACKERS
Maximum power point trackers, Perturb and observe, Incremental conductance method, Hill climbing method, , Hybrid and complex methods, Data based and other approximate methods, Instrument design, Other MPP techniques, Grid interactive PV system.

TEXTBOOKS:

1. F.C.Treble, “Generating electricity from Sun”, Pergamon Press.
2. A.K.Mukherjee, Nivedita Thakur,”Photovoltaic systems: Analysis and design”, PHI, 2011.

REFERENCES:

1. C.S.Solanki,” Solar Photovoltaic’s: Fundamentals, Technologies and applications”, PHI, 2009.

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M. Tech – I& II Semester

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ENGLISH FOR RESEARCH PAPER WRITING

(Audit-I &II .1**)**

Prerequisite: None

Course objectives:

- To Understand that how to improve your writing skills and level of readability
- To Learn about what to write in each section
- To Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

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 Criticizing, 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, and skills are needed when writing the Conclusions

UNIT-VI:
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

TEXTBOOKS/ REFERENCES:

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
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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M. Tech – I& II Semester

L	T	P	C
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DISASTER MANAGEMENT
(Audit-I &II .2**)**

Prerequisite: None

Course Objectives:

- To learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- To evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- To develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- To understand the strengths and weaknesses of disaster management approaches,
- To plan and program in different countries, particularly their home country or the countries they work

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 Ecosystem. 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.

UNIT-VI:
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.

TEXTBOOKS/ REFERENCES:

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

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M. Tech – I& II Semester

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SANSKRIT FOR TECHNICAL KNOWLEDGE

(Audit-I &II .3**)**

Prerequisite: None

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- To learn of Sanskrit to improve brain functioning
- To Learn of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- To equip engineering scholars with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes: After completion of the course, students will be able to:

- Understand basic Sanskrit language
- Know ancient Sanskrit literature about science & technology can be understood
- Get 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

TEXTBOOKS/ REFERENCES:

1. "Abhyaspustakam", Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

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M. Tech – I& II Semester

L	T	P	C
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VALUE EDUCATION

(Audit-I &II .4**)**

Prerequisite: None

Course Objectives:

- To understand value of education and self- development
- To imbibe good values in students
- To know about the importance of character

Course outcomes: After completion of the course, students will be able to:

- Get Knowledge of self-development
- Learn the importance of Human values
- Develop 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 judgements

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 -Avoid fault Thinking. Free from anger, Dignity of labor-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-IV:

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

TEXTBOOKS/ REFERENCES:

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

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M. Tech – I& II Semester

L	T	P	C
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CONSTITUTION OF INDIA

(Audit-I &II .5**)**

Prerequisite: None

Course Objectives:

- To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- 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.
- 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: After completion of the course, students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- 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.
- Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I:

History of Making of the Indian Constitution: History Drafting Committee, (Composition& Working)

UNIT-II:

Philosophy of the Indian Constitution: Preamble**,** Salient Features

UNIT-III:

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-IV:

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-V:

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: ZilaPachayat. 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-VI:

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.

TEXTBOOKS/ REFERENCES:

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

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PEDAGOGY STUDIES

(Audit-I &II.6**)**

Prerequisite: None

Course Objectives:

- To review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- To identify critical evidence gaps to guide the development.

Course Outcomes: After completion of the course, students will be able to:

- Understand what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- Understand what is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- Understand 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 in formal 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 school curriculum 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.

TEXTBOOKS/ REFERENCES:

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.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. 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.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

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M. Tech – I & II Semester

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STRESS MANGEMENT BY YOGA

(Audit-I &II.7**)**

Prerequisite: None

Course Objectives:

- To achieve overall health of body and mind
- To overcome stress

Course Outcomes: After completion of the course, students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

UNIT-I:
Definitions of Eight parts of yog. (Ashtanga)

UNIT-II:
Yam and Niyam.

UNIT-III:
Do`s and Don't'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 yoga poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

TEXTBOOKS/ REFERENCES:

1. Janardan Swami Yogabhyasi Mandal, "Yogic Asanas for Group Tarining" Part-I, Nagpur
2. Swami Vivekananda, AdvaitaAshrama, "Rajayoga or conquering the Internal Nature", PublicationDepartment, Kolkata.

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M. Tech – I& II Semester **L T P C**
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PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
(Audit-I &II.8**)**

Prerequisite: None

Course Objectives:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awake wisdom in students

Course Outcomes: After completion of the course, students will be able to:

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

UNIT-I:

Neetisatakam-Holistic development of personality

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

UNIT-II:

Neetisatakam-Holistic development of personality

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

UNIT-III:

Approach to day-to-day work and duties.

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

UNIT-IV:

Statements of basic knowledge.

- Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad BhagwadGeeta:

UNIT-V:

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

TEXTBOOKS/ REFERENCES:

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