MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)

M.Tech. in Power Electronics and Electrical Drives

Scheme of Instruction and Examination

(Choice Based Credit System)

For the batches to be admitted with effect from the Academic Year 2021-22

I Semester

S.No.	Course Code	Course Title	Instruction Hours per week			Examination			Credits
						Max Marks		SEE Duration in Hours	
			L	T	P/D	CIE	SEE		
1	EE101PC	Power Electronic Converters	3	0	0	30	70	3	3
2	EE102PC	Machine Modeling and Analysis	3	0	0	30	70	3	3
3	EE11XPE	Professional Elective-I	3	0	0	30	70	3	3
4	EE11XPE	Professional Elective-II	3	0	0	30	70	3	3
5	EE101MC	Research Methodology & Intellectual Property rights	2	0	0	30	70	3	2
6	AC10XHS	Audit Course – I	2	0	0	30	70	3	0
7	EE151PC	Power Electronic Converters Lab	0	0	3	30	70	3	1.5
8	EE152PC	Machine Modeling and Analysis Lab	0	0	3	30	70	3	1.5
9	EN151HS	Finishing School – I	0	0	2	30	70	3	1
		Total Hours/Marks/Credits	**16**	**0**	**8**	**270**	**630**		**18**

II Semester

S.No.	Course Code	Course Title	Instruction Hours per week			Examination			Credits
						Max Marks		SEE Duration in Hours	
			L	T	P/D	CIE	SEE		
1	EE201PC	Advanced Power Electronic Converters	3	0	0	30	70	3	3
2	EE202PC	Electrical Drives	3	0	0	30	70	3	3
3	EE21XPE	Professional Elective – III	3	0	0	30	70	3	3
4	EE21XPE	Professional Elective – IV	3	0	0	30	70	3	3
5	AC20XHS	Audit Course – II	2	0	0	30	70	3	0
6	EE251PC	Advanced Power Electronic Converters Lab	0	0	3	30	70	3	1.5
7	EE252PC	Electrical Drives Lab	0	0	3	30	70	3	1.5
8	EE253PC	Mini Project with Seminar	0	0	4	100		3	2
9	MA252BS	Finishing School – II	0	0	2	30	70	3	1
		Total Hours/Marks/Credits	**14**	**0**	**12**	**340**	**560**		**18**

L: Lecture **T**: Tutorial **D**: Drawing **P**: Practical **CIE** - Continuous Internal Evaluation **SEE** - Semester End Examination

I & II Semester
Professional Electives

Professional Elective-I
EE111PE: Power Electronics for Renewable Energy Systems
EE112PE: Smart Grid Technologies
EE113PE: Dynamics of Electrical Machines
EE114PE: Modern Control Theory

Professional Elective-II
EE115PE: Power Semiconductor Devices and Modeling
EE116PE: Reactive Power Compensation and Management
EE117PE: High Frequency Magnetic Components
EE118PE: Hybrid Electric Vehicles

Professional Elective-III
EE211PE: Industrial Load Modeling and Control
EE212PE: Advanced Digital Signal Processing
EE213PE: SCADA Systems and Applications
EE214PE: PWM Converters and Applications

Professional Elective-IV
EE215PE: Advanced Microcontroller Based Systems
EE216PE: Distributed Generation
EE217PE: Power Quality
EE218PE: Integration of Energy Sources

Audit Courses

Audit Course-I
AC101HS: English for Research Paper Writing
AC102HS: Sanskrit for Technical Knowledge
AC103HS: Stress Management by Yoga

Audit Course-II
AC201HS: Disaster Management
AC202HS: Value Education
AC203HS: Pedagogy Studies
AC204HS: Personality Development through Life Enlightenment Skills

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3	0	0	3

M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
EE101PC: Power Electronic Converters

Prerequisites: Power Electronics

Course Objectives

- Understand the principle of operation of modern power semiconductor devices
- Comprehend the concepts of different power converters and their applications
- Analyze and design switched mode regulators for various industrial applications

Course Outcomes

- Able to choose appropriate device for a particular converter topology
- Able to use power electronic simulation packages for analyzing and designing power converters

Unit-I: AC Voltage Controllers

Single phase AC voltage controllers with Resistive, Resistive-inductive and Resistive-inductive-induced e.m.f. loads – ac voltage controllers with PWM Control – Effects of source and load inductances - Synchronous tap changers.
Three phase AC voltage controllers – Analysis of controllers with star and delta Connected Resistive, Resistive-inductive loads – Effects of source and load Inductances – Applications & Problems.

Unit-II: Cyclo -Converters

Single phase to single phase cyclo-converters – analysis of midpoint and bridge Configurations – Three phase to three phase cyclo-converters –analysis of Midpoint and bridge configurations – Limitations – Advantages – Applications & Problems - Matrix Converter.

Unit-III: 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, PWM–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 – Design of converters.

Unit-IV: D.C. To D.C. Converters

Analysis of step-down and step-up dc to dc converters with Resistive and Resistive-inductive loads – Switched mode regulators – Analysis of Buck Regulators - Boost regulators – buck and boost regulators-Cuk regulators – Condition for continuous inductor current and capacitor voltage – comparison of regulators –Multi output boost converters – advantages – Applications – Problems.

Unit-V: 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.

Three phase inverters – 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.

Suggested Readings:

1. Mohammed H. Rashid –"Power Electronics"– Pearson Education-Third Edition – first Indian reprint-2004.
2. Ned Mohan, Tore M. Undeland and William P.Robbins- "Power Electronics"– John Wiley & Sons – Second Edition.

Reference Books:

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, FredeBlabjerg Edition:" Control in power electronics" illustrated Published by Academic Press, 2002.
4. NPTEL online course, Power Electronics, by Prof. B. G. Fernandez,https://www.youtube.com/playlist?list=PLA07ACBDE053A8229

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
EE102PC: Machine Modeling and Analysis

Prerequisites: Electrical Machines

Course Objectives

- Identify the methods and assumptions in modeling of machines
- Recognize the different frames for modeling of AC machines
- Write voltage and torque equations in state space form for different machines

Course Outcomes

- Develop the mathematical models of various AC and DC machines
- Analyze the developed models in various reference frames

Unit-I

Basic Two-pole DC machine, Commutator machines, D.C. Compound Machine, Amplidyne, Single Phase A.C. Series machine, Repulsion Motor, Synchronous Machine without Damper, Synchronous Machine with Damper, Three phase Induction Machines, primitive 2-axis machine, Voltage and Current relationship, Torque equation.

Mathematical model of separately excited DC motor-Steady state analysis, Transient analysis and DC Series motor - Steady state Analysis, Numerical problems. Mathematical model of D.C. shunt motor -Steady state Analysis, Mathematical model of D.C. Compound motor -Steady state Analysis, Numerical Problems

Unit-II

Linear transformation-Invariance of Power, Transformation from a displaced brush axis, Transformation from one set of displaced brushes Transformation from two sets of displaced brushes – Phase transformation from three phases to two phases(a, b, c to α, β, o)- Numerical -Power Invariance – Active transformation-Transformation from rotating axis to stationary axis (α .β, o to d, q,o).

Circuit model of a 3 phase Induction motor – Linear transformation - Phase Transformation – Transformation to a Reference frame – Two axis models for induction motor

Unit-III

Real time model of a two phase induction machine-Assumptions-Analysis-Transformation to obtain constant matrices-Three phase to Two phase transformation-Assumptions-Analysis-Numerical.

Generalized model in Arbitrary Reference Frames-Derivation of commonly used Induction motor models-Stator Reference frames model-Rotor Reference frames model-Synchronously rotating reference frames model- Voltage and current Equations in stator reference frame – equation in Rotor reference frame – equations in a synchronously rotating frame – Electromagnetic Torque equation.

Unit-IV

Circuits model of a 3ph Synchronous motor – Two axis representation of Synchronous Motor-Assumptions-Self inductances of Stator-Mutual inductances of Stator-Mutual Inductance between Stator and Rotor-Inductances of Rotor-Transformation of Stator quantities-Transformation from Three phase to Two phase-Voltage and current Equations – Torque equation.

