VISION:

The vision of the department is to produce analytically proficient and technologically competent Electrical and Electronics Engineers who can serve and take forward the academic, industry and research organizations to newer heights and be effective for building the nation.

MISSION:

- To impart high quality technical education with the state of the art laboratory practice.
- To provide conducive academic ambience to enable best teaching and learning processes.
- To generate resources through research and consultancy projects for pursuing research and developmental activities in emerging areas.
- To associate with academic and industrial organizations for research activities to develop and provide vital and viable solutions for social needs indigenously.
- To develop leadership skills in students with high degree of ethics, morals and values and instill confidence to lead the organization.
1. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

<table>
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<tr>
<th>I.</th>
<th>Employability in Core Electrical and Electronics Engineering and other allied emerging areas</th>
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<tr>
<td>II.</td>
<td>Motivated to take up technical lead position and lead the organization competitively.</td>
</tr>
<tr>
<td>III.</td>
<td>Pursue higher studies and research</td>
</tr>
<tr>
<td>IV.</td>
<td>Act as a consultant and provide solutions to the practical problems of core organization.</td>
</tr>
<tr>
<td>V.</td>
<td>Take up entrepreneurship as career and be part of electrical and electronics product and service industries.</td>
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2. PROGRAM OUTCOMES (POs)

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<th>PO#</th>
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<tr>
<td>1</td>
<td><strong>Engineering knowledge</strong>: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.</td>
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<tr>
<td>2</td>
<td><strong>Problem analysis</strong>: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td>
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<tr>
<td>3</td>
<td><strong>Design/development of solutions</strong>: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.</td>
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<tr>
<td>4</td>
<td><strong>Conduct investigations of complex problems</strong>: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
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<tr>
<td>5</td>
<td><strong>Modern tool usage</strong>: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.</td>
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<tr>
<td>6</td>
<td><strong>The engineer and society</strong>: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.</td>
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<tr>
<td>7</td>
<td><strong>Environment and sustainability</strong>: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.</td>
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<td>8</td>
<td><strong>Ethics</strong>: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.</td>
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<tr>
<td>9</td>
<td><strong>Individual and team work</strong>: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.</td>
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<tr>
<td>10</td>
<td><strong>Communication</strong>: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.</td>
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<tr>
<td>11</td>
<td><strong>Project management and finance</strong>: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.</td>
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<td>12</td>
<td><strong>Life-long learning</strong>: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.</td>
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### 3. PROGRAM SPECIFIC OUTCOMES (PSOs)
After completion of B.E – EEE, the students would have,

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<tr>
<td>1.</td>
<td>The ability to understand, model, analyse, electrical circuits, equipment, Power system under steady state and transient conditions.</td>
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<td>The ability to formulate and design electrical systems for sustainable energy technologies.</td>
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<td>Ability for lifelong learning in electrical applications to societal problems.</td>
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<td>Ability to use knowledge in various domains to identify research gaps and hence to provide solution leading to new ideas and innovations.</td>
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### SEMESTER IV

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**Total:** 62
UNIT I MATRICES
Eigen values and Eigen vectors of a real matrix – Properties of Eigen values - Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES

UNIT III INTEGRAL CALCULUS

UNIT IV MULTIPLE INTEGRALS

UNIT V VECTOR CALCULUS
Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green’s theorem, Stoke’s and Gauss divergence theorems – Verification and applications in evaluating line, surface and volume integrals.

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Use the matrix algebra methods for solving practical problems.
CO2: Use differential calculus ideas on several variable functions.
CO3: Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO4: Apply multiple integral ideas in solving areas and volumes problems.
CO5: Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

REFERENCES:
PTPH3151

ENGINEERING PHYSICS

UNIT I  MECHANICS OF MATERIALS  9

UNIT II OSCILLATIONS, SOUND AND THERMAL PHYSICS  9

UNIT III  OPTICS AND LASERS  9

UNIT IV QUANTUM MECHANICS  9

UNIT V CRYSTAL PHYSICS  9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
After completion of this course, the students shall be
CO1: Understand the important mechanical properties of materials
CO2: Express the knowledge of oscillations, sound and applications of Thermal Physics
CO3: Know the basics of optics and lasers and its applications
CO4: Understand the basics and importance of quantum physics.
CO5: Understand the significance of crystal physics.

TEXT BOOKS:

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* 1’ = Low; ‘2’ = Medium; ‘3’ = High
UNIT I POLYMER CHEMISTRY

Engineering Plastics: Polyamides, Polycarbonates and Polyurethanes. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring

UNIT II NANOCHEMISTRY

UNIT III CORROSION SCIENCE

UNIT IV ENERGY SOURCES
Batteries - Characteristics - types of batteries – primary battery (dry cell), secondary battery (lead acid, lithium-ion-battery)- emerging batteries – nickel-metal hydride battery, aluminum air battery, batteries for automobiles and satellites - Fuel cells (Types) – H2-O2 fuel cell - Supercapacitors-Types and Applications, Renewable Energy: Solar- solar cells, DSSC

UNIT V WATER TECHNOLOGY

TOTAL: 45 PERIODS

OUTCOMES:
CO1: To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.

CO2: To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

CO3: To recognize and apply basic knowledge on suitable corrosion protection technique for practical problems.

CO4: To recognize different storage devices and apply them for suitable applications in energy sectors.

CO5: To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:
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• 1’ = Low; ‘2’ = Medium; ‘3’ = High

PTGE3153 PROGRAMMING IN C LT P C 2044

UNIT I BASICS OF C PROGRAMMING
6+12
Introduction to programming paradigms – Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

PRACTICALS:
- Designing programs with algorithms/flowchart
- Programs for i/o operations with different data types
- Programs using various operators
- Programs using decision making and branching statements

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS
6+12
Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

PRACTICALS:
- Programs using for, while, do-while loops and nested loops.
- Programs using arrays and operations on arrays.
- Programs implementing searching and sorting using arrays
- Programs implementing string operations on arrays

UNIT III FUNCTIONS AND POINTERS
6+12
Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation with malloc/calloc

PRACTICALS:
- Programs using functions
- Programs using recursion
- Programs using pointers & strings with pointers
- Programs using Dynamic Memory Allocation
UNIT IV  STRUCTURES AND UNION  
Storage class, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef, bit fields, enumerated data types, Union.

PRACTICALS:
- Programs using Structures
- Programs using Unions
- Programs to pointers to structures and self-referential structures

UNIT V  MACROS AND FILE PROCESSING  

PRACTICALS:
- Programs using pre-processor directives & macros
- Programs to handle file operations
- Programs to handle file with structure

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Write simple C programs using basic constructs.
CO2: Design searching and sorting algorithms using arrays and strings.
CO3: Implement modular applications using Functions and pointers.
CO4: Develop and execute applications using structures and Unions.
CO5: Solve real world problem using files.

TOTAL PERIODDS: 90 (30+60)

TEXT BOOKS:

REFERENCE BOOKS:

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- 1’ = Low; ‘2’ = Medium; ‘3’ = High
UNIT I  ORDINARY DIFFERENTIAL EQUATIONS  (9+3)
Homogeneous linear ordinary differential equations of second order, linearity principle, general solution-
Particular integral – Operator method – Solution by variation of parameters – Method of undetermined
coefficients – Homogenous equations of Euler–Cauchy and Legendre’s type – System of simultaneous linear
differential equations with constant coefficients.

UNIT II  LAPLACE TRANSFORMS  (9+3)
Existence theorem – Transform of standard functions – Transform of Unit step function and Dirac delta function
– Basic properties – Shifting theorems – Transforms of derivatives and integrals – Transform of periodic
functions – Initial and Final value theorem - Inverse Laplace – Convolution theorem (without proof) – Solving
Initial value problems by using Laplace Transform techniques.

UNIT III  FOURIER SERIES  (9+3)
Dirichlet’s conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series
– Complex form of Fourier series – Parseval’s identity – Harmonic Analysis.

UNIT IV  FOURIER TRANSFORMS  (9+3)
Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transform
of elementary functions – Convolution theorem (without proof) – Parsevals’s identity.

UNIT V  Z – TRANSFORM AND DIFFERENCE EQUATIONS  (9+3)
Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value
theorems – Formation of difference equation – Solution of difference equation using Z – transform.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Solve higher order ordinary differential equations which arise in engineering applications.
CO2: Apply Laplace transform techniques in solving linear differential equations.
CO3: Apply Fourier series techniques in engineering applications.
CO4: Understand the Fourier transforms techniques in solving engineering problems.
CO5: Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

REFERENCES:
   Delhi, 2009.
   New Delhi, 2017.
   New Delhi , 2012.
   2010.
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PTPH3251                                           PHYSICS FOR ELECTRICAL SCIENCES                                                   LT P C
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UNIT I           ELECTRICAL PROPERTIES OF MATERIALS                                                                                 9
Classical free electron theory – Expression for electrical conductivity– Thermal conductivity, expression
Wiedemann – Franz law – Quantum free electron theory – Degenerate energy states – Density of States –
– Conductors – Semiconductors – Insulators – tight-binding approximation. Electron effective
mass– the concept of hole.

UNIT II          SEMICONDUCTORS AND TRANSPORT PHYSICS                                                                       9
Intrinsic Semiconductors – Energy band diagram – direct and indirect bandgap semiconductors– Carrier
concentration in intrinsic semiconductors – Determination of band gap – extrinsic semiconductors - Carrier
concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier
transport in Semiconductors: Drift, mobility, diffusion and carrier lifetime – Hall effect –devices and sensors –
Ohmic contacts – Peltier coolers – Schottky diode – solar cell

UNIT III         DIELECTRIC AND MAGNETIC PROPERTIES OF MATERIALS                                                   9
Electric Dipole moment and polarization vector, Polarization mechanisms: electronic, ionic, orientational, interfacial
and total polarization dielectric constant and dielectric loss – dielectric strength and insulation – Applications of
dielectric materials. Origin of Magnetism – atomic magnetic moments – Bohr magneton magnetic materials: 
diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism. Ferromagnetism – origin and exchange
interaction – Domain theory –saturation magnetization and curie temperature-domain walls and motion – Hysteresis soft and hard magnetic materials GMR effect GMR materials – Applications Magnetic
data storage.

UNIT V          OPTICAL PROPERTIES OF MATERIALS                                                                                      9
Light waves in a homogeneous medium – refractive index – dispersion: refractive index-wavelength behavior group
velocity and group index – Fresnel’s equations: reflection and transmission coefficients, Absorption, 
emission and scattering of light – Luminescence – Phosphors LED’s Principle and working white LED, Laser
diode – optical Amplifiers – Organic LED and Plasma light emitting devices, LCD Homojunction and Hetero 
junction laser diodes. Optical data storage techniques(CD, DVD and Blue-ray disc,

UNIT V          NANODEVICES                                                                                                                        9
Electron density in a conductor – Significance between Fermi energy and volume of the material Quantum
confinement Quantum structures – Density of states for quantum wells, wires and dots Band gap of
nanomaterials Tunneling. Single electron phenomena – Single electron Transistor. The conductivity of metallic nanowires Ballistic transport Quantum resistance and conductance Carbon nanotubes:
Properties and applications Transporters Spintronic devices and application.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completing the above subject, students will have
CO1: Knowledge of the electrical properties of materials
CO2: Acquire an adequate understanding of semiconductor physics and the functioning of semiconductor devices

CO3: Come to have firm knowledge of the dielectric and magnetic properties of materials and their applications

CO4: Understand the optical properties of materials and working principles of various optical devices

CO5: Appreciate the importance of nanotechnology, the physics of nanodevices, low-dimensional structures and their applications

REFERENCES

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PTCY3251 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY LT P C

UNIT I   ENVIRONMENT AND BIODIVERSITY 6

UNIT II   ENVIRONMENTAL POLLUTION 6

UNIT III  RENEWABLE SOURCES OF ENERGY 6
Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV  SUSTAINABILITY AND MANAGEMENT 6
Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V  SUSTAINABILITY PRACTICES 6
and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1 To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

CO2 To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

CO3 To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4 To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

CO5 To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXTBOOKS:


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- 1-low, 2-medium, 3-high
UNIT I  INTRODUCTION TO DC AND AC CIRCUITS  
Types of sources, Independent and Dependent; Ohm's law, Kirchhoff's laws. Mesh, Node, super mesh and super node analysis.  
AC Circuits: Basic definitions; phasors and complex representation; RMS, Average value, form factor, peak factor- AC signals; solution of RLC networks; power, energy relations and power factor calculations. Mesh and Nodal Analysis.

UNIT II  NETWORK REDUCTION TECHNIQUES AND NETWORK THEOREMS  
Series parallel circuits; star and delta transformation; Superposition, Rreciprocity, Compensation, Thevenin's, Norton's and Maximum Power Transfer Theorems; Analysis with dependent and independent sources-Application to DC and AC networks.

UNIT III  SOLUTION OF FIRST AND SECOND ORDER NETWORKS  

UNIT IV  RESONANCE AND TWO PORT NETWORKS  
Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

UNIT V  THREE PHASE CIRCUITS  
Three phase balanced/unbalanced circuits, phase sequence — analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced loads – phasor diagram of voltages and currents – power and power factor measurements in three phase circuits.

