ACADEMIC REGULATIONS
COURSE STRUCTURE AND
DETAILED SYLLABUS

ELECTRICAL & ELECTRONICS ENGINEERING

For

M. Tech. (Power Electronics)
(Two Year Full Time Programme)

JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)
Kukatpally, Hyderabad – 500 085, Telangana, India.
2015
## I – SEMESTER

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## IV – SEMESTER

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Elective-I
1. Machine Modeling and Analysis
2. Reactive Power Compensation and Management
3. High Frequency Magnetic Components

Elective-II
1. Analysis of HVDC Systems
2. Renewable Energy Systems
3. Electric Traction Technologies

Elective-III
1. Modern Control Theory
2. Advanced Digital Signal Processing
3. Industrial Instrumentation

Elective-IV
1. Microcontrollers and Applications
2. Embedded Systems
3. Reliability Engineering
4. Optimization Techniques
5. Energy Generation from Waste
6. Integration of Energy Sources

Elective-V
1. Dynamics of Electrical Machines
2. Special Machines
3. Smart Grid Technologies

Elective-VI
1. Flexible AC Transmission Systems
2. Switched Mode Power Supplies
3. Digital Control Systems

Elective-VII
1. Power Quality
2. Solar Photo Voltaic Systems
3. Hybrid and Electric Vehicles

Elective-VIII
1. Programmable Logic Controllers and Applications
2. AI Techniques in Electrical Engineering
3. Energy Efficient Systems
4. Software Engineering
5. Energy Storage Technologies
6. Electrical Engineering Materials
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year I-Sem (Power Electronics) L T P C
4 0 0 4

POWER ELECTRONIC CONVERTERS
(Core Theory – 1)

Prerequisite: Power Electronics

Course Objectives:
• To understand the characteristics and principle of operation of modern power semiconductor devices.
• To comprehend the concepts of different power converters and their applications.
• To analyze and design switched mode regulators for various industrial applications.

Learning Outcomes:
At the end of the course, the student is able to:
• Choose appropriate device for a particular converter topology.
• 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

UNIT III: SINGLE PHASE & THREE PHASE 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

UNIT V: PULSE WIDTH MODULATED INVERTERS


TEXT BOOKS:

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 –
POWER ELECTRONIC CONTROL OF DC DRIVES
(Core Theory – 2)

Prerequisite: Power Electronics

Course Objectives:
- To introduce drive system, characteristics of drive, and operating modes of drive
- To comprehend the principle and operation of phase control & Chopper controlled of dc drives.
- To design a current and speed controllers to achieve closed loop operation of dc drives.

Course Outcomes:
After completing this course, student will be able to:
- Perform simulations of phase and chopper controlled dc drive both for open loop and closed loop operations.
- Choose proper gain values for speed and current controllers.
- Distinguish the difference between PWM controller and hysteresis controller.

UNIT–I: SINGLE-PHASE RECTIFIER CONTROLLED DC MOTOR
Separately excited DC motors and DC series motors with rectified single phase supply – singlephase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor.

UNIT–II: THREE-PHASE RECTIFIERS CONTROLLED DC MOTOR (SEPARATELY EXCITED & SERIES)

UNIT–III: CLOSED LOOP CONTROL OF DC DRIVE

UNIT–IV: CHOPPER CONTROLLED DC MOTOR DRIVES
Principle of operation of the chopper – Chopper with other power devices – model of the chopper – input to the chopper – steady state analysis of chopper controlled DC motor drives – rating of the devices – Pulsating torque.

UNIT–V: FOUR QUADRANT OPERATION OF DC DRIVES
Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic and Regenerative Braking operations. Four quadrant operation of D.C motors by single phase, three phase dual converters and Choppers – Closed loop operation of DC motor.
TEXT BOOKS:

REFERENCES:
ELECTIVE – 1.1: MACHINE MODELING AND ANALYSIS

Prerequisite: Electrical Machines

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:
At the end of the course, the student is able to:
- Develop the mathematical models of various machines like, induction motor and Synchronous machines using modeling equations.
- Analyze the developed models in various reference frames.

UNIT-I:
Mathematical model of separately excited DC motor and DC Series motor in state variable form – Transfer function of the motor - Numerical problems.

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

UNIT-III:

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

UNIT-V:
Modeling of Permanent Magnet Synchronous motor – Modeling of Brushless DC Motor.
TEXT BOOKS:
2. Analysis of electric machinery and Drives systems - Paul C. Krause, Oleg waysnezuk, Scott D. Sudhoff.
3. Thyristor control of Electric Drives - VedamSubranmanyam.
4. Power System Stability and Control –PrabhaKundur, EPRI.

REFERENCE BOOKS:
ELECTIVE – 1.2: REACTIVE POWER COMPENSATION AND MANAGEMENT

Prerequisite: Power Systems

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

Course Outcomes:
Upon the completion of this course, the student will be able to
- Distinguish the importance of load compensation in symmetrical as well as unsymmetrical 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 SYSTEM
Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

Transient state reactive power compensation in transmission systems:

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:

UNIT-V: USER SIDE REACTIVE POWER MANAGEMENT
KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations
Reactive power management in electric traction systems and arc furnaces:
Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures – power factor of an arc furnace

TEXT BOOKS:

REFERENCE BOOKS:
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year I-Sem (Power Electronics)  

ELECTIVE – 1.3: HIGH FREQUENCY MAGNETIC COMPONENTS

Prerequisite: None

Course Objectives:
• To have a knowledge on magnetic circuits
• To know the skin effect and proximity effect

Course Outcomes:
Upon the completion of this course, the student 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:

UNIT-II:

UNIT-III:

UNIT-IV:


UNIT-V:

TEXT BOOKS:

REFERENCES:
4. “Thompson --- Electrodynamic Magnetic Suspension.pdf”
7. Dixon--- “Eddy current losses in transformer windings.pdf”
ELECTIVE – 2.1: ANALYSIS OF HVDC SYSTEMS

Prerequisite: Power Electronics and Power Systems

Course Objectives:
- To Comprehend the conversion principles of HVDC Transmission
- Analysis of 3, 6, 12 pulse converters, rectifier and inverter operations of HVDC converters
- To identify the different types of Harmonics and its suppression methods including Filters
- To comprehend the requirement of grounding and grounding electrodes for HVDC systems.