Unit-V

Modeling of Permanent Magnet Synchronous motor-Classification based on direct field flux-Operating Principle-Constructional features-Vector Control Analysis-Classification based on wave shape-Applications.

Modeling of Brushless DC Motor-Operating Principle-Constructional features-Analysis-Equivalent Circuit and waveforms-Applications.

Suggested Readings:

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.

Reference Books:

1. Vedam Subranmanyam, Thyristor control of Electric Drives.
2. Prabha Kundur, Power System Stability and Control – EPRI.
3. Performance optimization of induction motors during Voltage-controlled soft starting, Article in IEEE Transactions on Energy Conversion, July 2004.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - I
EE111PE: Power Electronics for Renewable Energy Systems

Prerequisites: Power Electronics, Renewable Energy Systems

Course Objective

To prepare students to
- Provide knowledge about the stand alone and grid connected renewable energy systems
- Equipped with required skills to derive the criteria for the design of power converters for renewable energy applications
- Analyse and comprehend the various operating modes of wind electrical generators and solar energy systems
- Design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems
- To develop maximum power point tracking algorithms

Course Outcomes

At the end of the course, the student is able to
- Ability to understand and analyse power system operation, stability, control and protection
- Ability to handle the engineering aspects of electrical energy generation and utilization

Unit-I: Introduction

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Batteries, Hydrogen energy systems and hybrid renewable energy systems.

Unit-II: Electrical Machines For Renewable Energy Conversion

Reference theory fundamentals of Induction generator-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

Unit-III: Power Converters

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, Charge controllers, PWM Inverters, Grid Interactive Inverters-matrix converters.

Unit-IV: Analysis of Wind and PV Systems

Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system.

Unit-V: Hybrid Renewable Energy Systems

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT). Types of MPPT algorithm.

Suggested Readings:

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, NewDelhi,2009.

Reference Books:

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', Second edition, wiley India Pvt. Ltd, 2012.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - I
EE112PE: Smart Grid Technologies

Prerequisites: Power Systems, Electrical Measurements, Power Quality

Course Objectives

To prepare students to
- Understand concept of smart grid and its advantages over conventional grid
- Know smart metering techniques
- Learn wide area measurement techniques
- Understanding the problems associated with integration of distributed generation & its solution through smart grid

Course Outcomes

On the successful 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. 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-II

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-III

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-IV

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

Unit-V

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area, Network (NAN), Wide Area Network (WAN), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid, Broadband over Power line (BPL), IP based protocols

Suggested Readings:

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

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "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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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - I
EE113PE: Dynamics of Electrical Machines

Prerequisites: Machine Modeling and Analysis

Course Objectives

- Understand generalized modeling of electrical machines
- Analyze different electrical machines with dynamic modeling

Course Outcomes

On the successful 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 equations of DC machines – operations of synchronous motor – Power angle characteristics

Unit-II: Electro dynamical Equation & Their Solutions

Spring and Plunger system - Rotational motion – mutually coupled coils – Lagrange's equation – Application of Lagrange's equation solution of Electro dynamical equations.

Unit-III: Dynamics of Dc Machines

Separately excited DC generations – stead state analysis – transient analysis – Separately excited D.C. motors – stead state analysis – transient analysis – interconnection of machines – Ward Leonard system of speed control.

Unit-IV: Induction Machine Dynamics

Induction machine dynamics during starting and braking– accelerating time–induction machine dynamic during normal operation–Equation for dynamical response of the induction motor.

Unit-V: Synchronous Machine Dynamics

Electromechanical equation – motor operation – generator operation – small oscillations – general equations for small oscillations.

Suggested Readings:

1. Bimbhra P.S. "Generalized Theory of Electrical Machines " Khanna Publishers 2002
2. Thyristor control of Electric Drives - VedamSubranmanyam.

Reference Books:

1. Sen Gupta D.P. and J.W "Electrical Machine Dynamics" Macmillan Press Ltd 1980.
2. Performance optimization of induction motors during Voltage-controlled soft starting, Article in IEEE Transactions On Energy Conversion, July 2004.

3. NPTEL Course on "Modelling and Analysis of Electrical Machines", https://www.youtube.com/playlist?list=PLbMVogVj5nJQBG9363J1uq5Fnq4m1yGXL

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - I
EE114PE: Modern Control Theory

Prerequisites: 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 non linear systems
- To analyze the concept of stability for nonlinear systems and their categorization
- To apply the comprehensive knowledge of optimal theory for Control Systems

Course Outcomes

On the successful completion of the course, students will be able to:

- Various terms of basic and modern control system for the real time analysis and design of control systems
- To perform state variables analysis for any real time system
- Apply the concept of optimal control to any system
- Able to examine a system for its stability, controllability and observability
- Implement basic principles and techniques in designing linear control systems
- Formulate and solve deterministic optimal control problems in terms of performance indices
- Apply knowledge of control theory for practical implementations in engineering and network analysis

Unit-I: Mathematical Preliminaries and State Variable Analysis

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 – Non Linear Systems - Types of Non-Linearity's – 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.

Suggested Readings:

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

Reference Books:

1. N K Sinha, Control Systems, New Age International – 3 rd edition.
2. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - II
EE115PE: Power Semiconductor Devices and Modeling

Prerequisites: Power Electronics

Course Objectives

- Improve power semiconductor device structures for adjustable speed motor control applications
- Understand the static and dynamic characteristics of current controlled power semiconductor devices
- Understand the static and dynamic characteristics of voltage-controlled power semiconductor devices
- Enable the students for the selection of devices for different power electronics applications
- Understand the control and firing circuit for different devices

Course Outcomes

On the successful 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 transient, turn off transient and reverse recovery transient, Schottky diodes, snubber requirements for diodes, diode snubber, modelling of Power diodes. Power BJT'S: Basic structure and V-I characteristics, breakdown voltages and control, secondary breakdown and it's control- FBSOA and RBSOA curves - on state losses, switching characteristics, resistive switching specifications, clamped inductive switching specifications, turn-on transient, turn-off transient, storage time, base drive requirements, switching losses.

Unit-II: Power BJT'S, SCR (Thyristors) & Triacs

Device protection- snubber requirements for BJT'S and snubber design switching aids, modeling of power BJT'S. 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 reapplied dv/dt limitations, gate drive requirements, ratings of thyristors, snubber requirements and snubber design, modelling of Thyristor. Basic structure and operation-I characteristics, ratings, snubber requirements, modelling of triacs.

Unit-III: Gate Turnoff Thyristor (GTO) & Power Mosfet's

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, over current protection of GTO'S, modelling of GTO'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 of Power MOSFET'S.

Unit-IV: Insulated Gate Bipolar Transistors (IGBT'S)

Basic structure and operation, latch up IGBT, switching characteristics, resistive switching specifications, clamped inductive switching specification – IGBT turn-on transient, IGBT 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, modeling.

Suggested Readings:

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.

Reference Books:

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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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - II
EE116PE: Reactive Power Compensation and Management

Prerequisites: Power System

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

Upon completing this course, the student will be able to

- Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads
- Observe various compensation methods in transmission lines
- Construct model 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

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 compensations - series capacitor compensation – compensation using synchronous condensers – examples

Unit – III

Reactive Power Coordination: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences

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 Are Furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers Electric arc furnaces – basic operations-furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Suggested Readings:

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.

Reference Books:

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just "Reactive Power Compensation: A Practical Guide, April, 2012, Wiley publication.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - II
EE117PE: High Frequency Magnetic Components

Prerequisites: Electrical Circuits and EMF, Power Systems

Course Objectives

- Know about magnetic circuits
- Know about high frequency magnetic components

Course Outcomes

On the successful 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.

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.