COURSE OUTCOMES:
Upon completion of the course, the students will be able to understand

CO1 the concepts of electrical circuits, fundamental laws and theorems.
CO2 the natural response and the forced response to excitations of the first and second order networks.
CO3 the concepts of complex frequency and its use in relating the forced response and natural response.
CO4 magnetic coupling and two port networks.
CO5 the concepts of poly phase circuits.

TEXT BOOKS:


REFERENCES:

LIST OF EXPERIMENT
1. Experimental verification of Kirchhoff’s voltage and current laws.
2. Experimental verification of network theorems (Thevenin’s, Norton’s, Superposition and maximum power transfer Theorem, reciprocity theorem).
3. Experimental determination of time constant of series RL, RC circuits.
4. Experimental determination of frequency response of RLC circuits.
5. Design and Simulation of series resonant circuits.
6. Design and Simulation of parallel resonant circuits.
7. Simulation of three phase balanced and unbalanced star & delta connected networks.
8. Experimental determination of power in a three phase circuits by two-watt meter method.
9. Measurement of power and power factor using two watt meter method.
10. Steady state analysis of series RL, RC and RLC circuits

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to understand and verify
CO1  the concepts of electrical circuits, fundamental laws and theorems.
CO2  the natural response and the forced response to excitations of the first and second order networks.
CO3  the concepts of complex frequency and its use in relating the forced response and natural response.
CO4  the concepts of resonant.
CO5  the concepts of poly phase circuits and power measurement.

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• 1-low, 2-medium, 3-high
UNIT I  ONE-DIMENSIONAL RANDOM VARIABLES (9+3)
Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II  TWO-DIMENSIONAL RANDOM VARIABLES (9+3)
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III  ESTIMATION THEORY (9+3)
Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV  TESTS OF SIGNIFICANCE (9+3)
Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – $\chi^2$ test for goodness of fit – Independence of attributes.

UNIT V  DESIGN OF EXPERIMENTS (9+3)
Completely Randomized Design – Randomized Block Design – Latin Square Design – $2^2$ factorial design.

TOTAL: 60 PERIODS

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

CO1: To analyze the performance in terms of probabilities and distributions achieved by the determined solutions.

CO2: To be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.

CO3: To apply the basic principles of the estimation theory to practical situations.

CO4: To demonstrate the knowledge of large / small sample theory in statistical inference.

CO5: To obtain a better understanding of the importance of the methods in modern industrial processes.

TEXT BOOKS:

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- 1-low, 2-medium, 3-high

### PTEE3301 ELECTROMAGNETIC THEORY LT P C 3 0 0 3

#### UNIT I ELECTROSTATICS I
9
Sources, effects and exposure limits of electromagnetic fields, Coordinate systems, Vector calculus- Gradient, Divergence and Curl, theorems and applications, Coulomb’s Law – Electric field intensity – Electric Field due to discrete and continuous charges – Gauss’s law and applications.

#### UNIT II ELECTROSTATICS II
9

#### UNIT III MAGNETOSTATICS
9
Lorentz force, magnetic field intensity (H) – Biot– Savart’s Law - Ampere’s Circuit Law and practical applications – Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions, Scalar and vector potential, Poisson’s Equation, Magnetic force, Torque, Inductance and mutual inductance, Energy density, Applications.

#### UNIT IV ELECTRODYNAMIC FIELDS
9

#### UNIT V ELECTROMAGNETIC WAVES
9

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:
Upon completion of the course, the students will be able to

- **Co1** apply the basic mathematical concepts related to electromagnetic fields and identify the electromagnetic sources and their effects.
- **Co2** compute and analyze electrostatic fields with practical applications.
- **Co3** compute and analyze magneto static fields with practical applications.
- **Co4** explain different methods of emf generation and Maxwell’s equations.
- **Co5** explain the concept of electromagnetic waves and characterizing parameters.

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PTEE3302 DIGITAL ELECTRONICS LT P C 3 0 0 3

UNIT I NUMBER SYSTEMS, BOOLEAN ALGEBRA AND COMBINATIONAL CIRCUITS 9
Number system, error detection, corrections & codes conversions, Boolean algebra: De-Morgan’s theorem, switching functions and minimisation using K-maps & Quine McCluskey method.

UNIT II DESIGN OF COMBINATIONAL LOGIC CIRCUITS USING GATES AND MSI DEVICES 9
Design of adder, substractor, comparators, code converters, encoders, decoders, multiplexers and demultiplexers, Realisation of Boolean Functions using MSI devices, memories and PLA.

UNIT III ANALYSIS AND DESIGN OF SYNCHRONOUS SEQUENTIAL CIRCUITS 9
Flip flops--SR, D, JK and T, shift registers, counters, state assignments analysis and design of synchronous sequential circuits, state diagram; state reduction.

UNIT IV ANALYSIS AND DESIGN OF ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

UNIT V LOGIC FAMILIES AND ARITHMETIC CIRCUITS 9
Logic families : RTL ad DTL circuits ,TTL ECL NMOS and CMOS :Design – Binary adder-4-bit adder IC, Adder/subtractor circuit using adder ICs, concept of carry look ahead, hardware multiplier circuit, Design with Multiplexers / Demultiplexers Introduction to VHDL.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

   CO1   To understand and examine the structure of various number systems and its application in
digital design to solve real world problems.

CO2 Analyze and design combinational logic circuits using gates.
CO3 Analyze and design combinational logic circuits using MSI devices.
CO4 Analyze and Design synchronous sequential logic circuits using Flip flops and gates.
CO5 Analyze and Design Asynchronous sequential logic circuits using Latches and gates.
CO6 Design of arithmetic circuits.

TEXT BOOKS:

REFERENCES:

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PTEE3303 ANALOG ELECTRONICS LT P C 3 0 0 3

UNIT I ELECTRONIC DEVICES AND THEIR CHARACTERISTICS
PN junction diodes – structure, operation and VI characteristics: drift and diffusion current, transient capacitance – BJT: structure, operation and characteristics; biasing; Introduction to JFET, MOSFET and UJT Applications.

UNIT II AMPLIFIER CIRCUITS
BJT small signal model – Analysis of CE amplifier, Gain and Frequency response Differential Amplifier - Two-stage amplifier-Common mode and Differential mode analysis Current mirror circuits - Introduction to internal circuit of typical OPAMPs.

UNIT III OPAMP AND CHARACTERISTICS
Ideal OPAMP characteristics, DC characteristics, AC characteristics, Voltage-series feedback: non- inverting amplifier and voltage -shunt feedback : inverting amplifier-Frequency response of OPAMP Basic applications: inverting, non- inverting and differential amplifier circuits, Adder-subtractor circuits Differentiation and integrator circuits.

UNIT IV APPLICATION OF OPAMPS
Instrumentation amplifiers, First-order and Second order active filters, V to I and I to V converters, Comparators and multi-vibrators, Waveform generators, Clippers and Clampsers, Peak detector, D/A converters (Weighted resistance type and R-2R ladder type), A/D converters (Flash type, Dual slope type and Successive Approximation types).
UNIT V SPECIAL ICS
555 Timer circuit: Functional block diagram, characteristics & applications – Astable and monostable multivibrator -566 Voltage Controlled Oscillator circuits - PLL Phase Locked Loop applications - Function generator circuit – Linear Voltage regulators.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1 understand the structure and underlying semiconductor physics concepts.
CO2 design circuits employing electronic devices.
CO3 understand the characteristics of OPAMP and its internal components.
CO4 analyze, design and implement analog electronic circuits involving OP-AMP.
CO5 analyze, design and implement analog electronic circuits involving timer 555.
CO6 analyze, comprehend and design of analog electronic circuits involving PLL, voltage regulator & other special ICs.

TEXT BOOKS:

REFERENCES:

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- 1-low, 2-medium, 3-high
I Experiments On Basic Electronic Devices:

1. Transistor based RC phase shift oscillator.
2. Transistorized Differential amplifier.

II Experiments using Linear Integrated Circuits (ICs):

3. OPAMP based amplifier circuits.
   i) Inverting amplifier.
   ii) Non-inverting amplifier and voltage follower.
   iii) Differential amplifier and Instrumentation amplifier.
4. Design of Adder-subtractor circuits using Op-Amp
5. Square wave oscillator/ tri-angular wave oscillator.
7. 555 – timer IC based astable multi-vibrator.

III Experiments using Digital Circuits:

8. Design of Adder-subtractor circuits using digital IC.
9. Study of basic digital ICs.
10. Design of combinational logic circuits.
11. Design of synchronous sequential logic circuits.
12. Study of counter ICs.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be

CO1 Ability to design circuits employing electronic devices.
CO2 Analyze, comprehend and design of analog electronic circuits involving OP-AMP.
CO3 Analyze, comprehend and design of analog electronic circuits involving 555 timer.
CO4 Ability to design various oscillators circuits.
CO5 Ability to understand the operation of basic gates and counter ICs Ability
CO6 to design combinational and sequential logic circuits

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- 1-low, 2-medium, 3-high
UNIT I  MAGNETIC FIELDS AND MAGNETIC CIRCUITS
Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

UNIT II  ELECTROMAGNETIC FORCE AND TORQUE
B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency.

UNIT III  DC MACHINES
Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation — Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation - Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

UNIT IV  DC MACHINE - MOTORING AND GENERATION
Armature circuit equation for motoring and generation. Types of field excitations — separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage and field current. Losses, load testing and back-to-back testing of DC machines.

UNIT V  TRANSFORMERS

TOTAL: 45 PERIODS

NOTE: The question paper for this course can be set with weightage of marks distribution as per the distribution of contact periods

COURSE OUTCOMES:
After completion of the subject, students will be able to
1. CO1 Understand the concepts of magnetic circuits.
2. CO2 Understand the principles of induced emf’s and torque in stationary and rotating machines.
3. CO3 Understand the operation of DC machines.
4. CO4 Analyse the differences in operation of different DC machine configurations.
5. CO5 Analyse the single phase and three phase transformers circuits.

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**PTEE3402**

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### UNIT I

**MODELING OF LINEAR TIME INVARIANT (LTIV) SYSTEMS**

- Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

### UNIT II

**TIME DOMAIN ANALYSIS**


### UNIT III

**FREQUENCY DOMAIN ANALYSIS**

- Bode plot, Polar plot and Nyquist plot – Frequency domain specifications – Introduction to closed loop Frequency Response - Effect of adding lag and lead compensators.

### UNIT IV

**STATE VARIABLE ANALYSIS**


### UNIT V

**DESIGN OF FEED BACK CONTROL SYSTEM**


**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

Upon completion of the course, the students will be able to

- **CO1** Represent simple systems in transfer function and state variable forms.
- **CO2** Analyse simple systems in time domain.
- **CO3** Analyse simple systems in frequency domain.
- **CO4** Infer the stability of systems in time and frequency domain.
- **CO5** Interpret characteristics of the system and find out solution for simple control problems.

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PTE3403 MICROPROCESSORS AND MICROCONTROLLERS LT P C 3 0 0 3

**UNIT I** INTRODUCTION TO 8085 ARCHITECTURE 9

**UNIT II** 8085 INSTRUCTION SET AND PROGRAMMING 9
Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing- Look up table – Subroutine - stack.

**UNIT III** INTERFACING BASICS AND ICS 9
Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8254 Timer/ Counter – Interfacing with 8085 - A/D and D/A converter interfacing.

**UNIT IV** INTRODUCTION TO 8051 MICROCONTROLLER 9

**UNIT V** INTRODUCTION TO ADVANCED ARCHITECTURE 9
ARM Cortex-M0 – overview - Programmer’s Model - Memory System Overview - System Control B lock - Microcontroller Start sequence – Ports: interfacing and programming.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
Upon completion of the course, the students will be

**CO1** Ability to write assembly language program for microprocessor and microcontroller.

**CO2** Ability to comprehend, design and simulate microprocessor based systems used for control and monitoring.

**CO3** Ability to analyze, design and implement interfacing of peripheral with microprocessor.

**CO4** Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

**CO5** Ability to understand and appreciate advanced architecture evolving microprocessor architecture.

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- 1-low, 2-medium, 3-high

PTEE3404 TRANSMISSION AND DISTRIBUTION  L T P C
3 0 0 3

UNIT I STRUCTURE OF POWER SYSTEM
Structure of electric power system: generation, transmission and distribution; Choice of transmission voltage, overhead and underground systems, Types of AC and DC distributors—distributed and concentrated loads—voltage tolerances, interconnection-advantages and limitations—EHVAC and HVDC transmission—Introduction to FACTS devices.

UNIT II TRANSMISSION LINE PARAMETERS
Parameters of single and three phase transmission lines with single and double circuits—Resistance, inductance and capacitance of solid, stranded and bundled conductors, conductor types—Symmetrical and unsymmetrical spacing and transposition-application of self and mutual GMD; skin and proximity effects—Effects of earth on capacitance of transmission line—interference with neighboring communication circuits, corona discharge, factors affecting corona-advantages and disadvantages.

UNIT III MODELLING AND PERFORMANCE OF TRANSMISSION LINES
Classification of lines—short line, medium line and long line—Evaluation of A,B,C,D constants- equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance and surge impedance loading; transmission efficiency and voltage regulation, real and reactive power flow in lines, Power-circle diagrams, methods of voltage control; Ferranti effect, Charging current and losses in an open circuited line.