Course Outcomes:
Upon the completion of this course, the student will be able to
- Find the applications of HVDC transmission in the power system with the acquired knowledge.
- Analyze different converter topologies viz. 3, 6 and 12 Pulse converters and understand it’s control aspects.
- Understand the filter configuration and harmonic suppression methods.
- Have knowledge on grounding electrodes and their design for HVDC systems.

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

STATIC POWER CONVERTERS: 3-pulse, 6-pulse, and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers

UNIT-II

UNIT-III

UNIT-IV
Active filters and their applications – Filters with VSC HVDC schemes – other methods of harmonic elimination.

UNIT-V
GROUNDING AND GROUNDING ELECTRODES FOR HVDC SYSTEMS: Introduction – Advantages and problems with ground return – HVDC systems grounding – The current field in earth near an electrode – Resistance of electrodes-electric current field – Distribution of current field between the electrodes – natural current field due to the Earth’s magnetic field – Effect of ground return on buried objects – requirements of electrodes – basic parameters of design of ground electrodes – design of land electrodes.

TEXT BOOKS:


REFERENCE BOOKS:

JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year I-Sem (Power Electronics)                        L  T  P  C
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ELECTIVE – 2.2: RENEWABLE ENERGY SYSTEMS

Prerequisite: None

Course Objectives:
• To create the awareness of energy conservation in students
• To identify renewable energy sources for electrical power generation
• To analyze different energy storage methods
• To have knowledge on environmental effects of energy conversion

Course Outcomes:
Upon the completion of this course, the student will be able to
• Find different renewable energy sources to produce electrical power
• Estimate conventional energy sources to produce electrical energy
• Role-play the fact that the conventional energy resources are depleted
• Arrange Stored energy and to avoid the environmental pollution

UNIT-I: SOLAR ENERGY SYSTEMS:
Introduction – solar radiation - solar thermal energy conversion - Flat plate collector -
concentric collectors- solar pond - central receiver system- solar pumping - Solar
photovoltaic systems - characteristics of PV cell- Photo voltaic modules - Types of Photo
voltaic systems.

UNIT-II: WIND ENERGY AND BIO GAS:
Basics of wind energy - classification of turbines - wind characteristics - energy extraction -
Betz limit - Modes of wind power generation- Bio Mass energy conversion - Anaerobic
Digestion - Aerobic Digestion - Gasification-Bio Gas Plants.

UNIT-III: OCEAN ENERGY CONVERSION:
Tidal Energy generation - characteristics of Tides - Power generation schemes -
Components in Tidal power plant- Wave Energy - Principle of wave energy plant - Wave
energy conversion machines - Ocean Thermal Energy conversion - Principle - cycles of
operation - Types of OTEC plants - Applications

UNIT-IV: GEO- THERMAL ENERGY AND FUEL CELLS: HYBRID ENERGY SYSTEMS:
Geothermal Energy - Structure of Earth's interior - Geothermal fields, gradient, resources -
Geothermal power generation - Fuel cells – Introduction - Principle of operation - Types of
Fuel cells - State of art fuel cells-energy output of a fuel cell - operating characteristics of fuel
cells - thermal efficiency - Need for Hybrid systems - Types of Hybrid systems.

UNIT-V: ENVIRONMENTAL ASPECTS OF ELECTRIC ENERGY GENERATION:
Introduction - Thermal pollution - Hydel power projects - Impact on environment - Nuclear
power generation – Impact on environment - Impact of renewable energy generation on
environment - Global environmental awareness.
TEXT BOOKS:


REFERENCES:

JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year I-Sem (Power Electronics)                      L  T  P  C
ELECTIVE – 2.3: ELECTRIC TRACTION TECHNOLOGIES

Prerequisite: None

Course Objectives:
- To be able to understand various systems of track electrification, power supply system and mechanics of electric train.
- To understand various motors used in the electric traction and their converters.

Course Outcomes:
Upon the completion of this course, the student will be able to
- Distinguish the importance of single and three phase traction system.
- Observe various Traction mechanics
- Construct model HV arrangements, Semiconductor converter controlled drives.

UNIT – I
Traction Systems: Electric drives - Advantages & disadvantages - System of track electrification - DC, 1-Phase low frequency, 3-Phase low frequency and composite systems, Problems of 1-phase traction system - Current unbalance, Voltage unbalance, Production of harmonics, Induction effects, Booster transformer - Rail connected booster transformer. Comparison between ac and dc systems.

UNIT – II
Traction mechanics: Types of services, Speed - time curves - Construction of quadrilateral and trapezoidal speed time curves, Average & schedule speeds. Tractive effort - Speed characteristic, Power of traction motor, specific energy consumption - Factors affecting specific energy consumption, Coefficient of adhesion, slip - Factors affecting slip, magnetically suspended trains.

UNIT – III
Power supply arrangements: High voltage supply, Constituents of supply system - Substations, Feeding post, Feeding & sectioning arrangements, Remote control center, Design considerations of substations, Over head equipment - principle of design of OHE, Polygonal OHE - Different types of constructions, Basic sag & tension calculations, Dropper design, Current collection gear for OHE.

UNIT – IV

UNIT – V
TEXT BOOKS:

REFERENCE:
1. www.siemens.com/mobility/locomotives
2. www.abb.com/railway
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year I-Sem (Power Electronics)  L  T  P  C

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ELECTIVE – 3.1: MODERN CONTROL THEORY

Prerequisite: Control Systems

Course Objectives:
- To explain the concepts of basics and modern control system for the real time analysis and design of control systems.
- To explain the concepts of state variables analysis.
- To study and analyze 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:
Upon completion of this course, students should 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

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

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.