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, SelfCapacitance of Single-Layer Inductors, Self-Capacitance of Multi-layer Inductors, Capacitance of Coaxial Cable

Suggested Readings:

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

Reference Books:

1. G.C. Chryssis, High frequency switching power supplies, McGraw Hill, 1989 (2nd Edn.)
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" Beattie ---"Inductance 101.pdf"
5. Dixon--- "Eddy current losses in transformer windings.pdf"
6. Texas Instruments --- "Windings.pdf"
7. Texas Instruments --- "Magnetic core characteristics.pdf" Ferroxcube --- "3f3 ferrite datasheet.pdf" Ferroxcube --- "Ferrite selection guide.pdf" Magnetics, Inc., Ferrite Cores (www.mag-inc.com)

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Professional Elective - II
EE118PE: Hybrid Electric Vehicles

Prerequisites: Electrical Drives

Course Objectives

- To understand upcoming technology of hybrid system
- To understand different aspects of drives application
- Learning the electric Traction

Course Outcomes

On the successful completion of the course, students will be able to:

- Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles
- To learn electric drive in vehicles / traction

Unit - I

History of hybrid, electric vehicles and fuel cell vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies- Air Pollution, Global warming, Petroleum Resources, induced costs, Basics of vehicle performance, Vehicle Resistance, Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation, Maximum Speed of a Vehicle, Gradeability, Acceleration Performance vehicle power source characterization Transmission characteristics- Gear Transmission, Hydrodynamic Transmission, Continuously Variable Transmission, Operating Fuel Economy, Braking Performance Mathematical models to describe vehicle performance.

Unit - II

Basic concept of hybrid traction, Architectures of Hybrid Electric Drive Trains, Introduction to various hybrid drive-train topologies- Series Hybrid Electric Drive Trains, Configuration of a series hybrid electric drive train, Parallel Hybrid Electric Drive Trains, Configuration of a parallel hybrid electric drive train Torque-Coupling Parallel Hybrid Electric Drive Trains , Speed-Coupling Parallel Hybrid Electric Drive Trains, Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains, Two-axle configuration, Two-shaft configuration, Hybrid electric drive train with speed coupling of planetary gear unit, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

Unit – III

Introduction to electric components used in hybrid and electric Vehicles, Configuration and control of DC Motor drives- Principle of Operation and Performance, Combined Armature Voltage and Field Control, Chopper Control of DC Motors, Multiquadrant Control of Chopper-Fed DC Motor Drives.

Unit – IV

Configuration and control of Induction Motor drives- Basic Operation Principles of Induction Motors, Steady-State Performance, Constant Volt/Hertz Control, Power Electronic Control, Field Orientation Control, Voltage Source

Inverter for FOC. configuration and control of Permanent Magnet Motor drives- Basic Principles of BLDC Motor Drives, BLDC Machine Construction and Classification, Properties of PM Materials. Configuration and control of Switch Reluctance Motor drives- Basic Magnetic Structure, Torque Production, SRM Drive Converter, Modes of Operation Generating Mode of Operation (Regenerative Braking).

Unit – V

Matching the electric drive and ICE, Transmission selection and gear step selection, Sizing the propulsion motor, its torque, constant power speed ratio and machine dimensions. Sizing the power electronics based on Switch Technology, Switching Frequency and Ripple capacitor design. Selecting the energy storage technology. Electrical overlay harness and communications. Supporting system including steering and braking system.

Suggested Readings:

1. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices" Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters"

Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
4. Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
EE101MC: Research Methodology & Intellectual Property Rights

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 the patent rights

Course Outcomes

At the end of this 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 report, Paper 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 grants 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.

Suggested Readings:

1. C. R. Kothari and Gaurav Garg, "Research Methodology – Methods and Techniques", New Age International
2. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Reference 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"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in NewTechnological Age", 2016.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Audit Course - I
AC101HS: English for Research Paper Writing

Course Objectives

Students will be able to:
- Improve their writing skills and level of readability
- Learn about structure and organization of sections and sub sections
- Develop requisite skills to write the title
- Enhance effective writing skills to publish research papers

Unit-I

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

Unit-II

Clarifying, Highlighting Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstract, Introduction

Unit-III

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

Unit-IV

Key Skills for: Writing a title, Writing an abstract, Writing an Introduction, Writing a review of the literature

Unit-V

Key skills for: Writing methods, Writing the results, Writing the discussion, Writing the conclusions.
Useful phrases and mechanics of effective writing to publish research papers.

Suggested Readings:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press(available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Audit Course – I
AC102HS: Sanskrit for Technical Knowledge

Course Objectives

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

Course Outcomes

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

Unit-I
Alphabets in Sanskrit

Unit-II
Past / Present / Future Tense, Simple Sentences

Unit-III
Order, Introduction of roots

Unit-IV
Technical information about Sanskrit Literature

Unit-V
Technical Concepts of Engineering - Electrical, Mechanical, Architecture, Mathematics

Suggested Readings:
1. Prathama Deeksha-Vempati Kutumbshastri "Teach Yourself Sanskrit", Rashtriya Sanskrit Sansthanam, New Delhi Publication

Reference Books:
1. Dr. Vishwas, Samskrita "Abhyaspustakam" -Bharti Publication, New Delhi
2. Suresh Soni "India's Glorious Scientific Tradition", Ocean books (P) Ltd., New Delhi.

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
Audit Course - I
AC103HS: Stress Management by Yoga

Course Objectives

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

Course Outcomes

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

Unit-I

Definitions of Eight parts of yoga. (Ashtanga)

Unit-II

Yam and Niyam.

Unit-III

Do's and Dont's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit-IV

Asan and Pranayam

Unit-V

i) Various yoga poses and their benefits for mind & body

ii) Regularization of breathing techniques and its effects-Types of pranayam

Suggested Readings:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur

Reference Books:

1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
EE151PC: Power Electronic Converters Lab

Prerequisites: Electrical and Electronic circuits, Power System Analysis & Power Electronics

Course Objectives

- Simulation of various AC-AC, AC-DC, DC-DC, DC-AC converter topologies

Course Outcomes

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

- Simulate AC-AC Converters
- Simulate AC-DC Converters
- Simulate DC-DC Converters
- Simulate DC-AC Converters
- Analysis of various converter topologies developed.

PART-A (Conduct any 5 hardware experiments)

1. Single phase full converter using RL and E loads.
2. Single phase semi converter using RL and E loads.
3. Three phase full converter using RL and E loads.
4. Three phase semi converter using RL and E loads.
5. Single phase AC Voltage controller using RL load.
6. Single phase Cyclo-converter using RL load.
7. Three phase six stepped inverter
8. Three-phase inverter with PWM controller.
9. BUCK ,BOOST and CUCK regulators
10. Space vector PWM converter

PART-B: (Conduct any 5 experiments using any simulation tool)

1. Single phase full converter using RL and E loads.
2. Single phase semi converter using RL and E loads.
3. Three phase full converter using RL and E loads.
4. Three phase semi converter using RL and E loads.
5. Single phase AC Voltage controller using RL load.
6. Single phase Cyclo-converter using RL load.
7. Three phase six stepped inverter
8. Three-phase inverter with PWM controller.
9. BUCK ,BOOST and CUCK regulators
10. Space vector PWM converter

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
EE152PC: Machine Modeling and Analysis Lab

Prerequisites: Electrical Machines, Machine Modeling Analysis

Course Objectives

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

Course Outcomes

After completion of this lab, the student will be able to

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

List of Experiments:

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

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

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M.Tech. in Power Electronics and Electrical Drives
I Semester Syllabus
EN151HS: Finishing School-I
(Common to all Branches)

Course Overview

- In view of the growing importance of English as a tool for global Communication and the consequent emphasis on training students to acquire language skills, this syllabus has been designed to develop linguistic, communicative and critical thinking competencies of Engineering students.

Course Objectives

- The main objective of this finishing school curriculum is to provide content for developing the LSRW skills of language learning and to facilitate proficiency in both receptive and productive skills, among students.

Methodology:

- Every Session will have activities on all the four skills-Listening, Speaking, Reading and Writing.
- To personalize the learning a variety of case studies and structured problem solving activities will be given to small groups and the teachers will facilitate peer reviews.
- Continuous grading, peer review and positive reinforcement will be emphasized
- Vocabulary exercises will also be a part of every session
- All sessions are designed to be student-centric and interactive.

Unit-I: Fundamentals of Communication

Unit Overview:

This is an introductory module that covers the fundamentals of communication. This module is intended to enable the students to communicate using greetings and small sentences/queries.