UNIT IV INSULATORS AND CABLES
Main components of overhead lines—Insulators-Types, voltage distribution in insulator string, improvement of string efficiency, Underground cables—Types of cables, insulation materials, Parameters of cable, Grading of cables, Capacitance of 3-core cable, heating, thermal resistance of cables,D.C cables.

UNIT V MECHANICAL DESIGN OF LINES AND GROUNDING
Mechanical design of transmission line, sag and tension calculations for different weather conditions, Tower spotting, Types of towers, Sub-station Layout (AIS, GIS), Methods of grounding – Substation and Building.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1 understand structure of power system with different voltage levels.
CO2 compute line parameters for different configurations.
CO3 model transmission line and to determine the performance of line.
CO4 choose various insulators and cables for transmission and distribution.
CO5 carry out mechanical design of transmission line and grounding.

TEXT BOOKS:

REFERENCES:

MAPPING OF COs WITH POs AND PSOs

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PTEE3411 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY LT P C 0 0 4 2

Programming exercises / Experiments with µP 8085:

1. Simple arithmetic operations with 8085: Multi precision addition / subtraction /multiplication / division.
3. Interface Experiments:
   a. A/D Interfacing
   b. D/A Interfacing
4. Interface Experiment: Traffic light controller.
5. Interface Experiment: Stepper motor controller interface.
Programming exercises / Experiments with µC 8051:

8. Interface Experiments:
   a. A/D Interfacing
   b. D/A Interfacing
10. Interface Experiment: Stepper motor controller interface.

Experiments with Digital ICs :

11. Study of ARM board
12. ARM I/O interfacing with LCD / 7 segment LED

TOTAL : 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 design and implement combinational logic circuits and to analysis simple sequential logic circuits.
CO2 write assembly language program for microprocessor and microcontroller.
CO3 design and implement interfacing of peripheral with microprocessor and microcontroller.
CO4 analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring
CO5 analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

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• 1-low, 2-medium, 3-high

PTEE3501 ELECTRICAL MACHINES – II LT P C

UNIT I FUNDAMENTALS OF AC MACHINE WINDINGS 8
Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn Coil — active portion and overhang; full-pitch coils, concentrated winding, distributed winding, Winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed Current through winding - concentrated and distributed, Sinusoidally distributed winding, Winding distribution factor.

UNIT II PULSATING AND REVOLVING MAGNETIC FIELDS 6
Constant magnetic field, pulsating magnetic field — alternating current in windings with Spatial displacement, Magnetic field produced by a single winding — fixed current and Alternating current Pulsating fields produced by spatially displaced windings, Windings Spatially shifted by 90 degrees, Addition
of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three- phase balanced currents), revolving magnetic field.

UNIT III INDUCTION MACHINES 15

UNIT IV SINGLE-PHASE INDUCTION MOTORS 6
Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.

UNIT V SYNCHRONOUS MACHINES 10
Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation and pre-determination methods. Operating characteristics of synchronous machines, V-curves. Salient pole machine — two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

NOTE: The question paper for this course can be set with weightage of marks distribution as per the distribution of contact periods.

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 Understand the concepts of windings, MMFs and rotating magnetic fields.
CO2 Understand the operation of AC machines.
CO3 Analyse the performance characteristics of AC machines.
CO4 Analyse the starting and speed control of AC machines.
CO5 Understand the field applications of AC machines.

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- 1-low, 2-medium, 3-high
UNIT I SWITCHING POWER SUPPLIES 9
MOSFET dynamic behaviour - driver and snubber circuits - low power high switching frequency switching Power supplies, buck, boost, buck-boost converters – Isolated topologies – resonant converters switching loss calculations and thermal design.

UNIT II INVERTERS 9
IGBT : Static dynamic behaviour single phase half bridge and full bridge inverters - VSI : (1 phase and three phase inverters square wave operation) - Voltage control of inverters single, multi pulse, sinusoidal, space vector modulation techniques – various harmonic elimination techniques - CSI.

UNIT III SINGLE PHASE RECTIFIERS 9
Power Diode – half wave rectifier – mid-point secondary transformer based full wave rectifier – bridge rectifier - distortion factor - LC filters – SCR-Two transistor analogy based turn-ON, Controlled converters (1 pulse, 2 pulse) displacement factor – ripple and harmonic factor effect of source inductance, inverter angle limit.

UNIT IV THREE PHASE RECTIFIERS 9
Three phase diode rectifiers– Concern for power quality, Controlled converters (3 pulse, 6 pulse) Computation of performance parameters.

UNIT V AC PHASE CONTROLLERS 9
TRIAC triggering concept with positive and negative gate pulse triggering, TRIAC based phase controllers various configurations for SCR based single and three phase controllers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 To understand operation of semiconductor devices, its dynamic characteristics and to design & analyze low power SMPS.
CO2 Analyze the various uncontrolled rectifiers and design suitable filter circuits.
CO3 Analyze the operation of the n-pulse converters and evaluate the performance parameters.
CO4 Understand various PWM techniques and apply voltage control and harmonic elimination methods to inverter circuits
CO5 Understand operation AC voltage controllers and its applications

TEXT BOOKS:

REFERENCES:

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- 1-low, 2-medium, 3-high
UNIT I POWER SYSTEM OVERVIEW
Need for system planning and operational studies - Power scenario in India - Power system components – Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram - Network graph, Bus incidence matrix, Primitive network-, Bus admittance matrix from primitive parameters - Representation of off-nominal transformer - Formation of bus admittance matrix of large power network.

UNIT II POWER FLOW ANALYSIS

UNIT III SYMMETRICAL FAULT ANALYSIS
Importance of short circuit studies - Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix by building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level Current limiting reactors.

UNIT IV UNSYMMETRICAL FAULT ANALYSIS
Symmetrical components - Sequence impedances – Sequence circuits of synchronous machine, transformer and transmission line-Sequence networks--Analysis of unsymmetrical faults: single-line- to-ground, line-to-line and double-line-to-ground using Thevenin’s theorem and Z-Bus- computation of post fault currents in symmetrical component and phasor domains.

UNIT V STABILITY ANALYSIS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of the above subject, students will be able to
CO1 Model the various power system components for steady-state analysis.
CO2 Carry out the power flow analysis by Gauss-Seidel and Newton-Raphson methods.
CO3 Conduct the fault analysis of power system for balanced faults.
CO4 Carry out the short circuit analysis of the power system for unbalanced faults using symmetrical component theory.
CO5 Compute the stability of the system with the help of equal area criteria and Modified-Euler and Runge-Kutta fourth order methods.

TEXT BOOKS:

REFERENCES

<table>
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<th>LIST OF EXPERIMENTS:</th>
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<tr>
<td>1. Open circuit and load characteristics of DC shunt / separately exited DC generator and critical speed.</td>
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<td>2. Load test on DC series DC shunt and DC Compound motor.</td>
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<td>3. Swinburne’s test and speed control of DC shunt motor.</td>
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<td>4. Hopkinson’s Test</td>
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<td>5. Load test on single-phase transformer and Sumpner’s test.</td>
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<td>6. Open circuit and short circuit tests on single phase transformer.</td>
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<td>7. Regulation of three phase alternator by EMF, MMF and ZPF methods.</td>
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<td>8. V and Inverted V curves of Three Phase Synchronous Motor.</td>
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<td>10. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).</td>
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<td>11. Load test on single-phase induction motor.</td>
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<td>15. Simulation of PMDC machines.</td>
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| TOTAL: 60 PERIODS |

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<td>CO1: Ability to understand and analyse predetermination methods of calculating regulation for synchronous generations.</td>
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<td>CO2: Acquire hands on experience of conducting various tests on transformers, three phase induction motor and single phase induction motor.</td>
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<td>CO3: Ability to acquire knowledge on separation of losses for static and induction motors.</td>
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<td>CO4: Ability to understand the concepts related with exciting current, armature current and power factor for a synchronous motor.</td>
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<td>CO5: Ability to understand the performance characteristics of AC and DC machines.</td>
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<td>CO6: Capability to understand the parameters that control the speed of DC motor.</td>
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- 1-low, 2-medium, 3-high

PTEE3512
POWER ELECTRONICS LABORATORY
L T P C
0 0 4 2

LIST OF EXPERIMENTS:
1. Characteristics of SCR and TRIAC
2. Characteristics of MOSFET and IGBT
3. AC to DC half controlled converter
4. AC to DC fully controlled Converter
5. Step down and step up MOSFET based choppers
6. IGBT based single phase PWM inverter
7. IGBT based three phase PWM inverter
8. AC Voltage controller
9. Switched mode power converter.
10. Simulation of PE circuits (1Φ & 3Φ semi converter, 1Φ & 3Φ full converter, dc-dc converters ac voltage controllers).

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 Determine the characteristics of SCR, IGBT, TRIAC, MOSFET and IGBT.
CO2 Understand the performance of AC voltage controllers by simulation and experimentation and to find the transfer characteristics of full converter, semi converter, step up and step down choppers by simulation and experimentation.
CO3 Analyze the voltage waveforms for PWM inverter using various modulation techniques.
CO4 Design and experimentally verify the performance of basic DC/DC converter topologies used for SMPS

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- 1-low, 2-medium, 3-high
UNIT I  FAULTS AND PROTECTIVE SCHEMES  
Nature, causes and consequence of faults – fault statistics, types of faults (symmetrical and unsymmetrical) – fault current calculation, Reactors— need for protective schemes-zones of protection and essential qualities of protection.

UNIT II  ELECTROMAGNETIC RELAYS  
Basic requirements of protective relaying – Classification and Operating principles of relays- Electromagnetic Relays – Over current, Directional, Distance, Differential and Negative sequence relays, R-X diagram – Universal Torque equation.

UNIT III  APPARATUS PROTECTION  
Application of instrument transformers in protection schemes – Protection of transformer, generator,motor, bus bars, feeders and transmission line.

UNIT IV  STATIC RELAYS AND NUMERICAL PROTECTION  
Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators Block diagram of Numerical relays – Over current protection, transformer differential protection, distant protection of transmission lines.

UNIT V  CIRCUIT BREAKERS  
Physics of arcing phenomenon and arc interruption - DC and AC circuit breaking – re-striking voltage and recovery voltage - RRRV - current chopping - interruption of capacitive and inductive currents, resistance switching- Types of circuit breakers – air, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 analyse different types of faults and their effects on power system and understand the practical significance of protection zones.

CO2 understand the basic principles, construction and characteristics of different Electromagnetic relays.

CO3 protect different power equipments like transformer, generator etc., against various electrical faults.

CO4 understand different aspects of static relays and numerical protection schemes.

CO5 understand the principles, construction, selection and problems associated with Different types of circuit breaker.

TEXT BOOKS:

REFERENCES:
UNIT I  INTRODUCTION  9
Power scenario in Indian grid — National and Regional load dispatching centers — requirements of good power system - necessity of voltage and frequency regulation. System load variation, load curves - load forecast. Fundamentals of electricity markets: Privatization and deregulation, Types of electricity markets, Electricity market developments in India. IT application in electricity markets.

UNIT II  REAL POWER - FREQUENCY CONTROL  9
Basics of speed governing mechanisms and modeling-speed regulation of two generators in parallel - Load Frequency Control (LFC) of single area system - static and dynamic analysis LFC of two area system - tie line modeling - block diagram representation of two area system - static and dynamic analysis - tie line with frequency bias control – state variable model - integration of economic dispatch control with LFC.

UNIT III  REACTIVE POWER – VOLTAGE CONTROL  9
Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop static and dynamic analysis – stability compensation – voltage drop in transmission line methods of reactive power injection tap changing transformer, SVC and STATCOM for voltage control.

UNIT IV  ECONOMIC OPERATION OF POWER SYSTEM  9
Statement of economic dispatch problem - input and output characteristics of thermal plant incremental cost curve - optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) - lambda-iteration method - base point and participation factors method. Statement of Unit Commitment (UC) problem - constraints on UC problem - solution of UC problem using priority list - special aspects of short term and long term hydrothermal scheduling problems.

UNIT V  COMPUTER CONTROL OF POWER SYSTEM  9
State estimation – measurements and errors - weighted least square estimation various operating states, state transition diagram. Need of computer control of power system - concept of energy control centers and functions – PMU system monitoring, data acquisition and controls - System hardware configurations SCADA and EMS functions. IT based energy management systems – case study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
- CO1 Analyze the day-to-day operation of electric power system.
- CO2 Analyze the control actions that are implemented to meet the minute-to-minute variation of system real power demand.
- CO3 Analyze the compensators for reactive power control.
- CO4 Prepare day ahead and real time economic generation scheduling.
- CO5 Understand computer control of power system and the role of IT for efficient Energy Management system.

TEXT BOOKS:
New Delhi, 34th reprint, 2010.


REFERENCES:

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- 1-low, 2-medium, 3-high

PTEE3603 MEASUREMENT AND INSTRUMENTATION LT P C 3 0 0 3

UNIT I MEASUREMENT CONCEPTS AND ANALOG INSTRUMENTS 9

UNIT II SENSORS AND TRANSDUCERS 9

UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS 9

UNIT IV DIGITAL INSTRUMENTATION 9

UNIT V PLC AND VIRTUAL INSTRUMENTATION 9
Evolution of PLC – Sequential and Programmable controllers – Architecture – Programming of PLC – Functional blocks – Communication Networks for PLC. Introduction to Virtual Instrumentation (VI) –

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
After completion the above subject, students will be able to

- **CO1** understand the concepts of measurement and the structural elements of various analog instruments.
- **CO2** understand the principles of various transducers.
- **CO3** understand the importance of signal conditioning circuits.
- **CO4** understand the concepts of digital instrumentation.
- **CO5** understand the PLC and virtual instrumentation.