**TEXT BOOKS:**
1. M.Gopal, Modern Control System Theory, New Age International - 1984

**REFERENCES:**
ELECTIVE – 3.2: ADVANCED DIGITAL SIGNAL PROCESSING

Prerequisite: Digital signal processing

Course Objectives:
- To emphasize the advanced concepts of digital signal processing and the mathematical basis of discrete time signal analysis.
- To introduce the implementation of DSP algorithms and power spectrum analysis.

Course Outcomes:
After completion of this course, the students will be able to
- Solve the various types of practical problems of DSP processors.
- Develop DSP based real time systems.
- Design and analyze various filters.

UNIT–I
DIGITAL FILTER STRUCTURES: Block diagram representation – Equivalent Structures – FIR and IIR digital filter Structures All pass Filters - tunable IIR Digital Sine-cosine generator - Computational complexity of digital filter structures.

UNIT–II

UNIT–III
DSP ALGORITHM IMPLEMENTATION: Computation of the discrete Fourier transform- Number representation – Arithmetic operations – handling of overflow – Tunable digital filters – function approximation.

UNIT–IV

UNIT–V
TEXT BOOKS:

REFERENCE BOOKS:
3. Auntoniam, Digital Filter Analysis and Design, TMH.
ELECTIVE – 3.3: INDUSTRIAL INSTRUMENTATION

Prerequisite: None

Course Objectives:
- To study the characteristics of instruments
- Analyze the various types of transducers
- Principle of operation and selection of transducers depend on their applications.
- Basic knowledge of displacement, strain, pressure, temperature, flow, level, density, and viscosity measurements.

Course Outcomes:
After completion of this course, the students will be able to
- Select the transducers and their types, usage and operation and different characteristics of transducers.
- Calibrate the various instruments and application of various instruments to different fields.
- Implement process techniques, instrumental setups as well as controlling and monitoring of various processes in the industries.

UNIT – I: INTRODUCTION:
Introduction to Instrumentation system - Static and Dynamic characteristics of Instruments - Principles of transducers.

UNIT- II: MEASUREMENT OF DISPLACEMENT & STRAIN:
Displacement and proximity gauges - Linear Variable Differential Transformer (LVDT) - Measurement of strain: Strain Gauge - unbalanced Wheatstone bridge.

UNIT – III: MEASUREMENT OF TEMPERATURE:
Thermocouples - Resistance Temperature Detector (RTD) - Thermisters and radiation pyrometer.

UNIT- IV : MEASUREMENT OF FLOW:
Measurement of level: Capacitance based and Float based method. Differential pressure flow meters - variable area flow meters- variable reluctance flow meters - Turbine flow meter - Ultrasonic flow meter (Both transit time and Doppler Shift) - Electromagnetic flow meter and mass flow meter.

UNIT – V: MEASUREMENT OF PRESSURE & OTHER QUANTITIES:
Elastic transducers- Low pressure measurement-McLeod and ionization gauge-Load cell - Torque Cell - pH probe and viscosity measurement - Basics of Data transmission - Synchro and Servo motor - Pneumatic and Hydraulic Instrumentation system.

TEXT BOOK:
1. E. Doeblin," Industrial Instrumentation"- CRC Press
2. A.K.Sawhney,Course in Electrical and Electronics Measurements and Instrumentation, DhanpatRai& Company
ELECTIVE – 4.1: MICROCONTROLLERS AND APPLICATIONS

Prerequisite: Microprocessors and Interfacing Devices

Course Objectives:
- To relate the basic architecture and addressing modes of a microcontroller.
- To explain the principles of top down design to microcontroller software development.
- To demonstrate assembly language programs for the advanced Microcontroller, assembly language code for high-level language structures such as IF-THEN-ELSE and DO-WHILE.
- To analyze a typical I/O interface and to discuss timing issues.
- To identify different types of memory used in microcontrollers.

Course Outcomes:
Upon the completion of this course, the student will be able to:
- Distinguish types of computers & microcontrollers.
- Know 8-Bit, 16-Bit & 32 Bit advanced Microcontrollers.
- Develop Real time Applications of Microcontrollers & Demonstrate RTOS for Microcontrollers.
- Translate Hardware applications using Microcontrollers.

UNIT-I: OVERVIEW OF ARCHITECTURE & MICROCONTROLLER RESOURCES

UNIT-II: 8051- MICROCONTROLLERS INSTRUCTION SET
Basic assembly language programming – Data transfer instructions – Data and Bit-manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt flow.

UNIT-III: REAL TIME CONTROL
INTERRUPTS: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051.
TIMERS: Programmable Timers in the MCU’s – Free running counter and real time control – Interrupt interval and density constraints.

UNIT-IV: SYSTEMS DESIGN

UNIT-V: REAL TIME OPERATING SYSTEM FOR MICROCONTROLLERS:
Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers.

ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

TEXT BOOKS:

REFERENCES:
6. Microprocessors, Nilesh B. Bahadure, PHI Learning PVT. Ltd.
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year I-Sem (Power Electronics)  
ELECTIVE – 4.2: EMBEDDED SYSTEMS

Prerequisite: Microprocessors and Interfacing Devices

Course Objectives:

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

Course Outcomes:

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

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

UNIT- I: OVERVIEW OF EMBEDDED SYSTEM

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

UNIT-III: DEVICES, DEVICE DRIVERS & BUSES FOR DEVICE NETWORKS
I/O devices, Timer & Counter devices, Serial Communication, Communication between devices using different buses. Device drives, Parallel and serial port device drives in a system, Interrupt servicing mechanism, context and periods for context switching, Deadline and Interrupt Latency.

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

UNIT-V: HARDWARE AND SOFTWARE CO-DESIGN
Embedded system design and co-design issues in software development, design cycle in development phase for Embedded System, Use of ICE & Software tools for development of ES, Issues in embedded system design.