Learning Outcomes:

The students should be able to:

- Respond to questions
- Engage in informal conversations.
- Speak appropriately in formal situations
- Write formal and informal emails/letters

Competencies:

- Greeting appropriately
- Introducing themselves, a friend
- Situational Dialogue writing
- Responding to simple statements and questions both verbally and in writing
- Writing an email with appropriate salutation, subject lines, introduction and purpose of mail.
- Using appropriate vocabulary for both formal and informal situations.
- JAM sessions.

Sessions:

1. Introduction to Formal and Informal Conversations (Listening Activity)
2. Informal Conversations
3. Informal Conversations - Writing
4. Formal Conversations
5. Formal Conversations – Writing

6. Grammar-Prepositions
7. Adjectives and Degrees of Comparison
8. Word formation: Prefixes and Suffixes

Unit–II: Rational Recap

Unit Overview:

The module enables the participants to organize their communication, structure their speaking and writing, explain their thoughts/ideas, and summarize the given information.

Learning Outcomes:

The students should be able to:

- Classify content and describe in a coherent form
- Recognize and list the key points in a topic/message/article.
- Compare and contrast using appropriate structure
- Explain cause and effect
- Use appropriate transitions in their presentations and written assignments

Competencies:

- Organizing the communication based on the context and audience
- Structuring the content based on the type of information.
- Explaining a technical/general topic in detail.
- Writing a detailed explanation/process
- Recapitulating

Sessions:

1. Introduction to Mind maps
2. Classification
3. Sequencing
4. Description and Enumeration

Unit-III: Narrations and Dialogues

Unit Overview:

The Module is intended to develop the desired level of language competence that enables them to narrate and participate in casual dialogues.

Learning Outcomes:

The students should be able to

- Narrate a message/story/incident, both verbally and in writing.
- Describe an event/a session/ a movie/ an object / image
- Understand Vocabulary in context

Competencies:

- Framing proper phrases and sentences to describe in context
- Reading Stories and articles and summarizing.
- Speaking fluently with clarity
- Listening for main ideas and reformulating information in his/her own words
- Drawing and write appropriate conclusions, post reading a passage.
- Speaking Reading and Writing descriptive sentences and paragraphs
- Using appropriate tenses, adjectives and adverbs in conversations and written tasks

Sessions:

Grammar: Verb, Tenses

1. Recalling and Paraphrasing
2. Describing Events
3. Describing Objects/ Places
4. Story Telling
5. Describing Hypothetical events

Unit-IV: Technical Expositions and Discussions

Unit Overview:

The module enables the students to build strategies for effective interaction and help them in developing decisive awareness and personality, maintaining emotional balance.

Learning Outcomes:

The students should be able to:

- Participate in Professional discussions by providing factual information, possible solutions, and examples.

Competencies:

- Comprehending key points of a topic and identifying main points including supporting details.
- Construct a logical chain of arguments and decisive points.
- Writing a review about a product by providing reasons, causes and effects

Sessions:

Based on Case Studies

1. Compare and Contrast
2. Cause and Effect
3. Problem and Solution

Unit-V: Drawing Conclusions

Unit Overview:

This module is intended to provide necessary inputs that enable the studentsto draw conclusions out of a discussion and provide reports.

Learning Outcomes:

Students should be able to:

- Provide logical conclusions to the topics under discussion.
- Prepare, present, and analyze reports.

Competencies:

- Reasoning skills - Coherent and logical thinking
- Reporting and Analyzing skills.
- Analyzing the points discussed.
- Connecting all points without gaps.
- Connectives
- Communicating the decisions

Sessions:

1. Report Writing
2. Reasoning
3. Analyzing
4. Generalization and Prediction
5. Précis writing

Minimum Requirement

Interactive Communication Skills Lab: A Spacious room with movable chairs and audio-visual aids with a Public-Address System, an LCD and a projector with Internet Connectivity, Handycam Camcorder with 4K recording facility with tripod.

Reference Books:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
2. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
3. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.
5. English Vocabulary in Use series, Cambridge University Press 2008.

6. Handbook for Technical Communication by David A. Mc Murrey & Joanne Buckley. 2012.Cengage Learning.
7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
8. Job Hunting by Colm Downes, Cambridge University Press 2008.
9. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009
10. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition.

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
EE201PC: Advanced Power Electronic Converters

Prerequisites: Power Electronics

Course Objectives

- Understand various advanced power electronics devices.
- Describe the operation of multi level inverters with switching strategies for high power applications.
- Comprehend the design of resonant converters and switched mode power supplies.

Course Outcomes

After completion of this lab, the student will be able to

- Develop and analyze various converter topologies.
- Design AC or DC switched mode power supplies.

Unit-I: Modern Power Semiconductor Devices

Modern power semiconductor devices – Insulated 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) – symbol, structure and equivalent circuit – comparison of their features.

Unit-II : Resonant Pulse Inverters

Resonant pulse inverters – series resonant inverters – series resonant inverters with unidirectional switches – series resonant inverters with bidirectional switches – analysis of half bridge resonant inverter – evaluation of currents and voltages of a simple resonant inverter – analysis of half bridge and full bridge resonant inverter with bidirectional switches – Frequency response of series resonant inverters – for series loaded inverter – for parallel loaded inverter – For series and parallel loaded inverters – parallel resonant inverters – Voltage control of resonant inverters - numerical problems.

Unit-III: Resonant Converters

Resonant converters – zero current switching resonant converters – L type ZCS resonant converter – M type ZCS resonant converter – zero voltage switching resonant converters – comparison between ZCS and ZVS resonant converters – Two quadrant ZVS resonant converters – resonant dc-link inverters – evaluation of L and C for a zero current switching inverter – Numerical problems.

Unit-IV: Multilevel Inverters

Multilevel concept – Classification of multilevel inverters – Diode clamped Multilevel inverter – principle of operation – main features – improved diode Clamped inverter – principle of operation – Flying capacitors multilevel inverter-principle of operation – main features – cascaded multilevel inverter – principle of operation – main features – Multilevel inverter applications -features of Multilevel inverters – comparisons of multilevel converters.

Unit V: D.C & A.C Power Supplies

DC power supplies – classification - switched mode dc power supplies – fly back Converter – forward converter – push-pull converter – half bridge converter – Full bridge converter – Resonant d c power supplies – bidirectional

power supplies – Applications.

AC power supplies – classification – switched mode ac power supplies – Resonant AC power supplies– bidirectional ac power supplies – multistage conversions – control circuits – applications.

Suggested Readings:

1. Mohammed H. Rashid –"Power Electronics"– Pearson Education-Third Edition – first Indian reprint -2004.
2. Ned Mohan, Tore M. Undeland and William P.Robbins- "Power Electronics"– John Wiley & Sons – Second Edition.

Reference Books:

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, FredeBlabjerg Edition:" Control in power electronics" illustrated Published by Academic Press, 2002.
4. NPTEL online course, "Pulse width Modulation for Power Electronic Converters" Dr. G. Narayanan, https://www.youtube.com/playlist?list=PLbMVogVj5nJQoZqyLxx-cg_dYE-Dt2UMH

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
EE202PC: Electrical Drives

Prerequisites: Power Electronics, Electrical Machines

Course Objectives

To prepare the students to
- Understand the concept controllers and chopper controlled drives.
- Understand principle of operation of scalar control of AC motor and corresponding speed-torque characteristics
- Comprehend the vector control for Induction motor drive.
- Explain the static resistance control and Slip power recovery drive
- Explain synchronous motor drive characteristics and its control strategies

Course Outcomes

The students will be able to
- Develop controllers for controlled rectifiers and choppers for DC motor drives.
- Develop induction motor for variable speed operations using scalar vector control
- Develop induction motor for vector control techniques
- Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.
- Knowledge about the control of synchronous 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 modeling of three phase converter – Steady state analysis of three phase converter controlled DC motor drive, Two quadrant three phase converter controlled DC motor drive. **Transfer functions of subsystem:** DC motor and load, converter. Current and speed controllers, Current and speed feedback, **Design of controllers:** Current and speed controllers, Motor equations, filter in the speed feedback loop, speed controller.