**TEXT BOOKS:**

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- **1-low, 2-medium, 3-high**

**PTEE3611** CONTROL AND INSTRUMENTATION LABORATORY LT P C 0 0 4 2

**LIST OF EXPERIMENTS**

**Control systems:**
1. Analog (op amp based) simulation of linear and nonlinear differential equations
2. Mathematical modeling and simulation of physical systems in at least two fields Mechanical→ Electrical→ Chemical process.
3. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform
4. Root Locus based analysis in simulation platform
5. Determination of transfer function of a physical system using frequency response and Bode’s asymptotes
6. Design of Lag, lead compensators and evaluation of closed loop performance
7. Design of PID controllers and evaluation of closed loop performance
8. Test of controllability and observability in continuous and discrete domain in simulation platform

Instrumentation:
1. Static and Dynamic characteristics of Electrical and Non electrical sensors.
3. Design of A/D and D/A converters.
5. PLC programming for Process Control Applications.

Mini Project :
Demonstration of PC based data acquisition with complete closed loop control including sensor and actuator dynamics.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 model and analyze simple physical systems and simulate the performance in analog and digital platform.
CO2 design and implement compensators and simple controllers in standard forms.
CO3 design signal conditioning circuits for various transducers.
CO4 program PLC and develop GUI application for a physical system.
CO5 design PC based data acquisition with complete closed control loop and evaluate its performance for simple physical systems.

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SEMINAR VII
PTEE3701 HIGH VOLTAGE ENGINEERING LT P C
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UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9
Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages – Reflection and Refraction of Travelling waves - protection against over voltages- Insulation Coordination.

UNIT II DIELECTRIC BREAKDOWN 9
Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields -Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids,
Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment.

UNIT III GENERATION AND MEASUREMENTS OF HIGH VOLTAGESAND HIGH CURRENTS 9

UNIT IV HIGH VOLTAGE TESTING 9
High voltage testing of electrical power apparatus- International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers.

UNIT V HIGH VOLTAGE APPLICATIONS IN INDUSTRY 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of the above subject, students will be able to
CO1 analyze various over voltages and its effects on power systems.
CO2 understand the breakdown phenomena in different dielectric medium under uniform and non-uniform fields.
CO3 explain the methods of generating and measuring High DC, AC, Impulse voltage and currents.
CO4 suggest and conduct suitable HV testing of Electrical power apparatus as per Standards.
CO5 explain the Industrial Applications of High Voltage Engineering.

TEXT BOOKS

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- 1-low, 2-medium, 3-high
UNIT I  DESIGN OF FIELD SYSTEM AND ARMATURE  9

UNIT II  DESIGN OF TRANSFORMERS  9

UNIT III  DESIGN OF DC MACHINES  9

UNIT IV  DESIGN OF INDUCTION MOTORS  9

UNIT V  DESIGN OF SYNCHRONOUS MACHINES  9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 understand basics of design considerations for rotating and static electrical machines.
CO2 design of single and three phase transformer.
CO3 design of armature and field of DC machines.
CO4 design of stator and rotor of induction motor.
CO5 design and analyze synchronous machines.

TEXT BOOKS
2 M V Deshpande ‘Design and Testing of Electrical Machines’ PHI learning Pvt Lt, 2011

REFERENCES:
LIST OF EXPERIMENTS:

1. Computation of Transmission line constants.
4. Symmetric and unsymmetrical fault analysis using any power system simulation tool.
5. Transient stability analysis of SMIB System.
7. Stability analysis of AVR.
8. Relay Coordination using any power system simulation tool.
10. Co-ordination of over-current and distance relays for radial line protection.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject,

CO1 Learners will be able to analyze the power flow using Newton-Raphson method and Fast decoupled method.

CO2 Learners will be able to perform contingency analysis & economic dispatch.

CO3 Learners will be able to Set Digital Over Current Relay and Coordinate Relay.
UNIT I  DEMOCRATIC VALUES

Reading Text: Excerpts from John Stuart Mills’ On Liberty

UNIT II  SECULAR VALUES
Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.

Reading Text: Excerpt from Secularism in India: Concept and Practice by Ram Puniyani

UNIT III  SCIENTIFIC VALUES

Reading Text: Excerpt from The Scientific Temper by Antony Michaelis R

UNIT IV  SOCIAL ETHICS
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.

Reading Text: Excerpt from 21 Lessons for the 21st Century by Yuval Noah Harari

UNIT V  SCIENTIFIC ETHICS
Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.


TOTAL: 30 PERIODS

REFERENCES:
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

COURSE OUTCOMES
Students will be able to
CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life
CO2 : Practice democratic and scientific values in both their personal and professional life.
CO3 : Find rational solutions to social problems.
CO4 : Behave in an ethical manner in society
CO5 : Practice critical thinking and the pursuit of truth.
UNIT I  INTRODUCTION TO ELECTRICAL POWER CABLES  7

UNIT II  CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS  7

UNIT III  SUPPLY DISTRIBUTION SYSTEMS AND CABLES  7

UNIT IV  TRANSMISSION SYSTEMS AND CABLES  7

UNIT V  CABLE INSTALLATION, TESTING, MAINTENANCE  7

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)  10
Demonstration of cable architecture with cable samples of all types.

1. Understanding the cable manufacturing process through factory visit.
2. Familiarization of the cable laying procedure through field visits.
3. Familiarization of cable jointing / end termination techniques.
4. Understanding and familiarization of cable fault locating techniques through field visit to local distribution company or inhouse laboratory.
5. Understanding testing procedures and condition monitoring tests

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 understand the fundamental of underground cable system.
CO2 gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.
CO3 understand different types of cable used in distribution system.
CO4 acquire knowledge on Underground cables used in transmission system
CO5 understand the cable installations procedures and practices.
CO6 understand the theory / methodology of cable fault detection and rectification, testing and maintenance.

TEXT BOOKS:


REFERENCES:

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PTEE3002                                   SUBSTATION ENGINEERING AND AUTOMATION      LT P C
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UNIT I       SUBSTATION DESIGN DEVELOPMENT  7

UNIT II      SUBSTATION EQUIPMENT         7

UNIT III     PROTECTION AND SUBSTATION AUTOMATION     7
UNIT IV  SUBSTATION DESIGN & LAYOUT ENGINEERING

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.

UNIT V  INTERFACE ENGINEERING

Civil & Structural Engineering - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Battery sizing for a substation with a load cycle based on IEEE 1115 Ni-cd - A case study
OR
2. DG and auxiliary transformer sizing for a substation auxiliary power supply - A case study
3. Overcurrent Relay coordination in a substation - A case study
4. Earthmat sizing calculation for an outdoor substation based on IEEE80- A case study
OR
5. Direct stroke lightning protection calculation for outdoor switchyard based on IEC 62305- Acase study

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Understand the key deciding factors involved in substation design and operation
CO2 Know about the sizing and selection of equipment which forms part of substation
CO3 Know about composite layout design aspects of the substation with different services and the challenges including statutory clearances.
CO4 Understand about Interdisciplinary aspects involved in substation design
CO5 Understand different protection and control scheme involved in substation design
CO6 Know about substation automation system and different communication protocol involved for efficient operation of a substation

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UNIT I INTRODUCTION
Reactive power control in electrical power transmission lines—load & system compensation, Uncompensated transmission line—shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, Types of HVDC transmission System.

UNIT II STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC)
VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC—Advantages of slope in dynamic characteristics—Influence of SVC on system voltage—Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC— Different modes of operation, Applications.

UNIT III VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS

UNIT IV LINE COMMUTATED HVDC TRANSMISSION
Operation of Gratz bridge - Effect of delay in Firing Angle — Effect of commutation overlap - Equivalent circuit,. Basic concept of HVDC transmission. Modes of operations and control of power flow, CC and CIA mode of operation.

UNIT V VSC BASED HVDC TRANSMISSION
Basic 2 level IGBT inverter operation- 4 Quadrant operation- phase angle control- dq Control - Control of power flow in VSC based HVDC Transmission, Topologies of MTDC system.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10
1. Simulation of FC+TSR connected to IEEE 5 bus system
2. Realization of reactive power, support by SVC in open loop and closed loop control insimulation.
3. Regulation of line flows employing TCSC and TSSC in closed loop control in simulation
4. Simulation of two terminal HVDC Link, closed loop control in CC and CIA mode in simulation
5. Realization of four quadrant operation of VSC in open loop mode in simulation

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 To Identify and understand the problems in AC transmission systems and understand the need for Flexible AC transmission systems and HVDC Transmission
CO2 To understand the operation and control of SVC and TCSC and its applications to enhance the stability and damping.
CO3 To Analyze basic operation and control of voltage source converter based FACTS controllers
CO4 To demonstrate basic operation and control of Line Commutated HVDC Transmission
CO5 To explain the d-q control based operation of VSC based HVDC Transmission

TEXT BOOKS:

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PTEE3004 ENERG Y MANAGEMENT AND AUDITING LT P C

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT

UNIT II MATERIAL AND ENERGY BALANCE
Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager — employees training and planning - Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES

UNIT IV ENERGY EFFICIENCY IN COMPR ESSED AIR SYSTEM

UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10
2. Performance Analysis of Electric Motor and Energy Efficient Motor (EEM)
3. Performance Analysis of fan characteristic curves at different operating points
4. Case study of illumination system
5. Performance Analysis of Compressors

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject,
CO1 Students able to acquire knowledge in the field of energy management and auditing.
CO2 Learned the about basic concepts of economic analysis, material and energy balance.
CO3 Able to design the effective thermal utility system.
CO4 Able to improve the efficiency in compressed air system.
CO5 Acquired the design concepts in the field of lighting systems, light sources and various forms of cogeneration.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
1. https://facilio.com/blog/commercial-energy-audit

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UNIT I INTRODUCTION AND SURVEY
Sources of different types of transients - RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients - study of transients in system planning - Importance of grounding.

UNIT II SWITCHING TRANSIENTS
Basic concept of switching transients - resistance switching and equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit - capacitance switching with a restrike, with multiple restrikes - ferro resonance.

UNIT III LIGHTNING TRANSIENTS
Theories of cloud formation - mechanism of lightning discharges and characteristics of lightning strokes — model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

UNIT IV TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS
Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves. Computation of overvoltages using EMTP.

UNIT V TRANSIENTS IN INTEGRATED POWER SYSTEM
The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - overvoltage induced by faults - switching surges on integrated system Qualitative application of EMTP for transient computation.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation/Quiz/Surprise Test/Solving GATE questions/etc) 10
1. Simulation of circuit transients
2. Computation of over voltages for switching surges
3. Computation of over voltages for lightning surges
4. Computation of transients

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Explain the principles of transients and its concepts.
CO2 Know the different types of switching transients and the way to draw the necessary equivalent circuit.
CO3 Explain the concepts behind lighting and the way to protect the same.
CO4 Compute the transient behavior in transmission line.
CO5 Explain the behavior of the Circuit during switching and to learn the simulation tool.

TEXT BOOKS:

REFERENCES:
UNIT I INTRODUCTION
Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid.

UNIT II SMART METERING
Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU).

UNIT III SMART GRID TECHNOLOGIES (Transmission)
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area monitoring, Protection and control.

UNIT IV SMART GRID TECHNOLOGIES (Distribution)
DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)
1. Assignment-Familiarization of National and International Initiatives in Smart Grid
2. Simulation of smart meter using (MATLAB/ ETAP/SCILAB/ LABVIEW/ Proteus/Equivalent open source software).
3. Visit to a substation for analysing the Automation Technologies like Monitoring, Protection and control.
4. Awareness about High-efficiency Distribution Transformers, Phase Shifting Transformers in a substation.
5. Introduction to recent technologies in electric vehicles and understanding the operation of EV, HEV and PHEV.
6. Simulation of IoT based digital communication system for smart grid applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 understand the importance and objectives of Power System Grid.
CO2 know and understand the concept of a smart grid.
CO3 identify and discuss smart metering devices and associated technologies.
CO4 get an overview of Microgrid and Electric Vehicle Technology.
CO5 have an up to date knowledge on the various computing technologies; to understand the role of Big Data and IoT for effective and efficient operation of Smart Grid.

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PTEE3007 RESTRUCTURED POWER MARKET LT P C 3 0 0 3

UNIT I INTRODUCTION 9

UNIT II PRICING OF TRANSMISSION NETWORK AND CONGESTION MANAGEMENT 9
Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management.

UNIT III LOCATIONAL MARGINAL PRICES (LMP) AND FINANCIAL TRANSMISSION RIGHTS 9

UNIT IV ANCILLARY SERVICE MANAGEMENT 9
Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services.
UNIT V  MARKET EVOLUTION
US market: California energy market - Reforms in Indian power sector: Framework of Indian power sector, Reform initiatives, Availability Based Tariff (ABT), The Electricity Act 2012, Open Access issues, Power exchange, role of RLDC and NLDC.