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

REFERENCES:
1. An embedded software primer by David Simon, PEA
2. Embedded systems design: Real world design by Steve Heath; Butterworth Heinenann, Newton mass USA 2002
3. Data communication by Hayt.
Elective – 4.3: Reliability Engineering

Prerequisite: None

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

Course Outcomes:
Upon the completion of this course, the student will be able to
- Apply fundamental knowledge of Reliability to modeling and analysis of series-parallel and Non-series parallel systems.
- Solve some practical problems related with Generation, Transmission and Utilization of Electrical Energy.
- Understand or become aware of various failures, causes of failures and remedies for failures in practical systems.

Unit I:

Unit II:

Unit III:
Classification of engineering systems: series, parallel and series-parallel systems- Expressions for the reliability of the basic configurations. Reliability evaluation of Non-series-parallel configurations: Decomposition, Path based and cutest based methods, Deduction of the Paths and cut sets from Event tree.

Unit IV:
UNIT-V:
Approximate system Reliability analysis of Series systems, parallel systems with two and more than two components, Network reduction techniques. Minimal cutset/failure mode approach.

TEXT BOOKS:

REFERENCE BOOKS:
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ELECTIVE-4.4: OPTIMIZATION TECHNIQUES

Prerequisite: None

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

Course Outcomes:
Upon the completion of this course, the student will be able to
- Know basic theoretical principles in optimization.
- Formulate optimization models and obtain solutions for optimization.
- Apply methods of sensitivity analysis and analyze post processing of results.

UNIT – I
Introduction and Classical Optimization Techniques:

Classical Optimization Techniques

UNIT – II
Linear Programming

UNIT – III
Transportation Problem
Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel’s approximation method – testing for optimality of balanced transportation problems.

UNIT – IV
Unconstrained Optimization Techniques
Univariate method, Powell’s method and steepest descent method.

Constrained Nonlinear Programming:
Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.
UNIT – V
Dynamic Programming:

TEXT BOOKS:

REFERENCES:
4. Linear Programming by G. Hadley
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ELECTIVE-4.5: ENERGY GENERATION FROM WASTE

Prerequisite: NCPG

Course Objectives:
- To understand the theory of Nonconventional energy sources.
- To develop an interest in applying energy generation from waste and solve problems of Engineering and Technology.

Course Outcomes:
Upon the completion of this course, the student will be able to
- Apply fundamental knowledge of NCPG to Generate Energy from Waste.
- Solve some practical problems related.
- Understand or become aware of various failures, causes of failures and remedies for failures in practical systems

UNIT-I:

UNIT-II:
Land Fill method of Solid waste disposal Land fill classification, Types, methods and Sitting consideration, Layout and preliminary design of landfills: Composition, characteristics, generation, Movement and control of landfill leachate and gases, Environmental monitoring system for land fill gases.

UNIT-III:

UNIT-IV:
Biogas production, Land fill gas generation and utilization, Thermo-chemical conversion: Sources of energy generation, Gasification of waste using Gasifiers, Briquetting, Utilization and advantages of briquetting, Environmental benefits of Bio-chemical and Thermo-chemical conversion.

UNIT-V:
TEXT BOOKS:

REFERENCES:
5. AD Bhide, BB Sundaresan, Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983

Google books:
(i) e-waste Management: From waste to ResourceKlaus Hieronymi, RamzyKahnat, Eric williams Tech. & Engg.-2013(Publisher: Earthscan 2013).
(ii) What is the impact of E-waste: Tamara Thompson
(iii) E-waste poses a Health Hazard: SairudeenPattazhy

6. Weblinks :
www.unep.org
www.routledge.com
www.amazon.com
www.bookdepository.com
www.ecoactiv.com
ELECTIVE-4.6: INTEGRATION OF ENERGY SOURCES

Prerequisite: Power Generation
Power Electronics
Power system Stability
Non-conventional energy sources

Preamble:
A comprehensive discussion of renewable energy resources, the associated conversion technologies for electric power generation and challenges in renewable energy integration to the grid are provided in this course. The course also introduces the importance hybrid systems and isolated systems.

Course Objectives:
Upon successful completion of the course the students will be familiar with:

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

Course Outcomes:
At the end of the course, the student should 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 - Challenges in modeling intermittent nature of renewable power in a power system.

TEXT BOOKS:
2. Renewable Energy IntegrationChallenges and SolutionsSeries: Green Energy and TechnologyHossain, Jahangir, Mahmud, Apel (Eds.)
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POWER CONVERTERS SIMULATION LAB

Course Objectives:
Upon successful completion of the lab students will be familiar with:
- Simulation of various AC-AC, AC-DC, DC-DC, DC-AC converter topologies
- Modeling and simulation of industrial drives

Course Outcomes:
At the end of the course, the student should be able to:
- Simulate AC-AC Converters
- Simulate AC-DC Converters
- Simulate DC-DC Converters
- Simulate DC-AC Converters
- Model and Simulate DC drives fed by power electronics converters
- Model and Simulate AC drives fed by power electronics converters

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.
7. Three-phase inverter with PWM controller.
8. DC-DC Converters.

Note: Use any two suitable software’s for each simulation.
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ADVANCED POWER ELECTRONIC CONVERTERS
(Core Theory – 3)

Prerequisite: Power Electronics

Course Objectives:
• To understand various advanced power electronics devices.
• To describe the operation of multi level inverters with switching strategies for high power applications.
• To comprehend the design of resonant converters and switched mode power supplies.

Course Outcomes:
After taking this course, 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

UNIT III: RESONANT CONVERTERS

UNIT IV: MULTILEVEL INVERTERS
drives -Switching device currents – dc link capacitor voltage balancing – features of Multilevel inverters – comparisons of multilevel converters.

UNIT V: D.C & A.C POWER SUPPLIES

TEXT BOOKS:
JNTUH COLLEGE OF ENGINEERING HYDERABAD

M.Tech. I Year II-Sem (Power Electronics)POWER ELECTRONIC CONTROL OF AC DRIVES
(Core Theory – 4)

Prerequisite: Power Electronic Devices and Circuits

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 taking this course, 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.

