ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2022
CHOICE BASED CREDIT SYSTEM

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - (TRAINING INTEGRATED)

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
   I. Find employment in Core Electrical and Electronics Engineering and service sectors.
   II. Get elevated to technical lead position and lead the organization competitively.
   III. Enter into higher studies leading to post-graduate and research degrees.
       Become consultant and provide solutions to the practical problems of core organization.
   IV. Become an entrepreneur and be part of electrical and electronics product and service industries.

2. PROGRAMME OUTCOMES (POs):
   After going through the four years of study, our Electrical and Electronics Engineering Graduates will exhibit ability to:

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<tr>
<th>PO#</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
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<tr>
<td>1</td>
<td>Engineering knowledge</td>
<td>Apply knowledge of mathematics, basic science and engineering science.</td>
</tr>
<tr>
<td>2</td>
<td>Problem analysis</td>
<td>Identify, formulate and solve engineering problems.</td>
</tr>
<tr>
<td>3</td>
<td>Design/development of solutions</td>
<td>Design an electrical system or process to improve its performance, satisfying its constraints.</td>
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<td>4</td>
<td>Conduct investigations of complex problems</td>
<td>Conduct experiments in electrical and electronics systems and interpret the data.</td>
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<td>5</td>
<td>Modern tool usage</td>
<td>Apply various tools and techniques to improve the efficiency of the system.</td>
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<tr>
<td>6</td>
<td>The Engineer and society</td>
<td>Conduct themselves to uphold the professional and social obligations.</td>
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<tr>
<td>7</td>
<td>Environment and sustainability</td>
<td>Design the system with environment consciousness and sustainable development.</td>
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<td>8</td>
<td>Ethics</td>
<td>Interacting industry, business and society in a professional and ethical manner.</td>
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<td>9</td>
<td>Individual and team work</td>
<td>Function in a multidisciplinary team.</td>
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<td>10</td>
<td>Communication</td>
<td>Proficiency in oral and written Communication.</td>
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<td>11</td>
<td>Project management and finance</td>
<td>Implement Cost effective and improved system.</td>
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<td>12</td>
<td>Life-long learning</td>
<td>Continue professional development and learning as a life-long activity.</td>
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3. PROGRAM SPECIFIC OUTCOMES (PSOs):

On completion of Electrical and Electronics Engineering program, the student will have the following Program Specific Outcomes.

1. **Foundation of Electrical Engineering**: Ability to understand the principles and working of electrical components, circuits, systems and control that are forming a part of power generation, transmission, distribution, utilization, conservation and energy saving. Students can assess the power management, auditing, crisis and energy saving aspects.

2. **Foundation of Mathematical Concepts**: Ability to apply mathematical methodologies to solve problems related with electrical engineering using appropriate engineering tools and algorithms.

3. **Computing and Research Ability**: Ability to use knowledge in various domains to identify research gaps and hence to provide solution which leads to new ideas and innovations.
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1-low, 2-medium, 3-high, ‘-’-no correlation
# ANNA UNIVERSITY, CHENNAI
# AFFILIATED INSTITUTIONS
# REGULATIONS 2022
# B.E. ELECTRICAL AND ELECTRONICS ENGINEERING – (TRAINING INTEGRATED)
# CHOICE BASED CREDIT SYSTEM
# I TO VIII SEMESTERS CURRICULUM AND SYLLABUS

## SEMESTER I

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Registration of Professional Elective Courses:

Professional Elective Courses will be registered from Semester V onwards. These courses are listed in different groups that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular group or from different group. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

Total number of professional elective courses per group may change in the each programme of study as 6 or 7 or 8. If there is shortage of courses in a group the same may be chosen from another group of the same programme.
# Professional Elective Courses

## Power Engineering

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# ELECTRIC VEHICLE TECHNOLOGY

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COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I MATRICES  

UNIT II DIFFERENTIAL CALCULUS  

UNIT III FUNCTIONS OF SEVERAL VARIABLES  

UNIT IV INTEGRAL CALCULUS  
Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS  

TOTAL : 60 PERIODS

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: Apply differential calculus tools in solving various application problems.
CO3: Able to use differential calculus ideas on several variable functions.
CO4: Apply different methods of integration in solving practical problems.
CO5: Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS:
3. James Stewart, "Calculus : Early Transcendentals ", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].