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 Understand the process of restructuring of power industry and analyze the philosophy of market models
CO2 analyze various methods for calculating wheeling charges and congestion management in deregulated power system
CO3 analyze the locational marginal pricing and financial transmission rights
CO4 analyze the ancillary service management
CO5 explain the evolution of Indian and US power markets

TEXT BOOKS:

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PTEE3008  DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS  

UNIT I  RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES  
Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends.

UNIT II  SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS  

UNIT III  THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES  
Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization,Current Control, Implementation of
the Current Controllers, Maximum Power Point Tracking.

UNIT IV SMALL WIND ENERGY SYSTEMS

UNIT V DOUBLY-FED INDUCTION GENERATOR-BASED WECS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)
1. Simulation of inverter for PV systems
2. Simulation of WECS with DFIG

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Review the perspectives of renewable energy systems
CO2 Integrate photovoltaic systems with grid
CO3 Study inverter for PV systems
CO4 Elaborate the working of small wind power systems
CO5 Study the features of induction machine and doubly fed induction machine

TEXT BOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
4. https://www.academia.edu/32704493/Wind_Power_Lecture_Notes

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UNIT I    PRESENT POWER SCENARIO IN INDIA  

UNIT II   POWER GRIDS

UNIT III  MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS

UNIT IV    WIND ENERGY SYSTEM GRID INTEGRATION

UNIT V   GRID INTER CONNECTION
Grid Code requirements - Grid integration of WECS-Grid Integration of PV systems.

LAB COMPONENT:  
1. Develop a model for the control of DC micro grid for non linear loads  
2. Simulation study of three phase inverters with fixed and sine PWM techniques, Simulation and Design of buck/boost converters.  
3. Simulate a Grid Connected Wind Energy System with STATCOM and investigate the improvement in power quality.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to  
CO1 Review the power sector scenario in India.  
CO2 Model a micro grid system.  
CO3 Model a converter for power grid distributed system.  
CO4 Integrate wind energy system.  
CO5 Simulate three phase inverter with fixed and sine PWM.

TEXT BOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
1. https://www.academia.edu/14628492/Current_Power_Scenario_In_India
3. https://energyeducation.ca/encyclopedia/Electrical_grid

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PTEE3010 SUSTAINABLE AND ENVIRONMENTAL FRIENDLY HV INSULATION SYSTEM 3 0 0 3

UNIT I SUSTAINABLE AND ENVIRONMENTAL ENERGY AND PRODUCTS 9
Carbon print, global warming potential, environment requirement for any product and system.

UNIT II ALTERNATE GREEN GASEOUS INSULATORS 9
SF6 gas and its hazardous environmental effects, alternate gases, gaseous mixtures and other sources and it’s properties.

UNIT III ALTERNATE GREEN LIQUID INSULATORS 9
hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environmental friendly liquid such as ester oil, vegetable oils dielectric and it’s properties.

UNIT IV ALTERNATE GREEN SOLID INSULATORS 9
hazardous effects of existing solid dielectric materials, alternate sources of environmental friendly solid dielectric and its properties.

UNIT V EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS 9
Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications and standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Know about sustainable and environmental energy and products.
CO2 Describe the alternate green gaseous insulators.
CO3 Describe the alternate green liquid insulators.
CO4 Describe the alternate green solid insulators.
CO5 Elaborate the standards for Green insulation systems.

REFERENCES:

CONVERTERS AND DRIVES

PTEE3011 ELECTRICAL MACHINES – III LT P C 2023

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS 6

UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS 6

UNIT III SWITCHED RELUCTANCE MOTORS 6

UNIT IV STEPPER MOTORS 6

UNIT V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES 6

LAB COMPONENT: 30
Using electromagnetic software
1. Simulation of BLDC motor
2. Simulation of SRM motor
3. Simulation of stepper motor
4. Simulation of PMSM motor
5. Simulation of any other special machines

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 model and analyze power electronic systems and equipment using computational software.
CO2 optimally design magnetics required in special machines based drive systems using FEM based software tools.
CO3 analyse the dynamic performance of special electrical machines
CO4 understand the operation and characteristics of other special electrical machines.
CO5 design and conduct experiments towards research.

REFERENCES:
5. Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009

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PTEE3012 ANALYSIS OF ELECTRICAL MACHINES

UNIT I MODELING OF BRUSHED-DC ELECTRIC MACHINERY 6

UNIT II REFERENCE FRAME THEORY 6
Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame.

UNIT III INDUCTION MACHINES 6
Three phase induction machine - equivalent circuit— free acceleration characteristics — voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no-load and load conditions- Machine variable form, arbitrary reference variable form.

UNIT IV SYNCHRONOUS MACHINES 6
Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park’s equations).

UNIT V  MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS


LAB COMPONENT: 30

1. Modeling of DC machines.
2. Simulation under no-load and loaded conditions for a PMDC motor
4. Simulation under no-load and load conditions of a three phase induction machine in machine variable form and arbitrary reference variable form.
5. Simulation under no-load and load conditions of a three phase synchronous machine in machine variable form and arbitrary reference variable form.

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separatelyexcised motor) and to simulate DC motors using state models.
CO2 Apply reference frame theory for, resistive and reactive elements (three phase).
CO3 Compute the equivalent circuit and torque of three phase induction motor and synchronousmotor in machine variable arbitrary reference frame variable.
CO4 Find the need and advantages of multiphase machines.
CO5 Demonstrate the working of multiphase induction and synchronous machine.
CO6 Compute the model of three phase and multiphase induction and synchronous machine.

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UNIT I  MULTILEVEL TOPOLOGIES  6
Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT II  CASCADED H-BRIDGE MULTILEVEL INVERTERS  6

UNIT III  DIODE CLAMPED MULTILEVEL CONVERTER (DCMC)  6

UNIT IV  FLYING CAPACITOR MULTILEVEL CONVERTER (FCMC)  6
Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

UNIT V  CASCADED ASYMMETRIC MULTILEVEL CONVERTER  6
Modulation Strategy- Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

LAB COMPONENT:
1. Simulation of Fixed PWM, Sinusoidal PWM for an inverter,
2. Simulation of H bridge inverter with R load.
3. Simulation of three level diode clamped MLI with R load.
4. Simulation of three level capacitor clamped MLI with R load.
5. Simulation of MLI with reduced switch configuration.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 understand the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
CO2 analyze the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation.
CO3 comprehend the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count.
CO4 analyze the voltage balancing performance in Diode clamped MLI.
CO5 simulate three level, capacitor clamed and diode clamped MLI with R and RL load.

TEXT BOOKS:

REFERENCES:
5. Iftekhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid
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PTEE3014 ELECTRICAL DRIVES LT P C

UNIT I DRIVE CHARACTERISTICS 6
Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant
Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics –
Selection of motor.

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 6
Steady state analysis of the single and three phase converter fed separately excited DC motor drive –
continuous and discontinuous conduction – Time ratio and current limit control – 4 quadrant operation
of converter / chopper fed drive.

UNIT III INDUCTION MOTOR DRIVES 6
Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening
mode – voltage / current fed inverter – closed loop control.

UNIT IV SYNCHRONOUS MOTOR DRIVES 6
V/f control and self-control of synchronous motor: Margin angle control and power factor control –
permanent magnet synchronous motor.

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 6
Transfer function for DC motor / load and converter — closed loop control with current and speed
feedback — armature voltage control and field weakening mode — design of controllers; current
controller and speed controller-converter selection and characteristics.

LAB COMPONENT: 30
1. Simulation of converter and chopper fed DC drive
2. Simulation of closed loop operation of stator voltage control of induction motor drive
3. Simulation of closed loop operation of v/f control of induction motor drive
4. Simulation of synchronous motor drive

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 understand the basic requirements of motor selection for different load profiles.
CO2 Analyse the steady state behavior and stability aspects of drive systems.
CO3 Analyse the dynamic performance of the DC drive using converter and chopper control.
CO4 Simulate the AC drive.
CO5 Design the controller for electrical drives.

TEXTBOOKS:
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**PTEE3015 SMPS AND UPS LT P C 2023**

**UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS**
6
Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode – Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships – Introduction to discontinuous conduction mode.

**UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS**
6
Introduction - classification - forward- flyback- pushpull - half bridge - full bridge topologies - C’uk converter as cascade combination of boost followed by buck - isolated version of C’uk converter - design of SMPS — Introduction to design of magnetic components for SMPS, using relevant software - Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.

**UNIT III CONVERTER DYNAMICS**
6
AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

**UNIT IV CONTROLLER DESIGN**
6

**UNIT V POWER CONDITIONERS AND UPS**
6

**LAB COMPONENT:**
1. Simulation of Basic topologies.
2. Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.
3. Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.
4. Simulation study of controller design for basic topologies.
5. Simulation of battery charger for EV applications.

**TOTAL: 60 PERIODS**
COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1  understand the working of buck boost and buck-boost converters in continuous and discontinuous conduction mode.
CO2  build buck/boost converters using suitable design method.
CO3  Analyze the behaviors of isolated DC-DC converters and to design SMPS for battery operated vehicle.
CO4  compute state space averaged model and transfer function for buck, boost and buck-boost converters.
CO5  comprehend the P, PI and PID controller performance analytically and by simulation for buck boost and buck-boost converters
CO6  compare the different topologies of UPS and also simulate them.

TEXT BOOKS:

REFERENCES:

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PTEE3016  POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS  
LT  P C  2 0 2 3

UNIT I  INTRODUCTION TO RENEWABLE ENERGY SYSTEMS  6
Classification of Energy Sources — Importance of Non-conventional energy sources — Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of renewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT II  ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS)  6
Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III  POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS  6
Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost

UNIT IV  POWER CONVERTERS FOR WIND SYSTEMS  


UNIT V  HYBRID RENEWABLE ENERGY SYSTEMS  

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind- PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

LAB COMPONENT:  

1. Simulation on modelling of Solar PV System- V I Characteristics  
2. Simulation on Modelling of fuel cell- V I Characteristics  
4. Simulation of DFIG/ PMSG based Wind turbine.  
5. Simulation on Grid integration of RES.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to  

**CO1** critically evaluate the available renewable energy sources.  
**CO2** comprehend the working principles of electrical machines and power converters used for wind energy conversion system.  
**CO3** comprehend the principles of power converters used for solar PV systems.  
**CO4** Examine the available hybrid renewable energy systems.  
**CO5** Simulate AC-DC converters, buck/boost converters, AC-AC converters and PWM inverters.

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UNIT I  SIMULATION BASICS IN CONTROL SYSTEMS
Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bodle plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT II  SYMBOLIC CALCULATIONS

UNIT III  SLIDING MODE CONTROL BASICS

UNIT IV  POWER FACTOR CORRECTION CIRCUITS
Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

UNIT V  CONTROLLER DESIGN FOR PFC CIRCUITS
Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter - PFC circuits employing bridgeless topologies.

LAB COMPONENT:
1. Simulation exercises on zero, first and second order basic blocks.
2. Simulation exercises based on symbolic calculations.
3. Simulation of Sliding mode control based buck converter.
5. Simulation of Single-Phase PFC circuit employing Cuk converters

COURSE OUTCOMES:
After completion the above subject, students will be able to

CO1 calculate transfer function for constant, differential, integral, First order and Second order factors.
CO2 illustrate the effect of poles and zero’s in the ‘s’ plane.
CO3 select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.
CO4 compute the control expression for DC – DC buck converter using sliding mode control theory.
CO5 determine the controller expression for power factor correction circuits.
CO6 simulate sliding mode control of buck converter and power factor correction circuit.

TEXT BOOKS:

REFERENCES:
UNIT I  INTRODUCTION TO POWER QUALITY
Terms and definitions – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuation - Power frequency variations - International standards of power quality – Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT II  VOLTAGE SAGS AND INTERRUPTIONS
Sources of sags and interruptions - Estimating voltage sag performance - Thévenin’s equivalent source - Analysis and calculation of various faulted condition - Voltage sag due to induction motor starting - Estimation of the sag severity - Mitigation of voltage sags, active series compensators - Static transfer switches and fast transfer switches.

UNIT III  OVERVOLTAGES & HARMONICS

UNIT IV  POWER QUALITY MONITORING
Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - Power line disturbance analyzer – Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters - Disturbance analyzer.

UNIT V  POWER QUALITY MITIGATION

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10
1. Harmonic analysis of single phase power converters (Semi converters and FullConverters) with R and RL load via simulation
2. Harmonic analysis of three phase power converters (Semi converters and FullConverters) with R and RL load via simulation
3. Harmonic analysis of single phase inverters with R and RL load via simulation
4. Harmonic analysis of three phase inverters with R and RL load via simulation
5. Mitigation of Harmonics using Tuned Filter

TOTAL: 45 PERIODS
COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Comprehend the Basics of Power Quality issues and their Standards.
CO2 Understand the concepts of Sag and Swell problems.
CO3 Appreciate the harmonic problems and understand the enhancement methods.
CO4 Analyze the Power Quality problems and understand the monitoring Instruments.
CO5 Understand the mitigation methods including conventional compensation and modern techniques like usage of DSTATCOM and DVR.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
http://nptel.iitm.ac.in/courses.php
https://old.amu.ac.in/emp/studym/2442.pdf
https://electricalacademia.com/electric-power
https://www.intechopen.com/books/6214
https://www.academia.edu/43237017/
Use_Series_Compensation_in_Distribution_Networks_33_KV

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EMBEDDED SYSTEMS

PTEE3019 EMBEDDED SYSTEM DESIGN LT P C 2023

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 6
Introduction to Embedded Systems – Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

UNIT II EMBEDDED NETWORKING 6

UNIT III INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER 6
Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interrupt sources – multiple interrupts – context and periods for context switching, interrupt latency and deadline — Introduction to Device Drivers.

UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN 6
Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication-shared memory, message passing- Interprocess Communication- Introduction to process synchronization using semaphores.

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 6
Embedded Product Development Life Cycle - Case Study: Precision Agriculture- Autonomous car.

LAB COMPONENT: 30
1. Laboratory exercise: Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:
   a. Introduction to IDE and Programming Environment.
   b. Configure timer block for signal generation (with given frequency).
   c. Interrupts programming example using GPIO.
   d. I²C communication with peripherals
   e. Master-slave communication between processors using SPI.
   f. Networking of processor using Wi-Fi.
   g. Basic RTOS concept and programming
2. Assignment: Introduction to VxWorks, μC/OS-II, RT Linux
3. Embedded systems-based Mini project

TOTAL:60 PERIODS

COURSE OUTCOMES:
CO1 The hardware functionals and software strategies required to develop various Embedded systems.
CO2 The basic differences between various Bus communication standards.
CO3 The incorporation of the interface as Interrupt services.
CO4 The various scheduling algorithms through a Real-time operating system.
CO5 The various embedded concepts for developing automation applications.

TEXTBOOKS:
REFERENCES:

List of Open Source Software/ Learning websites:
https://nptel.ac.in/courses/108102045
https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture
materials/A practical introduction to real-time systems for undergraduate engineering.pdf
https://www.circuitbasics.com/basics-of-the-i2c-communication-protocol/
https://www.tutorialspoint.com/embedded_systems/es_interrupts.htm
https://www.theengineeringprojects.com/2016/11/
examples-of-embedded-systems.html#:~:text=Embedded%20Product%3A%20Automatic%20Washing%20Machine,
done%20by%20your%20machine%20itself.

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PTEE3020 EMBEDDED C- PROGRAMMING LT P C 2023

UNIT I BASIC C PROGRAMMING
Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT II EMBEDDED C

UNIT III 8051 Programming in C
Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051 Accessing code ROM space in 8051, Data serialization using 8051.

UNIT IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C
Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051interrupts and programming, Programming for timer configuration.

UNIT V 8051 INTERFACING
8051:ADC interfacing , DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motorinterfacing.
LAB COMPONENT: 30
1. Laboratory exercise: Use 8051 microcontroller/Embedded processor/IDE/open source platform to give hands-on training on Embedded C- programming.
   a. Introduction to IDE (like code blocks, vscode, etc) and Programming Environment (like Keililu vision, Proteus)
   b. Configuring an I/O port using bitwise programming.
   c. Configuring timer for generating hardware delay.
   d. Flashing an LED using an interrupt
   e. Serial communication using UART port of 8051
   f. Interfacing an ADC with 8051
   g. Interfacing an analog sensor with 8051
   h. Interfacing 16x2 LCD with 8051
   i. Configuring timer for generating PWM signal
   j. Interfacing a stepper motor with 8051
2. Assignment: Introduction to Arduino IDE, Raspberry Pi
3. Embedded C-Programming -Based Mini project.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1 Deliver insight into embedded C programming and its salient features for embedded systems.
CO2 Illustrate the software and hardware architecture for distributed computing in embedded systems.
CO3 Develop a solution for problems by using the concept learned in programming using the embedded controllers.
CO4 Develop simple applications with 8051 by using its various features and interfacing with various external hardware.
CO5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning websites:
https://www.hackerrank.com/
https://www.cprogramming.com/
https://www.allaboutcircuits.com/technical-articles/introduction-to-the-c-programming-language-for-embedded-applications/
https://onlinecourses.nptel.ac.in/noc19_cs42/preview
https://microcontrollerslab.com/8051-microcontroller-tutorials-c/
https://www.circuitstoday.com/getting-started-with-keil-uvision
UNIT I ARM ARCHITECTURE

UNIT II ARM MICROCONTROLLER PROGRAMMING
ARM general Instruction set — Thumb instruction set –Introduction to DSP on ARM- basic programming.

UNIT III PERIPHERALS OF ARM

UNIT IV ARM COMMUNICATION
ARM With CAN, I²C, and SPI protocols.

UNIT V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR

LAB COMPONENTS:
1. Laboratory exercise:
   a) Programming with IDE - ARM microcontroller
   b) Advanced Timer Features, PWM Generator.
   c) RTC interfacing with ARM using Serial communication programming, Stepper motorcontrol.
   d) ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.
2. Seminar:
   a) ARM and GSM/GPS interfacing
   b) Introduction to ARM Cortex Processor
3. Raspberry Pi based Mini project.

TOTAL:60 PERIODS

COURSE OUTCOMES:
CO1 Interpret the basics and functionality of processor functional blocks.
CO2 Observe the specialty of RISC processor Architecture.
CO3 Incorporate the I/O hardware interface of processor with peripherals.
CO4 Emphasis the communication features of the processor.
CO5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in commercial embedded processors.
TEXT BOOKS:

REFERENCES:

List of Open Source Software/ Learning websites:
https://nptel.ac.in/courses/117106111
https://onlinecourses.nptel.ac.in/noc20_cs15/preview
https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarch.pdf
https://maxembedded.com/2013/07/introduction-to-single-board-computing/
https://www.youtube.com/watch?v=J4fhE4Pp55E&list=PLGs0VKk2DiYppwUUM2wxzcI9B_JHK4Bfh

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PTEE3022 EMBEDDED CONTROL FOR ELECTRIC DRIVES LT P C 2023

UNIT I INTRODUCTION TO ELECTRIC DRIVES 6

UNIT II EMBEDDED SYSTEM FOR MOTOR CONTROL 6
Embedded Processors choice for motor control- Sensors and interface modules for Electric drives-IoT for Electrical drives applications.

UNIT III INDUCTION MOTOR CONTROL 6
Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three-phase induction motor- Embedded processor based three phase induction motor speed control.

UNIT IV BLDC MOTOR CONTROL 6
Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BLDC motor speed control.

UNIT V SRM MOTOR CONTROL 6
Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.
LAB COMPONENTS:

1. Laboratory exercise: Use any System level simulator/MATLAB/open source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phase inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package


4. Mini project: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

COURSE OUTCOMES:

CO1 Interpret the significance of embedded control of electrical drives.
CO2 Deliver insight into various control strategies for electrical drives.
CO3 Developing knowledge of Machine learning and optimization techniques for motor control.
CO4 Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

TEXT BOOKS:


REFERENCES:


List of Open Source Software/ Learning website:

1. https://archive.nptel.ac.in/courses/108/104/108104140/

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TOTAL: 60 PERIODS
UNIT I  INTRODUCTION  6
Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

UNIT II  HOME AUTOMATION  6

UNIT III  SMART APPLIANCES AND ENERGY MANAGEMENT  6

UNIT IV  SMART WEARABLE DEVICES  6

UNIT V  EMBEDDED SYSTEMS AND ROBOTICS  6
Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

LAB COMPONENTS:  30
1. Laboratory exercise: Use Arduino/ R pi/ any other Embedded processors to give hands on training to understand concepts related to smart automation.
   a. Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform
   b. Design and implementation of a smart home system.
   c. Bluetooth Based Home Automation Project using Android Phone
   d. GSM Based Home Devices Control
   e. Pick and place robots using Arduino/ any suitable Embedded processor
2. Assignment: Revolution of Smart Automation system across the world and its current scope available in India
3. Mini project: Design of a Smart Automation system (for any application of students choice)

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1 Understand the concepts of smart system design and its present developments.
CO2 Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.
CO3 Acquire knowledge on different platforms and Infrastructure for Smart system design.
CO4 Infer about smart appliances and energy management concepts.
CO5 Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
https://microcontrollerslab.com/home-automation-projects-ideas/
https://www.learnrobotics.org/blog/simple-robot/
https://robolabor.ee/homelab/en/iot

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PTEE3024 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS LT P C 2023

UNIT I  INTRODUCTION TO AUTOMOTIVE SYSTEMS 6
Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control unit- open-source ECU.

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES 6
Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

UNIT III VEHICLE MANAGEMENT SYSTEMS 6

UNIT IV ONBOARD DIAGNOSTICS AND COMMUNICATION 6
OBD , Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY and MOST.

UNIT V RECENT TRENDS 6
Navigation- Autonomous car- Role of IoT in Automotive systems.

LAB COMPONENTS:
1. Laboratory exercise: Use MATLAB SIMULINK / equivalent simulation / open source tools
   a. Simulation study of automotive sensors and actuators components.
   c. CAN Connectivity in an Automotive Application using vehicle network toolbox.
   d. Interfacing a sensor used in car with microcontroller.
e. Establishing connection between Bluetooth module and microcontroller.

2. Assignment: AUTOSAR
3. Mini project: Battery Management system for EV batteries

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Insight into the significance of the role of embedded system for automotive applications.
CO2 Illustrate the need, selection of sensors and actuators and interfacing with ECU.
CO3 Develop the Embedded concepts for vehicle management and control systems.
CO4 Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs.
CO5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded systems design and its application in automotive systems.

TEXTBOOKS:


REFERENCES:


List of Open Source Software/ Learning website:

2. https://microcontrollerslab.com/can-communication-protocol/

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PTEE3025 VLSI DESIGN LT P C

UNIT I CMOS BASICS
MOSFET Scaling - CMOS logic design- Dynamic CMOS –Transmission Gates- BiCMOS.

UNIT II IC FABRICATION
CMOS IC Fabrications: n well, p well, twin tub, SoI - Design Rules and Layout.

UNIT III PROGRAMABLE LOGIC DEVICES
PAL, PLA, CPLD architecture and application.
UNIT IV  RECONFIGURABLE PROCESSOR  6
FPGA- Architecture, FPGA based application development- Introduction to FPAA.

UNIT V  HDL PROGRAMMING  6
Verilog HDL- Overview - structural and behavioural modeling concepts-Design examples- CarryLook ahead adders, ALU, Shift Registers.

LAB COMPONENTS:  30
1. Laboratory exercise : Use any FPGA Board /IDE/open source package/ platform to give hands on training on CMOS design/ reconfigurable processor based applications,
   a. CMOS logic circuit simulation using any open source software package
   b. Experiments : structural and behavioural modeling based Verilog HDL programs
   c. Experiment: Combinational and sequential Digital logic implementation with FPGA.
   d. Implementation of carry look ahead adder with FPGA
   e. Implementation of ALU with FPGA
2. Assignment : Low Power VLSI.
3. FPGA based Mini project.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1 Develop CMOS design techniques.
CO2 Learn and build IC fabrication.
CO3 Explain the need of reconfigurable computing with PLDs.
CO4 Design and development of reprogrammable FPGA.
CO5 Illustrate and develop HDL computational processes with improved design strategies.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
https://archive.nptel.ac.in/courses/108/107/108107129/
http://gn.dronacharya.info/ ECEDept/Downloads/QuestionPapers/
7th_Sem/VLSI-DESIGN/UNIT-1/Lecture-3.pdf
https://kanchiuniv.ac.in/coursematerials/GSK_Notes_on_PLD_in_VLSI_design.pdf
https://www.tutorialspoint.com/vlsi_design/vlsi_design_vhdl_introduction.htm#:~:text=VHDL%20stands%20for%20very%20high,DoD)%20under%20the%20VHSIC%20program
UNIT I  INTRODUCTION TO MEMS AND NEMS

Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Materials for MEMS and NEMS - Applications of MEMS and NEMS.

UNIT II  MICRO-MACHINING AND MICROFABRICATION TECHNIQUES

Photolithography- Micro manufacturing, Bulk micro machining, surface micro machining, LIGA.

UNIT III  MICRO SENSORS AND MICRO ACTUATORS

Micromachining : Capacitive Sensors- Piezoresistive Sensors- Piezoelectric actuators.

UNIT IV  NEMS TECHNOLOGY

Atomic scale precision engineering- Nano Fabrication techniques – NEMS for sensors and actuators.

UNIT V  MEMS AND NEMS APPLICATION

Bio MEMS- Optical NEMS- Micro motors- Smart Sensors - Recent trends in MEMS and NEMS.

LAB COMPONENTS:

1. Laboratory experiment: Simulation of MEMS sensors and actuators using Multi physics tool
   a. Simulation of a typical piezo resistive sensor
   b. Simulation of a typical Piezoelectric actuator
   c. Simulation study of a bio sensor
   d. Simulation study of a micro motor
3. Mini project : Design and analysis of any MEMS/NEMS device using multi physics tool

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Explain the material properties and the significance of MEMS and NEMS for industrial automation.

CO2 Demonstrate knowledge delivery on micromachining and micro fabrication.

CO3 Apply the fabrication mechanism for MEMS sensor and actuators.

CO4 Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE
https://nptel.ac.in/courses
https://www.iitk.ac.in/me/mems-fabrication
http://mems.iiti.ac.in/
https://onlinecourses.nptel.ac.in/noc22_ee36/preview

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PTEE3027 DIGITAL SIGNAL PROCESSING LT P C 2023

UNIT I INTRODUCTION 6
Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

UNIT II DISCRETE TIME SYSTEM ANALYSIS 6
Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Introduction to Fourier Transform – Discrete time Fourier transform.