UNIT-I:
STATOR SIDE CONTROL OF INDUCTION MOTOR DRIVES

UNIT–II: ROTOR SIDE CONTROL OF INDUCTION MOTOR DRIVES

UNIT–III:
CONTROL OF SYNCHRONOUS MOTOR DRIVES: Synchronous motor and its characteristics – Control strategies – Constant torque angle control – Unity power factor control – Constant mutual flux linkage control – closed loop operation.
UNIT–IV:
**VARIABLE RELUCTANCE MOTOR DRIVE:** Variable Reluctance motor drive – Torque production in the variable reluctance motor Drive characteristics and control principles – Current control variable reluctance motor service drive.

**PMSM & BRUSHLESS DC MOTOR DRIVES:** Three phase full wave Brushless dc motor – Sinusoidal type of Brushless dc motor- current controlled Brushless dc motor Servo drive.

UNIT–V:

TEXT BOOKS:

REFERENCE BOOKS:
ELECTIVE – 5.1: DYNAMICS OF ELECTRICAL MACHINES

Prerequisite: Machine Modeling and Analysis

Course Objectives:
- To introduce generalized modeling electrical machines
- To analyze different electrical machines with dynamic modeling

Course Outcomes:
After taking this course, the student 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

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

UNIT-III: DYNAMICS OF DC MACHINES

UNIT-IV: INDUCTION MACHINE DYNAMICS

UNIT-V: SYNCHRONOUS MACHINE DYNAMICS

TEXT BOOKS:
JNTUH COLLEGE OF ENGINEERING HYDERABAD

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ELECTIVE – 5.2: SPECIAL MACHINES

Prerequisite: Electrical Machines

Course Objectives:

- To learn the constructional features, principle of operation, methods of control and applications of stepper motors.
- To understand the constructional features, principle of operation, methods of control and applications of Switched reluctance motors.
- To have an insight into the constructional features, principle of operation, methods of control and applications of PMBLDC motors.
- To know about the types, the constructional features, principle of operation, methods of control and applications of PMSM.
- To gain knowledge in the types, the constructional features, principle of operation, methods of control and applications of Synchronous machine.

Course Outcomes:

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

- Realize the need for stepper motors and the various applications in industries.
- Draw the operational characteristics and the applications of SRM.
- Know the various types of PMBLDC motors, rotor position sensors, methods of control and their applications.
- Know features, control and the applications of various special machines.

UNIT–I: STEPPER MOTORS

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

UNIT-II: VARIABLE RELUCTANCE STEPPING MOTORS

Variable reluctance (VR) Stepping motors, single-stack VR step motors, Multiple stack VR motors-Open-loop control of 3-phase VR step motor-closed-Loop control of step motor, discriminator (or rotor position sensor) transilator, major loop-characteristics of step motor in open-loop drive – comparison between open-loop position control with step motor and a position control servo using a conventional (dc or ac) servo motor- Suitability and areas of application of stepping motors-5- phase hybrid stepping motor - single phase - stepping motor, the construction, operating principle torque developed in the motor.

SWITCHED RELUCTANCE MOTOR:

Introduction – improvements in the design of conventional reluctance motors- Some distinctive differences between SR and conventional reluctance motors - principle of operation of SRM- Some design aspects of stator and rotor pole arcs, design of stator and rotor and pole arcs in SR motor-determination of $L(\theta)$ profile - power converter for SR motor - A numerical example – Rotor sensing mechanism and logic control, drive and power circuits, position sensing of rotor with Hall problems-derivation of torque expression, general linear case.
UNIT–III: PERMANENT MAGNET MATERIALS AND PMDC MACHINES
Introduction, Hysteresis loops and recoil line- stator frames (pole and yoke - part) of conventional PM dc Motors, Equivalent circuit of PM Generator and Motor-Development of Electronically commutated dc motor from conventional dc motor.

BRUSHLESS DC MOTOR: Types of construction – principle of operation of BLDM- sensing and switching logic scheme, sensing logic controller, lockout pulses --drive and power circuits, Base drive circuits, power converter circuit-Theoretical analysis and performance prediction, modeling and magnet circuit d-q analysis of BLDM - transient analysis formulation in terms of flux linkages as state variables-Approximate solution for current and torque under steady state –Theory of BLDM as variable speed synchronous motor ( assuming sinusoidal flux distribution )- Methods or reducing Torque Pulsations, 180 degrees pole arc and 120 degree current sheet.

UNIT-IV: LINEAR INDUCTION MOTOR
Development of a double sided LIM from rotary type IM- A schematic of LIM drive for electric traction development of one sided LIM with back iron-field analysis of a DSLIM fundamental assumptions.

UNIT-V: PERMANENT MAGNET AXIAL FLUX (PMAF) MACHINES
Construction, Armature windings – Toroidal Stator and Trapezoidal Stator Windings, Torque and EMF equations, Phasor diagram and output equation.

TEXT BOOKS:
1. Special electrical machines, K. Venkataratnam, - University press.
2. Special electrical machines, E. G. Janardanan, - PHI.

REFERENCE BOOKS:
3. Switched Reluctance Motor Drives by R. Krishnan, CRC Press,
ELECTIVE – 5.3: SMART GRID TECHNOLOGIES

Prerequisite: None

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

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

UNIT–I: INTRODUCTION

SMART GRID TO EVOLVE A PERFECT POWER SYSTEM: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

UNIT–II: DC DISTRIBUTION AND SMART GRID
AC Vs DC sources-Benefits of and drives of DC power delivery systems - Powering equipment and appliances with DC-Data centers and information technology loads - Future neighborhood-Potential future work and research.

INTELLIGRID ARCHITECTURE FOR THE SMARTGRID: Introduction- Launching intelligent grid –Intelligent grid today - Smart grid vision based on the intelligent grid architecture- Barriers and enabling technologies.