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 by averaging, **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: Stator Side Control Of Induction Drives

Introduction to AC motor drives, Torque production, Equivalent circuit analysis, Speed–Torque Characteristics with variable voltage operation, Variable frequency operation, Variable stator current operation. Scalar control, Voltage fed inverter control, Open loop volts/Hz control, speed control slip regulation, speed control with torque and flux control, current controlled voltage fed inverter drive.

Rotor Side Control Of Induction Motor Drives: Introduction to rotor resistance control, Slip power recovery drives, Static Kramer Drive, Phasor diagram, Torque expression, speed control of Kramer Drive, Static Scheribus Drive, modes of operation.

Unit–IV: Vector Control of Induction Motor Drives

Introduction, Principles of Vector control, Vector control methods: Direct methods of vector control, Indirect methods of vector control, **Adaptive control techniques:** Self tuning regulator, Model referencing control, Introduction to direct torque control of induction motor.

Unit–V: Control of Synchronous Motor Drives

Introduction to Synchronous motor, characteristics, Control strategies: Constant torque angle control, Unity power factor control, Constant mutual flux linkage control – closed loop operation of synchronous motor drive.

Suggested Readings:

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

Reference Books:

1. MD Murthy and FG Turn Bull, Power Electronics and Control of AC Motors –Pergman Press 1st edition
2. G. K. Dubey, Fundamentals of Electrical Drives – Narosa publications – 1995.
3. BK Bose, Power Electronics and AC Drives – Prentice Hall Eagle wood diffs New Jersey - 1st edition
4. M H Rashid, Power Electronic circuits Deices and Applications – PHI – 1995.
5. NPTEL online course on Electric Drives by Prof. Gopakumar, https://www.youtube.com/playlist?list=PL350C8304DD04538D
6. NPTEL course on Advanced Electric Drives by Dr. S.P. Das, https://www.youtube.com/playlist?list=PLA5CA7D35114BA425

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -III
EE211PE: Industrial Load Modeling and Control

Prerequisites: Power Systems, PSOC

Course Objectives

To prepare the students to
- 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
- Study Reactive power management in Industries

Course Outcomes

On the successful completion of the course, students will be able to:
- Knowledge about load control techniques in industries and its application.
- 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 Curves-Load Shaping Objectives-Methodologies, Barriers; Classification of Industrial Loads- Continuous and Batch processes -Load Modeling

Unit-II

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

Unit-III

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

Unit-IV

Captive power units- Operating and control strategies- Power Pooling- Operation models, Energy banking - Industrial Cogeneration.

Unit-V

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

Suggested Readings:

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.

Reference Books:

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

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -III
EE212PE: Advanced Digital Signal Processing

Prerequisites: Digital Signal Processing

Course Objectives

To prepare the students to
- Understand the difference between discrete-time and continuous-time signals
- Understand and apply Discrete Fourier Transforms (DFT)

Course Outcomes

On the successful completion of the course, students will be able to:
- Know 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.
- Know about the various linear signal models and estimation of power spectrum of stationary Random signals
- Design optimum FIR and IIR filters

Unit-I

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

Unit-II

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear 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.

Suggested Readings:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Graw-Hill Edition 1998.
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions .-2000.

Reference Books:

1. S Salivahanan. A. Vallavaraj C. Gnanapriya, Digital Signal Processing – TMH – 2 nd reprint 2001.
2. Lourens R Rebinarand Bernold, Theory and Applications of Digital Signal Processing
3. Auntoniam, Digital Filter Analysis and Design, TMH.
4. NPTEL online course, Advanced Digital Signal Processing-Wavelets and multirate by Prof. V. M. Gadrehttps://www.youtube.com/playlist?list=PLbMVogVj5nJRY7X-t MNDHPG dm fZ y fHC7J

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -III
EE213PE: SCADA Systems and Applications

Prerequisites: Power Systems, Electronics and communication

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

On the successful 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 eachSystem.
- Knowledge about single unified standard architecture IEC 61850.
- To 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

Evolution of SCADA, Definition of SCADA, What is SCADA, Objectives of SCADA, Benefits of SCADA, Functions of SCADA, Features of SCADA: Alarms Handling, Trends curves, Real Time access and archiving and database Management, Computer Networking and processing. Communication technologies. Data acquisition systems, Functional requirements and Components, Monitoring and supervisory functions, SCADA applications in Utility Automation: Electric power generation, transmission and distribution, Water, Wastewater Utilities and Sewage, Buildings, facilities and environments, Oil and Gas Trans & Distributions, Wind Power Generation, Communication Networks, Industrial Plans and Process Control Industries SCADA, Usage of SCADA, Consideration and benefits of SCADA system

Unit-II: SCADA System Components

Human Machine Interface, Supervisory System, Remote Terminal Units, Programmable Logic Controllers, Communication Infrastructure, SCADA Programming Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED):Protection function including phasor estimation Programmable logic and breaker control Metering and power quality analysis Self-monitoring and external circuit monitoring Event reporting and fault diagnosis Tools for settings, commissioning, and testing Programmable LCD display and PLC: Block diagram, programming languages, Ladder diagram, Functional block diagram, Applications, Interfacing of PLC with SCADA. Communication Network, Communication Network, SCADA Server, SCADA/HMI Systems

Unit-III: SCADA Architecture

Various SCADA architectures: First Generation: Monolithic or Early SCADA systems, Second Generation: Distributed SCADA systems, Third Generation: Networked SCADA systems and Fourth Generation: Internet of things technology, SCADA systems advantages and disadvantages of each system –Single unified standard architecture, IEC 61850 SCADA: Introduction to IEC 61850, IEC 61850 – Fundamentals, IEC 61850 – Object Structure, IEC 61850 – Other features

Unit-IV: SCADA Communication

SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Protocols in SCADA Communication, EC 60870-5, DNP3 Protocol, DNP3 Security, DNP3 in SCADA Communication, Advantages of using DNP3, Comparison of T101 and DNP3 Comparison of various communication protocols, Other SCADA Protocols: Modbus RTU, RP-570, Profibus, Conitel, SCADA Communication: various industrial communication technologies-wired and wireless methods and fiber optics. Open standard communication protocols.

Unit-V: SCADA Applications in Power System

Utility applications - Transmission and Distribution sector- operations, monitoring, analysis and improvement. Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration Industries - oil, gas and water, Case studies, Implementation.

Suggested Readings:

1. Stuart A Boyer. SCADA-Supervisory Control and Data Acquisition', Instrument Society of America Publications. USA. 1999.
2. Gordon Clarke, Deon Reynders: “Practical Modern SCADA Protocols: DNP3, 60870.5 andRelated Systems”, Newnes Publications, Oxford, UK, 2004.
3. David Bailey, Edwin Wright, Practical SCADA for Industry, Newnes (an imprint of Elsevier), 2003

Reference Books:

1. William T. Shaw, Cyber security for SCADA systems, PennWell Books, 2006
2. KLS Sharma, Overview of Industrial Process Automation, Elsevier Publication
3. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric Power, PennWell 1999

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -III
EE214PE: PWM Converters and Applications

Prerequisites: Power Electronics

Course Objectives

- Understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
- Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

Course Outcomes

On the successful completion of the course, students will be able to:

- Knowledge concepts and basic operation of PWM converters, including basic circuit operation and design
- Learn the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality
- Able to recognize and use the following concepts and ideas:Steady-State and transient modeling and analysis of power converters with various PWM techniques.

Unit-I

AC/DC and DC/AC power conversion, Overview of applications of voltage source converters and current source converters.

Unit-II

Pulse width modulation techniques for bridge converters, Bus clamping PWM.Space vector based PWM., Advanced PWM techniques.

Unit-III

Practical devices in converter, Calculation of switching and conduction power losses.

Unit-IV

Compensation for dead time and DC voltage regulation, Dynamic model of PWM converter.Multilevel converters, Constant V/F induction motor drives.