UNIT III DISCRETE FOURIER TRANSFORM & COMPUTATION 6

UNIT IV DESIGN OF DIGITAL FILTERS 6
FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Analog filter design - Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation - Warping, prewarping - Frequency transformation.

UNIT V DIGITAL SIGNAL PROCESSORS 6

LAB COMPONENTS:
1. Laboratory exercise : Use any DSP processor/MATLAB/open source platform to give hands on
training on basic concepts of Digital Signal Processing
a. To determine impulse and step response of two vectors 
   b. To perform convolution between two vectors 
   c. To compute DFT and IDFT of a given sequence. 
   d. To perform linear convolution of two sequence using DFT 
   e. Design and Implementation of FIR Filter 
   f. Design and Implementation of IIR Filter 
   g. To determine z-transform from the given transfer function and its ROC 
2. Assignment: Implementation of FIR/IIR filter with FPGA. 
3. DSP processors based Mini project

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1 Explain the concepts of digital signal processing.
CO2 Illustrate the system representation using transforms.
CO3 Learn the transformation techniques for time to frequency conversion.
CO4 Design suitable digital FIR, IIR algorithm for the given specification.
CO5 Use digital signal processor for application development.

TEXTBOOKS:
2. Robert J.Schilling & Sandra L.Harris ,’ Introduction to Digital Signal Processing usingMATLAB’,

REFERENCES:
1. Emmanuel C Ifeachor and Barrie W Jervis ,”Digital Signal Processing – A Practical approach” 
5. B. Venkataramani, M. Bhaskar, ‘Digital Signal Processors, Architecture, Programming and 

List of Open Source Software/ Learning website:
https://nptel.ac.in/courses/117102060
https://www.tutorialspoint.com/digital_signal_processing/index.htm
https://www.elprocus.com/digital-signal-processor/
https://www.sciencedirect.com/topics/computer-science/digital-signal-processing- algorithm#:~:text=Digital%20signal%20processing%20algorithms%20are%20known%20as%20operations%20or%20ops
https://www.electronicshub.org/introduction-to-fpga/

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UNIT I  INTRODUCTION
Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC-Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety of PLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control.

UNIT II  IEC 61131-3
Rails- Runs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions- Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PC Communication to computer- FBD equivalent to LL- FBD Programming- IL- SFC-ST.

UNIT III  SCADA
Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control- Analog control, Master Terminal Unit- Operator interface.

UNIT IV  HART and Field Bus

UNIT V  PLC PROGRAMMING

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE)
1. Taking Local area to implement simple closed loop system for any system using PLC.
2. Making a complete automated control loop with Supervisory and HMI system.
3. Implementing an Alarm based control scheme and run in a simulated environment.
4. Designing an entire PLC logic for filling and draining water tank automatically.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1 Understand the basics and need for Automation in industries.
CO2 Explain the logic and flow of any particular programming written for a process.
CO3 Apply the knowledge to design or improve an existing program to increase productivity of any process.
CO4 Breakdown SCADA architecture and communication protocols.
CO5 Build and logic in any of the programming languages from IEC- 61131- 3 standard.

TEXT BOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
https://nptel.ac.in/courses/108105062
https://nptel.ac.in/courses/108105088
https://nptel.ac.in/courses/108106022
UNIT I UNDERSTANDING BIG DATA

UNIT II NOSQL DATA MANAGEMENT

UNIT III MAP REDUCE APPLICATIONS

UNIT IV BASICS OF HADOOP

UNIT V HADOOP RELATED TOOLS

LAB COMPONENTS:
Software Requirements:
Cassandra, Hadoop, Java, Pig, Hive and HBase.
1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files
3. Implement of Matrix Multiplication with Hadoop Map Reduce
4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
5. Installation of Hive along with practice examples.
6. Installation of HBase, Installing thrift along with Practice examples
7. Practice importing and exporting data from various databases.

TOTAL: 60 PERIODS
COURSE OUTCOMES:
CO1 Describe big data and use cases from selected business domains.
CO2 Explain NoSQL big data management.
CO3 Install, configure, and run Hadoop and HDFS.
CO4 Perform map-reduce analytics using Hadoop.
CO5 Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

TEXT BOOKS:

REFERENCES:

ELECTRIC VEHICLE TECHNOLOGY

PTEE3030                   ELECTRIC VEHICLE ARCHITECTURE                  LT P C
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UNIT I VEHICLE ARCHITECTURE AND SIZING

UNIT II VEHICLE MECHANICS

UNIT III POWER COMPONENTS AND BRAKES
Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

UNIT IV HYBRID VEHICLE CONTROL STRATEGY
Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE
Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)
Basics of MATLAB simulation
1. Variables and Expressions Formats.
2. Arrays, Vectors,
3. Matrices, Built-in functions, Trigonometric functions,
4. Data types and Plotting,
5. Simulation of drive cycles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs
CO2 Describe the various EV components
CO3 Describe the concepts related in the Plug-In Hybrid Electric Vehicles
CO4 Analyse the details and Specifications for the various EVs developed
CO5 Describe the hybrid vehicle control strategy

REFERENCES:
1. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, ‘Modern Electric, Hybrid Electric and
4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar,
León, Christian Montaleza, José Luis Maldonado, Marcos Tostado-Veliz, and Francisco Jurado,
Thermo, 2021.

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PTEE3031 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES L T P C 2023

UNIT I ELECTRIC VEHICLE DYNAMICS 6
Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy
requirements of EVs.

UNIT II MOTORS FOR ELECTRIC VEHICLES 6
Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant
power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors
(PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-
Choice of electric machines for EVs.

UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS 6
Transfer Function-How to build transfer function, identify poles, zeros, draw time response plots, bode plot
(Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double
Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state
space modelling-transfer function from state space Model.
UNIT IV MODELING OF DC-DC CONVERTERS

UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS

LAB COMPONENT:
1. Simple simulation exercises of basic control systems.
2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.
3. Design of buck converter.
4. Design of boost converter.
5. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 use appropriate electric machine for electric vehicle application.
CO2 compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators).
CO3 compute transfer function from state models.
CO4 design buck, boost and buck-boost converter.
CO5 compute a power stage transfer functions for DC-DC converters.
CO6 simulate DC-DC converters and to obtain gain margin and phase margin.

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UNIT I INTERNAL COMBUSTION ENGINES

UNIT II ELECTRIC VEHICLES AND VEHICLE MECHANICS
Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT III BATTERY MODELING, TYPES AND CHARGING

UNIT IV CONTROL PRELIMINARIES
Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

UNIT V CONTROL OF AC MACHINES
Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

LAB COMPONENT:
1. Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2. Modelling and thermal analysis of Li-Ion Battery.
3. Simulation of boost converter and calculating gain and phase margin from the transfer function.
4. Simulation of vector control of induction motor.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.
CO2 find gain margin & phase margin for various types of transfer functions of boost converter.
CO3 demonstrate the Control of A C Machines.
CO4 explain the concepts related with batteries and parameters of battery.
CO5 module the battery and to study the research and development for batteries.

REFERENCES:
UNIT I  CHARGING STATIONS AND STANDARDS 6
Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations.

UNIT II  POWER ELECTRONICS FOR EV CHARGING 6
Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III  EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 6
Introduction- EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT IV  WIRELESS POWER TRANSFER 6

UNIT V  POWER FACTOR CORRECTION IN CHARGING SYSTEM 6
Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

LAB COMPONENT:
1. Simulation and analysis for bi-directional charging V2G and G2V.
2. Design and demonstrate solar PV based EV charging station.
3. Simulate and infer wireless power charging station for EV charging.
4. Simulation of boost converter based power factor correction.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 illustrate various charging techniques and to know charging standards and regulations.
CO2 demonstrate the working o DC-DC converters used for charging systems and principles.
CO3 illustrate the advantages of renewable system based charging systems.
CO4 demonstrate the principles of wireless power transfer.
CO5 analyze the standards for wireless charging.
CO6 design and simulate boost converter based power factor correction.
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PTEE3034  TESTING OF ELECTRIC VEHICLES  LT P C  2 0 2 3

UNIT I  EV STANDARDIZATION  6
Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

UNIT II  TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES  6

UNIT III  FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC  6

UNIT IV  EMC IN ELECTRIC VEHICLES  6

UNIT V  EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM  6
Coupling Path.

LAB COMPONENT: 30
1. Design and simulate motor controller for hybrid electric vehicle applications
2. Simulation of EMC analysis for Wireless power transfer EV charging.
3. Design and simulation of EMI filter

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 describe the status and other details of standardization of EVs
CO2 illustrate the testing protocols for EVs and HEV components
CO3 analyze the safety cycle and need for functions safety for EVs
CO4 analyze the problems related with EMC for EV components
CO5 evaluate the EMI in motor drive and DC-DC converter system

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PTEE3035 GRID INTEGRATION OF ELECTRIC VEHICLES 3003

UNIT I DEFINITION, And STATUS OF V2G 7

UNIT II BENEFITS OF V2G 7

UNIT III CHALLENGES TO V2G 7
UNIT IV  
IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS

UNIT V  
GRID INTEGRATION AND MANAGEMENT OF EVS
Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)
1. Simulation of connecting three phase inverter to the grid.
2. Simulate and analyse the power quality issues of V2G systems
3. Design and simulate battery management system for smart grid with distributed generation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 explain the concepts related with V2G
CO2 study the grid connection of 3 phase Q inverter
CO3 explain the technical, economics, business, regulatory & political challenges related with V2G
CO4 demonstrate the impact of EV and V2G on smart grid and renewable energy system
CO5 explain the concept of grid integration and management of EVs

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UNIT I  MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR 6

UNIT II  SPEED CONTROL FOR ELECTRIC DRIVES 6

UNIT III  FUZZY LOGIC 6

UNIT IV  FPGA AND VHDL BASICS 6

UNIT V  REAL TIME IMPLEMENTATION 6
Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

LAB COMPONENT:
1. Design and simulate speed controller for induction motors in EV for both dynamic and steady state performance
2. Simulate a fuzzy logic controller based energy storage system for EV.
3. Fuzzy logic control of BLDC motor using FPGA in real time

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:

CO1 design the mathematical model of a BLDC motor and to discuss about its characteristics
CO2 demonstrate the PID control, anti windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor
CO3 illustrate the basics of fuzzy logic system
CO4 describe the basics of VHDL & FPGA applied to control of EVs
CO5 design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time

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PTEE3037          ENERGY STORAGE SYSTEMS          LT P C
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UNIT I           INTRODUCTION  7
Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II          THERMAL STORAGE SYSTEM  7
Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

UNIT III         ELECTRICAL ENERGY STORAGE  7
Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV          FUEL CELL  7

UNIT V          ALTERNATE ENERGY STORAGE TECHNOLOGIES  7

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) 10
1. Model, simulate and analyze the performance characteristics of thermal storage systems
2. Develop a model for latent heat storage in phase changing materials.
3. Model, simulate and analyze the performance characteristics of Lead Acid Batteries
4. Model, simulate and analyze the performance characteristics of Fuel Cell
5. Techno-economic analysis of different types of storage systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 Understand different types storage technologies
CO2 Design a thermal storage system
CO3 Model battery storage system
CO4 Analyze the thermodynamics of fuel cell
CO5 Analyze the appropriate storage technologies for different applications
CO6 explore the alternate energy storage technologies.
TEXT BOOKS:

REFERENCES:

List of Open Source Software/Learning website:

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PTEE3038 HYBRID ENERGY TECHNOLOGY LT P C 3 0 0 3

UNIT I  INTRODUCTION TO HYBRID ENERGY SYSTEMS  7

UNIT II  ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS)  7
Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III  POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS  7
Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buckboost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems - Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems.

UNIT IV  ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS  7
UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS


SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

1. Simulation of Wind energy conversion system
2. Simulation of power converters
3. Simulations of AC-DC-AC converters, PWM inverters and Matrix Converters with Resistive and dynamic loads

COURSE OUTCOMES:
Upon completion of the course, students will be able to:

CO1 analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power

CO2 select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system

CO3 design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems

CO4 analyze the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems

CO5 interpret the hybrid renewable energy systems.

TEXTBOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
1. https://www.sciencedirect.com/topics/engineering/hybrid-energy-system
3. https://www.academia.edu/35619294/
   Modeling_and_Performance_Analysis_of_Solar_PV_System_and_DC_DC_Converters
   Power_Converter_Electric_Machines_Renewable_Energy_Systems_Transportation
5. https://www.intechopen.com/chapters/64317

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MODERN CONTROL AND INDUSTRIAL AUTOMATION

PTEE3039 INDUSTRIAL AUTOMATION SYSTEMS L T P C 3 0 0 3

UNIT I INTRODUCTION 9
Need for automation systems - Architecture of Industrial Automation system. Introduction to PLC, SCADA and DCS – Introduction to Industrial Data Networks: - Foundation Field Bus and Profibus.

UNIT II FIELD DEVICES 9

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9
Role of computers in measurement and control - Elements of computer aided measurement and control:- Man-Machine interface, computer aided process control hardware and software – Industrial Internet of things (IIoT) – Cyber Security for Industrial automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9
Programmable Logic Controllers: - Hardware of PLC - PLC programming:-Ladder diagram with examples - PLC Communication and networking - Case studies: - Bottle filling application and Elevator control.