UNIT–III: DYNAMIC ENERGY SYSTEMS CONCEPT
Smart energy efficient end use devices-Smart distributed energy resources - Advanced whole building control systems- Integrated communications architecture - Energy management-Role of technology in demand response- Current limitations to dynamic energy management-Distributed energy resources-Overview of a dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.
UNIT–IV: ENERGY PORT AS PART OF THE SMART GRID:
Concept of energy - Port, generic features of the energy port.

POLICIES AND PROGRAMS TO ENCOURAGE END – USE ENERGY EFFICIENCY:
Policies and programs in action - multinational - national-state-city and corporate levels.

MARKET IMPLEMENTATION: Framework-factors influencing customer acceptance and response - program planning - monitoring and evaluation.

UNIT–V: EFFICIENT ELECTRIC END–USE TECHNOLOGY ALTERNATIVES

TEXT BOOKS:

REFERENCES:
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ELECTIVE – 6.1: FLEXIBLE AC TRANSMISSION SYSTEMS

Prerequisite: 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:
Upon the completion of this course, the student 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.

TEXT BOOKS:

REFERENCES:
ELECTIVE – 6.2: SWITCHED MODE POWER SUPPLIES

Prerequisite: Power Electronic Devices and circuits

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

Course Outcomes: After taking this course, student will be able to:
- Design converter system for electrical applications
- Understand and design SMPS.

UNIT – I
BASIC CONVERTER CIRCUITS:
Buck Regulator, Buck- Boost Regulator, Boost Regulator, Cuk Converters and Resonant Converters. Choice of switching frequency.

UNIT – II
ISOLATED SMPS:

UNIT – III
CONTROL ASPECTS
PWM Controllers, Isolation in feedback loop, Power Supplies with multiple output. Stability analysis using Bode Diagrams.

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

UNIT – V
ELECTRO MAGNETIC INTERFERENCE (EMI)
EMI Filter Components, Conducted EMI suppression, Radiated EMI suppression, Measurement.

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

THERMAL MODEL
TEXT BOOKS:

REFERENCES:
1. Krein P.T. Elements of Power Electronics., Oxford University Press
2. M.H.Rashid, Power Electronics. Prentice-Hall of India
ELECTIVE – 6.3: DIGITAL CONTROL SYSTEMS

Prerequisite: None

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

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

UNIT – I: Concept & Representation of Discrete time Systems

Z-transform:
Definition of Z-transforms – mapping between s-plane and z-plane – inverse z-transform – properties of z-transforms - ROC of z-transforms –pulse transfer function –relation between G(s) and G(z) – signal flow graph method applied to digital control systems.

UNIT- II: STATE SPACE ANALYSIS:

UNIT – III: Controllability, Observability & Stability tests
Concept of controllability, stabilizability, observability and reachability - Controllability and observability tests, Transformation of discrete time systems into controllable and observable forms.

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

UNIT-V: STATE OBSERVERS:
Design of - Full order and reduced order observers. Study of observer based control design
TEXT BOOKS:

REFERENCES:
2. M. Gopal, Digital Control and State Variable Methods, TMH.
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ELECTIVE – 7.1: POWER QUALITY

Prerequisite: Power Systems

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

Course Outcomes:
After taking this course, the student will be able to:
- Know the different characteristics of electric power quality in power systems,
- Learn about the applications of non-linear loads,
- Know the applications of Hartley and Wavelet Transforms,
- Learn how to mitigate the power quality problems
- Learn about the application of FACTS device on DG side.

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

UNIT-II:
LONG & SHORT INTERRUPTIONS

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

UNIT III:
SINGLE AND THREE-PHASE VOLTAGE Sag CHARACTERIZATION
Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration.

Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.
UNIT-IV:
POWER QUALITY CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS
Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

UNIT-V:
MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS
Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

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

TEXT BOOKS:

REFERENCES:
ELECTIVE – 7.2: SOLAR PHOTO VOLTAIC SYSTEMS

Pre-requisite: None

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

Course Outcomes:
After this course, the student will be able to
- Identify photovoltaic system components and system types
- Calculate electrical energy and power
- Correctly size system components, design considerations of solar equipment
- Design a basic grid-tie PV system.

UNIT – I

UNIT – II
SOLAR CELLS: Manufacture of Solar Cells-Technologies, Design of Solar cells, Photovoltaic modules, Design requirements, encapsulation systems, manufacture, power rating, hotspot effect, Design qualifications.

UNIT – III
PROTECTION AND MEASUREMENTS: Flat plate arrays, support structures, module interconnection and cabling, lightning protection, Performance measurement – using natural sun light and simulator, determination of temperature coefficients, internal series resistance, curve correction factor.

UNIT – IV
PHOTOVOLTAIC SYSTEMS: Photovoltaic systems- types- general design considerations-system sizing-battery sizing- inverter sizing-design examples – Balance of PV systems.

UNIT – V
MAXIMUM POWER POINT TRACKERS: Maximum power point trackers-algorithms-perturb and observe-incremental conductance method, hill climbing method, hybrid and complex methods, data based and other approximate methods, instrument design, other MPP techniques-Grid interactive PV system.

TEXT BOOKS:
1. Generating electricity from Sun, F.C.Treble, Pergamon Press
2. Photovoltaic systems: Analysis and design, A.K.Mukherjee, Nivedita Thakur, PHI 2011
ELECTIVE – 7.3: HYBRID AND ELECTRIC VEHICLES

Pre-requisites:
2. Electrical Machines-I.
3. Electrical Machines-II.
4. Power Electronics

Course Objectives:
Objectives of this course are to:
- Introduce the fundamental concepts, principles, analysis and design of hybrid and electric vehicles
- Introduce the various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used, energy storage devices, etc.