Unit-V

Estimation of current ripple and torque ripple in inverter fed drives, Line-side converters with power factor compensation. Active power filtering. Reactive power compensation, Harmonic current compensation, Selective harmonic elimination PWM technique for high power electric drives.

Suggested Readings:

1. Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John’s Wiley and Sons.
2. Erickson RW, “Fundamentals of Power Electronics”, Chapman and Hall.

Reference Books:

1. Vithyathil. J, “Power Electronics: Principles and Applications”, McGraw Hill.
2. NPTEL Online Course, Pulse width Modulation for Power Electronic Converters by Dr. G. Narayanan ,https://www.youtube.com/playlist?list=PLbMVogVj5nJQoZqyLxx-cg_dYE-Dt 2UMH

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -IV
EE215PE: Advanced Microcontroller Based Systems

Prerequisites: Computer Organization, Microcontrollers

Course Objectives

- Understand the architecture of advance microcontrollers
- Understand the applications of these controllers
- Know about FPGA.

Course Outcomes

On the successful completion of the course, students will be able to:

- Learn how to program a processor in assembly language and develop an advanced processor based system
- Learn configuring and using different peripherals in a digital system
- Compile and debug a Program
- Generate an executable file and use it

Unit-I

Basic Computer Organization, Accumulator based processes-Architecture-Memory Organization-I/O Organization

Unit-II

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication. Timers, Interrupts, Programming. Intel 8051 – Assembly language programming-Addressing-Operations-Stack & Subroutines, Interrupts, DMA.

Unit-III

PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/Oand data communication.

Unit-IV

Digital Signal Processor (DSP) - Architecture – Programming, Introduction to FPGA

Unit-V

Microcontroller development for motor control applications, Stepper motor control using micro controller.

Suggested Readings:

1. John.F.Wakerly: “Microcomputer Architecture and Programming”, John Wiley and Sons 1981.
2. Ramesh S.Gaonker: “Microprocessor Architecture, Programming and Applications with the 8085”, Penram International Publishing (India), 1994.

Reference Books:

1. Raj Kamal: “The Concepts and Features of Microcontrollers”, Wheeler Publishing, 2005.
2. Kenneth J. Ayala, “The 8051 microcontroller”, Cengage Learning, 2004.
3. John Morton,” The PIC microcontroller: your personal introductory course”, Elsevier, 2005.

4. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008.
5. Microchip datasheets for PIC16F877.
6. NPTEL Course on "Microprocessors and Microcontrollers " by Prof. Ajit Pal, Dept of Computer Science &Engg., IIT Kharagpur, https://www.youtube.com/playlist?list=PL0E131A78ABFBFDD

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -IV
EE216PE: Distributed Generation

Prerequisites: Power Systems, Power Electronics

Course Objectives

- Understand renewable energy sources.
- Gain understanding of the working of off-grid and grid-connected renewable energy generation schemes

Course Outcomes

On the successful 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 DGs Different types of interfaces, Inverter based DGs and rotating machine based interfaces, Aggregation of multiple DG units.

Unit-III

Technical impacts of DGs, Transmission systems 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 DGs Market facts, Issues and challenges Limitations of DGs, 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 DGs, Micro-grids with power electronic interfacing units.

Suggested Readings:

1. H. Lee Willis, Walter G. Scott, “Distributed Power Generation – Planning and Evaluation”, Marcel Decker Press.
2. M.GodoySimoes, Felix A.Farret, “Renewable Energy Systems – Design and Analysis with Induction Generators”, CRC press.

Reference Books:

1. Stuart Borlase. “Smart Grid: Infrastructure Technology Solutions” CRC Press
2. NPTEL online course on “Power Electronics and Distributed Generation” by Dr. Vinod John,Department of Electrical Engineering,IISc Bangalore.
   https://www.youtube.com/playlist?list=PLbMVogVj5nJTAcW3-MnF47B7VuNzbsMzb

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -IV
EE217PE: Power Quality

Prerequisites: Power Systems

Course Objectives

- To Study the basics of power quality and power quality standards
- To study Harmonics and its effects, interruptions and their origin
- To study voltage sag characterization and calculation of sag magnitude
- To analysis the behavior of different load under voltage sag
- To Study the analysis of conventional mitigation methods

Course Outcomes

After taking this course, the student will be able to:

- Know the different electric power quality issues in power systems
- Learn the harmonic distortion evaluation and controlling
- Learn to calculate sag magnitude and duration
- To observe equipment behavior under voltage sag
- Learn how to mitigate the power quality problems

Unit-I: Introduction

Introduction To Power Quality: overview of power quality phenomenon. Power quality terminology - Transients, Sag, Swell, interruptions, under voltages, over voltages, voltage unbalance, wave from distortion, Voltage fluctuations. Remedies to improve power quality, power quality monitoring and evaluation procedure

Power Quality Standards:

Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage Characteristics standards

Unit-II: Harmonics

Harmonic Distortion, Voltage versus Current Distortion, Harmonic Indexes, Sources of Harmonics, Effects of Harmonic Distortion, Harmonic Distortion Evaluations and principles of Controlling Harmonics.

Interruptions

Long interruptions: Difference between failures, outage, Interruptions, causes of Long Interruptions, costs of Interruption, Overview of Reliability evaluation to power quality.

Short Interruptions: origin of short interruptions, influence on equipment, single phase tripping, stochastic prediction of short interruptions.

Unit-III: Single and three-Phase voltage sag Characterization

Voltage sag –causes of voltage sag, sag magnitude and monitoring, sag coordination chart, theoretical calculation of voltage sag magnitude - non-radial systems and meshed systems, calculation of voltage sag duration. Sag due to three phase faults and classification, phase angle jumps, load influence on voltage sags, sags due to starting of induction motors.

Unit- IV: Power quality considerations in industrial power systems

Voltage tolerance curves-CBEMA, ITIC, SEMI. Voltage sag equipment behavior - Power electronic loads, computers and consumer electronics, induction motors, synchronous motors. Adjustable speed AC drives and its operation - Mitigation of AC Drives, Adjustable speed DC drive sand its operation – mitigation methods of DC drives.

Unit-V: Mitigation of interruptions & Voltage Sags

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods.

System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller, Cascade Connected Voltage Controllers.

Suggested Readings:

1. Math H J Bollen "Understanding Power Quality Problems" IEEE Press.
2. Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty "Electrical Power Systems Quality", McGraw Hill Education Private Ltd.

Reference Books:

1. C. Sankaran Power Quality, CRC Press.
2. R. Sastry Vedam Mulukutla S. Sarma "Power Quality VAR Compensation in Power Systems", CRC Press.
3. Power Quality: Problems and Mitigation Techniques by Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Wiley Publications, 2015

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Professional Elective -IV
EE218PE: Integration of Energy Sources

Prerequisites: Power Electronics, Renewable Energy Systems

Course Objectives

- Introduce the characteristics of various types of renewable energy sources and converters.
- Explain the importance of storage and sizing of hybrid systems.
- Introduce the control issues of isolated systems.
- Explain the harmonics, power quality, voltage imperfections, power injection issues on the grid by integrating renewable energy sources.

Course Outcomes

On the successful completion of the course, students will be able to:

- Identify the characteristics of renewable energy sources and converters.
- Analyze the importance of storage and sizing of hybrid systems.
- Realize the problems related to isolated systems.
- Analyze the challenges faced by the grid by integrating renewable energy sources

Unit-I: Review of Characteristics of Power Sources

Basic review of power generation from wind - Solar PV - Thermal - Small hydro - Biomass power strategies in each of these energy conversion systems - Review of maximum power point tracking techniques in solar PV and wind (perturb & observe, hill climbs, incremental conductance).

Unit-II: Converter Topologies

DC/DC converter (buck, boost, buck boost) - DC/AC inverters (sine, triangular, PWM techniques) - Phase locked loop for inverters.

Unit-III: Hybrid Systems

Advantages of hybrid power systems - Importance of storage in hybrid power systems - Design of hybrid power system based on load curve - Sizing of hybrid power systems

Unit-IV: Isolated Systems

Control issues in isolated systems for voltage and frequency - Small signal stability in isolated power systems - Importance of storage and dump load in isolated systems.