UNIT V DISTRIBUTED CONTROL SYSTEM 9
DCS: - LCU-Shared communication facility- Display Hierarchy- High Level and Low Level interfaces - Case studies: - DCS in cement plant and thermal power plant.

TOTAL 45 PERIODS

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1 Recall the basics of Industrial Automation.(L1)
CO2 Select appropriate Transmitters, Final control elements and Controllers for different application.(L3)
CO3 Analyse the Computer aided measurement and control. (L4)
CO4 Design Ladder programmes for PLC.(L5)
CO5 Explain about basic concepts of Distributed Control System.(L2)
CO6 Will be able to recommend right choice of automation systems for a given application.(L2)

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UNIT I BASICS CONCEPTS (7+2 SKILL) 9
Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Robot classifications and specifications- Asimov’s laws of robotics – dynamic stabilization of robots.

UNIT II POWER SOURCES, SENSORS AND ACTUATORS (7+2 SKILL) 9

UNIT III MANIPULATORS AND GRIPPERS DIFFERENTIAL MOTION (7+2 SKILL) 9

UNIT IV KINEMATICS AND PATH PLANNING (7+2 SKILL) 9
Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance Solution kinematics problem – robot programming languages.

UNIT V DYNAMICS AND CONTROL AND APPLICATIONS (7+2 SKILL) 9

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10
1. Learn any one programming language (C/C++, Python, Java etc.)
2. Kinds of sensors for industrial robot applications.
3. Familiarization with relevant software tool (MATLAB) and programming language
4. Controlling Arduino Robot using Android Smartphone
5. Real time robotics projects (Soccer robots, line follower etc.)

COURSE OUTCOMES (COs)
On successful completion of the course, students will be able to:
CO 1 Understand the evolution of robot technology and mathematically represent different types of robots. (L2)
CO 2 Get exposed to the case studies and design of robot machine interface. (L3)
CO 3 Analyze various control schemes of Robotics control. (L4)
CO 4 Ability to select appropriate configuration of rotor for a specific application. (L5)
CO 5 Ability to choose actuator/sensor for robot. (L1)

TEXT BOOKS:

REFERENCE BOOKS:

List of Open-Source Software/ Learning website:
1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/107106090
3. https://nptel.ac.in/courses/112101098

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PTEE3041

MODELS BASED CONTROL

UNIT I INTRODUCTION TO MIMO CONTROL (7+2 SKILL)
Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPID-Case studies.

UNIT II MODEL PREDICTIVE CONTROL SCHEMES (7+2 SKILL)

UNIT III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL)
State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies.

UNIT IV CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL)
Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.

UNIT V ADAPTIVE CONTROL SCHEME (7+2 SKILL)
Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model Predictive Control Scheme —Case Studies

TOTAL:45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Explore various MIMO controllers presently used in industries.
2. Develop MPC, Adaptive and MIMO controllers for industrial processes.
3. Implement the controllers for MIMO systems.
4. Using software tools for practical exposures to the controllers used in industries by undergoing training.
5. Realisation of various optimization techniques for economical operation of process.

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

CO1 Explain various control schemes on MIMO systems. (L1,L2)
CO2 Design controller for MIMO system. (L5)
CO3 Analyze the control schemes available in industries. (L4)
CO4 Design MPC, Adaptive controllers for practical engineering problems. (L5)
CO5 Choose suitable controllers for the given problems. (L3)

TEXT BOOKS:

REFERENCES:

List of Open-Source Software/ Learning website:
1. https://nptel.ac.in/courses/103103037
2. https://nptel.ac.in/courses/108103007
3. https://onlinecourses.nptel.ac.in/noc21_ge01/preview
4. https://nptel.ac.in/courses/127106225

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PTEE3042 NON LINEAR CONTROL

UNIT I STATE VARIABLE DESIGN (7+2 SKILL)

UNIT II PHASE PLANE ANALYSIS(7+2 SKILL)

UNIT III DESCRIBING FUNCTION ANALYSIS (7+2 SKILL)

UNIT IV OPTIMAL CONTROL (7+2 SKILL)
Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti’s equation – Application examples.

UNIT V OPTIMAL ESTIMATION (7+2 SKILL)
Optimal estimation – KalmanBucy Filter-Solution by duality principle-Discrete systems-Kalman Filter- Application examples.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10
1. Design of linear quadratic regulator (LQR) control system for any application of your own
2. Familiarization of Kalman filter in MATLAB
3. Seminar on pole placement design

**COURSE OUTCOMES:**

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

- CO1 Apply the knowledge gained on state feedback control and nonlinear control. (L3)
- CO2 Carry out analysis for common nonlinearities in a system. (L4)
- CO3 Apply advanced control theory to practical engineering problems. (L3)
- CO4 Design optimal controller. (L5)
- CO5 Understand the basics and Importance of Kalman filter. (L1,L2)

**TEXT BOOKS:**


**REFERENCES:**


**List of Open-Source Software/ Learning website:**

3. https://onlinecourses.nptel.ac.in/noc22_ee24/preview

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UNIT I  NON PARAMETRIC METHODS  7
Nonparametric methods: Transient analysis - frequency analysis - Correlation analysis - Spectral analysis.

UNIT II  PARAMETRIC METHODS  7

UNIT III  RECURSIVE IDENTIFICATION METHODS  7

UNIT IV  CLOSED-LOOP IDENTIFICATION  7

UNIT V  NONLINEAR SYSTEM IDENTIFICATION  7
Modeling of nonlinear systems using ANN- NARX & NARMAX - Training Feed-forward and Recurrent Neural Networks – TSK model – Adaptive Neuro-Fuzzy Inference System (ANFIS) -Introduction to Support Vector Regression.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ ‘Surprise Test / Solving GATE questions/ etc)  10
1. Familiarization of various system identification methods in MATLAB.
2. Seminar on ANFIS.
3. Exploration of other advanced system identification methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:

CO1 design and implement state estimation schemes.
CO2 develop various models (Linear & Nonlinear) from the experimental data.
CO3 choose a suitable model and parameter estimation algorithm for the identification of systems.
CO4 illustrate verification and validation of identified model.
CO5 develop the model for prediction and simulation purposes using suitable control schemes.

TEXT BOOKS:

REFERENCE:
List of Open Source Software/ Learning website:
2. https://nptel.ac.in/courses/103106149
4. https://nptel.ac.in/courses/111102143

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PTEE3044 ADAPTIVE CONTROL

UNIT I INTRODUCTION

UNIT II GAIN SCHEDULING
Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations -application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback.

UNIT III DETERMINISTIC SELF-TUNING REGULATORS
Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuningregulators — Disturbances with known characteristics.

UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS

UNIT V MODEL – REFERENCE ADAPTIVE SYSTEM
Introduction- MIT rule — Determination of adaptation gain - Lyapunov theory –Design ofMRAS using Lyapunov theory — Relations between MRAS and STR.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)
1. Learn any one relevant software tool (MATLAB/ SCILAB/ LABVIEW/ Equivalent opensource software)
2. Design of gain scheduling adaptive control using any one software tool
3. Analysis/Problem Solving - Ability to identify and define problems and solutions
4. Design and verification of MRAC by simulation

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 apply the estimation algorithm to estimate the parameters of the process.
CO2 apply the adaptive control concepts to control a process.
CO3 use appropriate software tools for design of adaptive controllers and analysis of the process.
CO4 identify, formulate, carry out research by designing suitable adaptive schemes for complex instrumentation problem.
CO5 apply the concepts to design adaptive control for multidisciplinary problem.
CO6 choose the techniques for self and lifelong learning to keep in pace with the new technology.

TEXT BOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
5. https://www.vlab.co.in/

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UNIT I GENERAL PRINCIPLES OF MODELLING (7+2 SKILL)
Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs Nonlinear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic, Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODEBVP.

UNIT II MODELLING OF DISTRIBUTED PROCESSES (7+2 SKILL)
Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based Approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries.

UNIT III INTRODUCTION TO PROCESS MODELLING (7+2 SKILL)
Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g., Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.

UNIT IV MODELLING OF INDUSTRIAL PROCESSES (7+2 SKILL)
Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, -steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries.

UNIT V SIMULATION OF MATHEMATICAL MODELLING (7+2 SKILL)
Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation softwares and their applications, Review of solution techniques and available numerical software libraries - Case Studies.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)
1. Developing steady state /Dynamic mathematical model of different unit processes (ODE or PDE)
2. Simulation of steady state/ dynamic models using appropriate software
3. Open loop study based on the developed mathematical model.

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

CO1 Understand different methods of developing models for industrial processes. (L1)
CO2 Build mathematical models by applying relevant mathematics. (L3)
CO3 Implement mathematical models using relevant software. (L4)
CO4 Effectively perform analysis and subsequent conclusion for the developed mathematical models. (L5)
CO5 Interpret the results obtained from the mathematical model in terms of original real-world problem. (L2)

TEXT BOOKS:

REFERENCES:
5. C.D. Holland, “Fundamentals of Modelling Separation Processes”, Prentice Hall,
6. HussainAsghar, “Chemical Process Simulation”, Wiley Eastern Ltd., New Delhi,

List of Open-Source Software/ Learning website:
1. https://archive.nptel.ac.in/courses/103/107/103107096/
2. https://nptel.ac.in/courses/103101111
3. https://nptel.ac.in/courses/111107105
4. https://www.academia.edu/37228967/Process_Modeling_Simulation_and_Control_for_Chemical_Engineers

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PTEE3046 COMPUTER CONTROL OF PROCESSES L T P C

UNIT I DISCRETE STATE-VARIABLE TECHNIQUE
State equation of discrete time system with sample and hold – State transition equation – Methods of computing the state transition matrix – Decomposition of discrete time transfer functions – State diagram representations of Discrete time systems - Controllability and observability of linear time invariant discrete time system – Stability tests of discrete time system – State Observer.

UNIT II SYSTEM IDENTIFICATION

UNIT III DIGITAL CONTROLLER DESIGN

UNIT IV MULTI-LOOP REGULATORY CONTROL
UNIT V  MULTI-VARIABLE REGULATORY CONTROL

Introduction to Multivariable control – Multivariable PID Controller – Multivariable Internal Model Controller – Multivariable Dynamic Matrix Controller – Generalized Predictive Controller. Case Studies:
- Computer control of a thermal process.

TOTAL : 45 PERIODS

COURSE OUTCOMES (COs)
On successful completion of the course, students will be able to:

CO 1  Analyze the solution for discrete time systems and test the stability of the systems (L4)
CO 2  Evaluate the controllability, observability and stability of discrete time systems. (L1)
CO 3  Build empirical models by parametric and non parametric methods (L3)
CO 4  Design and analysis of various digital control techniques for SISO system. (L5)
CO 5  Demonstrate the concept of RGA and decoupler for MIMO system. (L2)
CO 6  Design a multiloop and multivariable control for industrial processes. (L6)

TEXT BOOKS:

REFERENCE BOOKS:

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1 - Low, 2-medium, 3-high, "-"- no correlation
UNIT I MEASUREMENT SCIENCE AND DISPLAYS 9
Instrumentation brief review-Concept of measurement - Functional elements of an instrument system –
Transducers - classification - classification of aircraft instruments-Instrument displays panels and cockpit
layout, Electronic Flight Instrument System.

UNIT II AIR DATA INSTRUMENTS AND SYNCHRO TRANSMISSION SYSTEMS 9
Air data instruments-airspeed, altitude, Vertical speed indicators, Altitude alerting systems, Machmeter,
Mach Warning system, Static Air temperature, Angle of attack measurement, Stall Warning system,
Synchronous data transmission system.

UNIT III GYROSCOPIC AND ADVANCED FLIGHT INSTRUMENTS 9
Gyroscope and its properties, gyro system, Gyro horizon, Erection systems for Gyro Horizons- Direction
gyro-direction indicator, Rate gyro-rate of turn and slip indicator, Turn coordinator, acceleration and turning
errors, Standby Attitude Director Indicator, Gyro stabilized Direction Indicating Systems, Advanced Direction
Indicators, Horizontal Situation Indicator.

UNIT IV AIRCRAFT COMPASS SYSTEMS & FLIGHT MANAGEMENT SYSTEM 9
Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope
system, DGU, RMI, deviation compensator. FMS- Flight planning-flight path optimization-operational modes-
4D flight management.

UNIT V POWER PLANT INSTRUMENTS & FLIGHT DATA RECORDING 9
Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control
instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR,Engine Fuel
Indicators, engine vibration monitoring, Cockpit Voice Recorder and Flight Data Recorder.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 design the error model and estimate the error in the aircraft instruments
CO2 explain about the various air data systems and synchronous data transmissions systems.
CO3 apply the principle of gyroscope, DGU, RMI, FMS in 4D flight management in the Avionics
domain requirements.
CO4 Classify the different sensors and select the appropriate one for the given requirements.
CO5 Explain the operation and importance of engine instruments and flight data recorder.

REFERENCES:
1. David Wyatt. ‘Aircraft Flight Instruments and Guidance Systems’, Routledge, Taylor & FrancisGroup,
2015.
publishing house PVT Ltd, 2010.
MAPPING OF COs WITH POs AND PSOs

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