Course Outcomes:
After this course, the student will be able to
- Get knowledge on hybrid electric vehicles
- Compare the advantages and disadvantages of hybrid electric vehicles over conventional vehicles
- Compare the merits and demerits of hybrid electric trains over electrical trains
- Know the different energy storage techniques
- Discuss the electric population, motor drive technologies
- Analyze the different types of energy management strategies

UNIT-I:
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT-II:
Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT-III:
Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.
UNIT-IV:

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT-V:
Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

REFERENCES:
ELECTIVE – 8.1: PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS

Prerequisite: None

Course Objectives:
- To provide and ensure a comprehensive understanding of using advanced controllers in measurement and control instrumentation.
- To illustrate about data acquisition - process of collecting information from field instruments.
- To analyze Programmable Logic Controller (PLC), IO Modules and internal features.
- To Comprehend Programming in Ladder Logic, addressing of I/O.
- To apply PID and its Tuning.

Course Outcomes:
Upon the completion of this course, the student will be able to
- Describe the main functional units in a PLC and be able to explain how they interact.
- They should know different bus types used in automation industries.
- Development of ladder logic programming for simple process.

UNIT-I:
PLC Basics PLC system, I/O modules and interfacing CPU processor programming equipment programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT-II:
PLC Programming input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill-press operation.
Digital logic gates programming in the Boolean algebra system, conversion examples
Ladder diagrams for process control Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT-III:
PLC Registers: Characteristics of Registers module addressing holding registers input registers, output registers. PLC Functions Timer functions and industrial applications counters counter function industrial applications, Architecture functions, Number comparison functions, number conversion functions.

UNIT-IV:
Data handling functions: SKIP, Master control Relay Jump Move FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axes and three axis Robots with PLC, Matrix functions.

UNIT-V:
Analog PLC operation: Analog modules and systems Analog signal processing multi bit data processing , analog output application examples, PID principles position indicator with PID control, PID modules, PID tuning, PID functions
TEXT BOOKS:

REFERENCES:
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ELECTIVE – 8.2: AI TECHNIQUES IN ELECTRICAL ENGINEERING

Prerequisite: None

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

Course Outcomes:
Upon the completion of this course, the student will be able to
- Understand feed forward neural networks, feedback neural networks and learning techniques.
- Understand fuzziness involved in various systems and fuzzy set theory.
- Develop fuzzy logic control for applications in electrical engineering
- Develop genetic algorithm for applications in electrical engineering.

UNIT – I: ARTIFICIAL NEURAL NETWORKS

UNIT- II: ANN PARADIGMS

UNIT – III: FUZZY LOGIC

UNIT – IV: GENETIC ALGORITHMS

UNIT–V: APPLICATIONS OF AI TECHNIQUES
TEXT BOOKS:

REFERENCES:
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ELECTIVE – 8.3. ENERGY EFFICIENT SYSTEMS

Prerequisite: Power Systems

Course Objectives:

• To have basic concepts of Electrical systems, motors, generating systems.
• To illustrate the application of Electrical systems in PF improvement scheme
• To illustrate the application of pumps and pumping system.

Course Outcomes:

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

• Understand the advantages of Electrical system and its basic components.
• Understand the implementation of Energy Efficient Technologies in Electrical Systems

UNIT-I:
Electricity billing, Electrical Load Management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and Transformer losses.

UNIT-II:

UNIT-III:
Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities. HVAC and Refrigeration system: vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air-conditioning system performance and saving opportunities, vapor absorption refrigeration system - working principle, types and comparison with vapour compression system, saving potential Fans and Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

UNIT-IV:
UNIT-V:
**Diesel generating system:** Factors affecting selection, energy performance assessment of diesel conservation avenues. **Energy Efficient Technologies in Electrical Systems:** Maximum Demand Controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy saving potential of each technology. Calculation of energy frequency ratio in the performance of star ratings.

**TEXT BOOKS:**

**REFERENCE:**
3. Bureau of Energy Efficiency (BEE) : www.bee-india.nic.in
7. www.bee-india.nic.in (Guide on Energy Efficient room Air conditioners)
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ELECTIVE – 8.4: SOFTWARE ENGINEERING

Prerequisites
1. A course on “Computer Programming and Data Structures”
2. A course on “Object Oriented Programming Through Java”

Course Objectives:
1. The aim of the course is to provide an understanding of the working knowledge of the techniques for estimation, design, testing and quality management of large software development projects.
2. Topics include process models, software requirements, software design, software testing, software process/product metrics, risk management, quality management and UML diagrams

Course Outcomes:
1. Ability to translate end-user requirements into system and software requirements, using e.g. UML, and structure the requirements in a Software Requirements Document (SRD).
2. Identify and apply appropriate software architectures and patterns to carry out high level design of a system and be able to critically compare alternative choices.
3. Will have experience and/or awareness of testing problems and will be able to develop a simple testing report

UNIT-I:
Introduction to Software Engineering: The evolving role of software, changing nature of software, software myths.
A Generic view of process: Software engineering- a layered technology, a process framework, the capability maturity model integration (CMMI), process patterns, process assessment, personal and team process models.
Process models: The waterfall model, incremental process models, evolutionary process models, the unified process.

UNIT-II:
Software Requirements: Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document.
Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management.
System models: Context models, behavioral models, data models, object models, structured methods.

UNIT-III:
Design Engineering: Design process and design quality, design concepts, the design model.
Creating an architectural design: software architecture, data design, architectural styles and patterns, architectural design, conceptual model of UML, basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams.
UNIT-IV:
Testing Strategies: A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, the art of debugging.
Product metrics: Software quality, metrics for analysis model, metrics for design model, metrics for source code, metrics for testing, metrics for maintenance.

UNIT-V:
Metrics for Process and Products: Software measurement, metrics for software quality.
Risk management: Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM, RMMM plan.
Quality Management: Quality concepts, software quality assurance, software reviews, formal technical reviews, statistical software quality assurance, software reliability, the ISO 9000 quality standards.

TEXT BOOKS:
3. The unified modeling language user guide Grady Booch, James Rambaugh, Ivar Jacobson, Pearson Education.