Unit-V: Issues in Integration of Renewable Energy Sources

Overview of challenges in integrating renewable sources to the grid - Impact of harmonics on power quality - Need to maintain voltage within a band and fluctuations in voltage because of renewable integration - Power inverter and converter technologies - Mechanism to synchronize power from renewable sources to the grid - Overview of challenges faced in designing power injection from offshore generation sources

Suggested Readings:

1. N. Mohan; T.M. Undeland; W.P. Robbins, Power Electronics, Converters, Applications and Design" 1995, John Wiley and Sons.
2. Hossain, Jahangir, Mahmud, Renewable Energy Integration Challenges and Solutions Series: Green Energy and Technology, Apel (Eds.).

Reference Books:

1. A. Farret, M. Godoy Simões, Integration of Alternative Sources of Energy Felix, December 2005, Wiley-IEEE Press.

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Audit Course – II
AC201HS: Disaster Management

Course Objectives

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in
- Provide knowledge about different disasters tools to handle disasters, methods for disaster management

Course Outcomes

- Understanding disasters, manmade hazards & vulnerabilities
- Understanding disaster management mechanism
- Understanding capacity building
- Understanding concepts
- Understanding planning of disaster management

Unit-I: Introduction & Disaster Prone Areas in India

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. 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-II: Repercussions of Disasters and Hazards

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 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-IV: 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: Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Unit-V: 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.

Suggested Readings:

1. Nishith R., Singh A K, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep et. al.," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Manual on Disaster Management, National Disaster Management, Agency Govt of India.

Reference Books:

1. Goel S.L., Disaster Administration and Management Text and Case Studies", Deep Publication Pvt. Ltd., New Delhi.
2. Pandharinath N., Rajan CK, Earth and Atmospheric Disasters Management BS Publications 2009.
3. National Disaster Management Plan, Ministry of Home affairs, Government of India (http://www.ndma.gov.in/images/policyplan/dmplan/draftndmp.pdf).

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Audit Course – II
AC202HS: Value Education

Course Objectives

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

Course Outcomes

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

Unit-I

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

Unit-IV

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

Unit-V

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

Suggested Readings:

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

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Audit Course – II
AC203HS: Pedagogy Studies

Course Objectives

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

Course Outcomes

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- 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 indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho 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.

Suggested Readings:

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. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

Reference Books:

1. Akyeampong K (2003) Teacher training in Ghana -does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
3. www.pratham.org/images/resource%20working%20paper%202.pdf.

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
Audit Course - II
AC204HS: Personality Development through Life Enlightenment Skills

Course Objectives

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

Course Outcomes

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

Unit-V

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

Suggested Readings:

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

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
EE251PC: Advanced Power Electronic Converters Lab

Prerequisites: Power Electronic Converters

Course Objectives

- Speed control techniques of DC and AC drives
- Gate drive circuit configurations for converter circuits
- Advanced converter topologies
- Open loop and closed loop speed control analysis of AC and DC drives

Course Outcomes

After completion of this lab, the student will be able to

- Know the speed control strategies of AC and DC drives
- Design speed, current controllers for AC and DC drives
- Get the knowledge on multi-level inverter/converter topologies
- Perform the open loop and closed loop speed control analysis of AC and DC drives
- Design the gate driver circuits for converter topologies
- Know the complete study of advanced converter technologies

PART-A: (Conduct any 5 hardware experiments)

1. Single phase diode clamped Multilevel inverter.
2. Single phase flying capacitor Multilevel inverter
3. Single phase cascaded Multilevel inverter
4. Push pull converter
5. Fly back converter
6. Forward converter
7. Series resonant converter
8. Parallel resonant converter
9. ZVS
10. ZCS

PART-B: Conductany 5experiments using any simulation tool

1. Single phase diode clamped Multilevel inverter.
2. Single phase flying capacitor Multilevel inverter
3. Single phase cascaded Multilevel inverter
4. Push pull converter
5. Fly back converter
6. Forward converter
7. Series resonant converter
8. Parallel resonant converter
9. ZVS
10. ZCS

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M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
EE252PC: Electrical Drives Lab

Prerequisites: Power Electronic Devices and Circuits and Electrical Machines

Course Objectives

- To understand principle 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 brushless dc motor principle of operation.

Course Outcomes

After completion of this lab, the student 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 1quadrant chopper
2. Speed control of separately excited DC Motor Drive with 4quadrant 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 4quadrant chopper for PMDC Motor Drive.
14. Isolated Gate Drive circuits for MOSFET/IGBT based circuits.

Note: Any ten experiments can be conducted.

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0	0	2	1

M.Tech. in Power Electronics and Electrical Drives
II Semester Syllabus
MA252BS: Finishing School-II
(Common to all Branches)

Course Objectives

This is a foundation course and aims to enhance employability skills in students.

- Students will be introduced to higher order thinking skills and problem-solving on the following areas - Arithmetic ability, Numerical ability and General reasoning.
- Students will be trained to work systematically with speed and accuracy while solving problems.

Course Outcomes

At the end of the course students will be able to:

- Solve questions on the above-mentioned areas using shortcut and smart methods
- Understand the fundamental concepts of Aptitude skills
- Perform calculations with speed and accuracy.

Unit-I: Quantitative Aptitude - Numerical Ability

- Number systems
- LCM & HCF
- Speed Math
- Divisibility Rules
- Square root
- Cube root
- Problems on numbers with shortcuts

Unit -II: Quantitative Aptitude- Arithmetic Ability-I

- Percentage
- Profit loss and discounts
- Simple and Compound interest
- Ratio proportions
- Averages

Unit-III: Quantitative Aptitude- Arithmetic Ability-II

- Pipes and Cisterns
- Ages
- Time-Speed-Distance
- Clocks & Calendars
- Venn diagrams
- Tables and graphs

Unit-IV: Reasoning Ability – General Reasoning-I

- Coding decoding
- Directions
- Series completions - Letter, Number & Element Series
- Seating arrangements

- Odd one out
- Spatial ability questions

Unit-V: Reasoning Ability- General Reasoning -II

- Analogies
- Alphabet Analogy
- Numerical Analogy
- Classification
- Alphabet Classification
- Word Classification
- Miscellaneous Classification
- Alphabet test
- Arranging words in Alphabetical Order
- Problems based on Letter-Word
- Problems based on Alphabetical Quibble
- Blood Relations
- Statements and conclusions
- Direction Sense test

Reference Books:

1. R.S. Aggarwal - Quantitative Aptitude for Competitive Examinations.
2. Arun Sharma - Quantitative Aptitude for CAT.
3. Arihant Publications - Fast Track Objective Arithmetic.
4. Sarvesh K.-Quantitative aptitude
5. A New Approach to Reasoning Verbal & Non-Verbal, Book by B.S. Sijwalii and Indu Sijwali
6. A Modern Approach to Logical Reasoning, Book by Agarwala Vikas and R.S. Aggarwal

M.Tech. in Power Electronics and Electrical Drives
Scheme of Instruction and Examination
(Choice Based Credit System)

III Semester

S.No.	Course Code	Course Title	Instruction Hours per week			Examination			Credits
						Max Marks		SEE Duration	
			L	T	P/D	CIE	SEE		
1	EE31XPE	Professional Elective - V	3	0	0	30	70	03	3
2		Open Elective	3	0	0	30	70	03	3
3	EE351PC	Dissertation Phase - I	0	0	20	100			10
Total Hours/Marks/Credits			**6**	**0**	**20**	**160**	**140**		**16**

IV Semester

S.No	Course Code	Course Title	Instruction			Examination			Credits
			Hours Per Week			Max. Marks		Duration of SEE in Hours	
			L	T	P	CIE	SEE		
1	EE451PC	Dissertation -II	0	0	32	50+ 50	--	-	16
		VIVA VOCE				--	100	-	
		Total Hours/Marks/Credits	**0**	**0**	**32**	**100**	**100**		**16**

L: Lecture **T**: Tutorial **D**: Drawing **P**: Practical **CIE** - Continuous Internal Evaluation **SEE** - Semester End Examination

List of Electives

Professional Elective – V

EE311PE: Reliability Engineering
EE312PE: Flexible AC Transmission Systems
EE313PE: HVDC Transmission
EE314PE: Energy Storage Technologies

Open Elective offered by the Department Electrical and Electronics Engineering to other branches:

EE321OE: Energy from Waste
EE322OE: Industrial Safety

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3	0	0	3

M.Tech. in Power Electronics and Electrical Drives
III Semester Syllabus
Professional Elective - V
EE311PE: Reliability Engineering

Prerequisites: Mathematics

Course Objectives

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

Course Outcomes

On the successful 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 related
- Understand or become aware of various failures, causes of failures and remedies for failures in practical systems.