REFERENCES:
Prerequisite: Power Systems

Course Objectives:
• To know about the Demand for Energy Storage.
• To study the roles of electrical energy storage technologies in electricity.
• To analyze the features of energy storage systems.

Course Outcomes:
At the end of the course the student will be able to:
• Evaluate various techniques for storing electrical energy.
• Understand the features of storage systems and apply them for conventional power generation, grid operation & service.

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 Microgrid, Smart House, Electric vehicles,

UNIT-IV: Management and control hierarchy of EES:
Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems and distributed generation (Virtual Power Plant), “Battery SCADA” – aggregation of many dispersed batteries.

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

Valuation Techniques:
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

TEXT BOOKS:
1. Techno-Economic Analysis of Different Energy Storage Technologies, Hussein Ibrahim and Adrian Ilinca
3. Energy Storage, Yves Brunet (Editor), May 2013, Wiley-ISTE

REFERENCES:
1. andreasoberhofer@gmx.de
2. www.ecofys.com/com/publications
3. www.iec.ch
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ELECTIVE – 8.6. ELECTRICAL ENGINEERING MATERIALS

Prerequisite: EMF

Course Objectives:
- To know the properties, characteristics of dielectric materials.
- To study the properties, characteristics of dielectric materials.
- To analyze the properties, characteristics of semiconductor materials.
- To discuss the different kind of materials for electric applications.
- To have a glance on the properties, characteristics of special materials.

Course Outcomes:
At the end of the course the student will be able to:
- Evaluate insulating, conducting and magnetic materials used in electrical machines.
- Understand the properties of liquid, gaseous and solid insulating materials.
- Evaluate transformer oil by testing

UNIT-I:
DIELECTRIC MATERIALS
Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, Polarization, Curie point, antiferromagnetic materials, piezoelectric materials, pyroelectric materials.

UNIT-II:
MAGNETIC MATERIALS
Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriiction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets, factors effecting permiability and hysteresis.

UNIT-III:
SEMICONDUCTOR MATERIALS
Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

UNIT-IV:
MATERIALS FOR ELECTRICAL APPLICATIONS
Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials, Solid Liquid and Gaseous insulating materials. Effect of moisture on insulation.
UNIT-V:
SPECIAL PURPOSE MATERIALS
Refractory Materials, Structural Materilas, Radioactive Materials, Galvonization and Impregnation of materials, Processing of electronic materials, Insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI.

TEXT BOOKS:

REFERENCE:
1. TTTI Madras: Electrical Engineering Materials
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POWER CONVERTERS LAB

Course Objectives:
Upon successful completion of the lab students will be familiar with:

- 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:
At the end of the course, the student should 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.

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

Note: Any ten experiments can be conducted.
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SOFT SKILLS LAB (Activity-based)

Course Objectives
- To improve the fluency of students in English
- To facilitate learning through interaction
- To illustrate the role of skills in real-life situations with case studies, role plays etc.
- To train students in group dynamics, body language and various other activities which boost their confidence levels and help in their overall personality development
- To encourage students develop behavioral skills and personal management skills
- To impart training for empowerment, thereby preparing students to become successful professionals

Learning Outcomes
- Developed critical acumen and creative ability besides making them industry-ready.
- Appropriate use of English language while clearly articulating ideas.
- Developing insights into Language and enrich the professional competence of the students.
- Enable students to meet challenges in job and career advancement.

INTRODUCTION
Definition and Introduction to Soft Skills – Hard Skills vs Soft Skills – Significance of Soft/Life/Self Skills – Self and SWOT Analysis and

1. Exercises on Productivity Development
- Effective/ Assertive Communication Skills (Activity based)
- Time Management (Case Study)
- Creativity & Critical Thinking (Case Study)
- Decision Making and Problem Solving (Case Study)
- Stress Management (Case Study)

2. Exercises on Personality Development Skills
- Self-esteem (Case Study)
- Positive Thinking (Case Study)
- Emotional Intelligence (Case Study)
- Team building and Leadership Skills (Case Study)
- Conflict Management (Case Study)

3. Exercises on Presentation Skills
- Netiquette
- Importance of Oral Presentation – Defining Purpose- Analyzing the audience- Planning Outline and Preparing the Presentation- Individual & Group Presentation- Graphical Organizers- Tools and Multi-media Visuals
- One Minute Presentations (Warming up)
- PPT on Project Work- Understanding the Nuances of Delivery- Body Language – Closing and Handling Questions – Rubrics for Individual Evaluation (Practice Sessions)

4. Exercises on Professional Etiquette and Communication
- Role-Play and Simulation- Introducing oneself and others, Greetings, Apologies, Requests, Agreement & Disagreement….etc.
• Telephone Etiquette
• Active Listening
• Group Discussions (Case study)- Group Discussion as a part of Selection Procedure- Checklist of GDs
• Analysis of Selected Interviews (Objectives of Interview)
• Mock-Interviews (Practice Sessions)
• Job Application and Preparing Resume
• Process Writing (Technical Vocabulary) – Writing a Project Report- Assignments

5. Exercises on Ethics and Values
Introduction — Types of Values - Personal, Social and Cultural Values - Importance of Values in Various Contexts
• Significance of Modern and Professional Etiquette – Etiquette (Formal and Informal Situations with Examples)
• Attitude, Good Manners and Work Culture (Live Examples)
• Social Skills - Dealing with the Challenged (Live Examples)
• Professional Responsibility – Adaptability (Live Examples)
• Corporate Expectations

Note: Hand-outs are to be prepared and given to students.
Training plan will be integrated in the syllabus.
Topics mentioned in the syllabus are activity-based.

SUGGESTED SOFTWARE:
The following software from 'train2success.com'
- Preparing for being Interviewed
- Positive Thinking
- Interviewing Skills
- Telephone Skills
- Time Management
- Team Building
- Decision making

SUGGESTED READING:
12. The Hindu Speaks on Education by the Hindu Newspaper