Unit-I: Reliability and Probability

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

Unit-II: Hazard Rate

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

Unit-III: Classification of Engineering Systems

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

Unit-IV: Discrete Markov Chains

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

Unit-V: Frequency and Duration Techniques

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

Suggested Readings:

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

Reference Books:

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

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3	0	0	3

M.Tech. in Power Electronics and Electrical Drives
III Semester Syllabus
Professional Elective - V
EE312PE: Flexible AC Transmission Systems

Prerequisites: Power Electronics and Power Systems

Course Objectives

- To develop the understanding of uncompensated lines and their behavior under heavy loading conditions.
- To understand the concept and importance controllable parameters of FACTS controllers.
- To emphasize the objectives of Shunt compensation, and basic operation of SVC and STATCOM.
- To analyze the functioning of series controllers like GCSC, TSSC and TCSC.

Course Outcomes

On the successful completion of the course, students will be able to:

- Choose proper controller for the specific application based on system requirements
- Understand various systems thoroughly and their requirements
- Interpret the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
- Detect the Power and control circuits of Series Controllers GCSC, TSSC and TCSC

Unit-I: **Facts Concepts**

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

Unit-II: **Voltage Source Converters**

Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

Unit-III: Static Shunt Compensation

Objectives of shunt compensation, mid-point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators hybrid VAR generators

Unit-IV: SVC and STATCOM

The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

Unit-V: Static Series Compensators

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC) Control schemes for GSC TSSC and TCSC.

Suggested Readings:

1. Hingorani H G and Gyugyi. L " Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.
2. Padiyar. K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007

Reference Books:

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012.
2. Yong-Hua Song, Allan Johns, "Flexible AC Transmission Systems", IET, 1999

L	T	P	C
3	0	0	3

M.Tech. in Power Electronics and Electrical Drives
III Semester Syllabus
Professional Elective - V
EE313PE: HVDC Transmission

Prerequisites: Power Electronics and Power Systems

Course Objectives

To prepare the students to
- Understand state of the art HVDC technology.
- Learn the Methods to carry out modeling and analysis of HVDC system frontier-area power flow regulation.

Course Outcomes

Student will be able to
- Expose the students to the state of the art HVDC technology.
- Knowledge of modeling and analysis of HVDC system for inter-area power flow regulation.

Unit-I
Development of HVDC Technology, DC versus AC Transmission, Selection of converter configuration. Rectifier and Inverter operation, , Control of HVDC converters and Systems.

Unit-II
Control of HVDC System and converter, Characteristics of controller, Basic means of control, compounding of rectifier, reversal of Power flow, Individual phase control, Cosine, Linear control, Equidistance pulse controller, Pulse frequency control, Pulse phase control, Pulse period control, Energization of DC line, Denergization of Bridge.

Unit-III
Faults, arc back, arc through misfire, Commutation failure, Quenching, Short circuit in the bridge, Over voltages on AC/DC side, Protection against Over Voltages.

Unit-IV
Interaction between AC-DC power systems. Modelling of HVDC systems, per unit system, Representation for power flow solution, representation for stability studies.

Unit-V
MTDC, Systems, Control of MTDC, Characteristic and Non- characteristic harmonics, filter design.

Suggested Readings:
1. J. Arrillaga, “High Voltage Direct Transmission”, Peter Peregrinus Ltd. London, 1983.
2. K. R. Padiyar, “HVDC Power Transmission Systems”, Wiley Eastern Ltd., 1990.

Reference Books:
1. E. W. Kimbark, “Direct Current Transmission”, Vol. I, Wiley Interscience, 1971.
2. Erich Uhlmann, “Power Transmission by Direct Current”, B.S. Publications, 2004.

L	T	P	C
3	0	0	3

M.Tech. in Power Electronics and Electrical Drives
III Semester Syllabus
Professional Elective - V
EE314PE: Energy Storage Technologies

Prerequisites: Power Electronics and Power Systems

Course Objectives

- Introduce generalized storage techniques
- Analyze the different features of energy storage systems
- Know the management and applications of energy storage technologies
- Know about electrical energy storage market potential by different forecasting methods

Course Outcomes

On the successful 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, and Longer Term Outlook.

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

Suggested Readings:

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

Reference Books:

1. Huggins and Robert, Energy Storage Fundamentals, Materials and Applications, Springer.
2. www.ecofys.com/com/publications.

L	T	P	C
3	0	0	3

Department of Electrical and Electronics Engineering
III Semester Syllabus
Open Elective
EE321OE: Energy from Waste

Course Objectives

- To enable students to understand of the concept of waste to energy.
- To learn about the best available technologies for waste to energy
- To link legal, technical & management principles for production of energy from waste.

Course Outcomes

On the successful completion of the course, students will be able to:

- Apply the knowledge about the operation of waste to energy plants.
- Analyze the various aspects of waste to energy plant.
- Apply the knowledge in planning & operation of waste to energy plants.

Unit-I: Introduction to Energy from Waste

Introduction to Energy from Waste: Energy Scenario in India, waste to energy potential, Classification of waste, solid waste, waste liquid, waste gas, important quality parameters, Solid waste as fuel – Agro based, Forest residue, Industrial waste – municipal solid waste, Importance of solid waste management – Conversion devices – Incinerators, gasifiers, digesters

Unit-II: Biomass Pyrolysis

Biomass Pyrolysis: Pyrolysis – Types, slow pyrolysis and fast pyrolysis process–Operating conditions and end products- Manufacture of charcoal and properties – Methods - Yields and application – Manufacture of pyrolytic oils and gases and their properties, yields and applications.

Unit- III: Biomass Gasification

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation, Circulating fluidized bed, Dual fluidized bed – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation-Comparison of gasification and combustion

Unit-IV: Biomass Combustion

Biomass Combustion: Factors affecting combustion process - Biomass stoves –Requirements, Improved chullahs, types, some exotic designs, Fixed bed combustors, Types-Underfeed stokers, Grate Firings, inclined grate combustors, Design, construction and operation, Fluidized bed combustors- Circulating fluidized bed and bubbling fluidized bed, Design, construction and operation,

Unit-V : Biogas

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

Suggested Readings:

1. Desai, Ashok V, Non-Conventional Energy, Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C. and Mahdi, S. S, Biogas Technology - A Practical Hand Book - Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Challal, D. S, Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.

Reference Books:

1. C. Y. WereKo- Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996.
2. C Parker and T Roberts (Ed), Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985

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3	0	0	3

Department of Electrical and Electronics Engineering
III Semester Syllabus
Open Elective
EE322OE: Industrial Safety

Course Objectives

- To provide information regarding different elements of industrial water pollution and Methods of treatment.
- To expose to the various industrial applications, maintenance, preventive measures taken against wear and tear.

Course Outcomes

On the successful completion of the course, students will be able to:

- Know how to take safety measures in executing works
- Identify the need for maintenance (or) replacement of equipment
- Understand the need for periodic and preventive maintenance

Unit-I: Industrial safety

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

Unit-II: Fundamentals of maintenance engineering

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

Unit-III: Wear and Corrosion and their prevention

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

Unit-IV: Fault tracing

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

Unit-V: Periodic and preventive maintenance

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

Reference Books:

1. Higgins & Morrow, Maintenance Engineering Handbook, Da Information Services.
2. H. P. Garg, Maintenance Engineering, S. Chand and Company.
3. Audels, Pump-hydraulic Compressors, McGraw Hill Publication.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London.