REFERENCES:

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COURSE OBJECTIVES:

- To introduce electric circuits and its analysis
- To provide key concepts to analyze and understand electrical circuits
- To impart knowledge on solving circuit equations using network theorems
- To educate on obtaining the transient response of circuits.
- To introduce the phenomena of resonance in coupled circuits.
- To introduce Phasor diagrams and analysis of single & three phase circuits

UNIT I BASIC CIRCUITS ANALYSIS 9+3

UNIT II NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS 9+3

UNIT III TRANSIENT RESPONSE ANALYSIS 9+3

UNIT IV RESONANCE AND COUPLED CIRCUITS 9+3

UNIT V THREE PHASE CIRCUITS 9+3
Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced and unbalanced – Phasor diagram of voltages and currents – Power measurement in three phase circuits – Power Factor Calculations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completing this course, the students will be able to:

CO1: Explain circuit’s behavior using circuit laws.
CO2: Apply mesh analysis/ nodal analysis / network theorems to determine behavior of the given DC and AC circuit.
CO3: Compute the transient response of first order and second order systems to step and sinusoidal input.
CO4: Compute power, line/ phase voltage and currents of the given three phase circuit.
CO5: Explain the frequency response of series and parallel RLC circuits.
CO6: Explain the behavior of magnetically coupled circuits.

TEXT BOOKS:

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TIEE3102 DIGITAL LOGIC CIRCUITS L T P C
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COURSE OBJECTIVES:
- To introduce the fundamentals of combinational and sequential digital circuits.
- To study various number systems and to simplify the mathematical expressions using Boolean functions word problems
- To study implementation of combinational circuits using Gates’ and MSI Devices.
- To study the design of various synchronous and asynchronous circuits
- To introduce digital simulation techniques for development of application oriented logic circuit

UNIT I NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES 9
Number system, error detection, corrections & codes conversions, Boolean algebra: De-Morgan’s theorem, switching functions and minimization using K-maps & Quine McCluskey method - Digital Logic Families - comparison of RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.
UNIT II  COMBINATIONAL CIRCUITS  
Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - simplification and implementation of combinational logic – multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.

UNIT III  SYNCHRONOUS SEQUENTIAL CIRCUITS  
Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Mealy models- Counters, state diagram; state reduction; state assignment.

UNIT IV  ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABILITY  
Asynchronous sequential logic Circuits-Transition stability, flow stability-race conditions, hazards &errors in digital circuits; analysis of asynchronous sequential logic circuits-introduction to Programmability Logic Devices: PROM – PLA –PAL, CPLD-FPGA.

UNIT V  VHDL  

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: Explain various number systems and characteristics of digital logic families
CO2: Apply K-maps and Quine McCluskey methods to simplify the given Boolean expressions
CO3: Explain the implementation of combinational circuit such as multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders
CO4: Design various synchronous and asynchronous circuits using Flip Flops
CO5: Explain asynchronous sequential circuits and programmable logic devices
CO6: Use VHDL for simulating and testing RTL, combinatorial and sequential circuits

TEXTBOOKS:

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TIEE3103 PROBLEM SOLVING AND PYTHON PROGRAMMING

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**COURSE OBJECTIVES:**
- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**UNIT I  COMPUTATIONAL THINKING AND PROBLEM SOLVING**

**UNIT II  DATA TYPES, EXPRESSIONS, STATEMENTS**
Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III  CONTROL FLOW, FUNCTIONS, STRINGS**
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.
Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V FILES, MODULES, PACKAGES
Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter’s age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to
 CO1: Develop algorithmic solutions to simple computational problems.
 CO2: Develop and execute simple Python programs.
 CO3: Write simple Python programs using conditionals and loops for solving problems.
 CO4: Decompose a Python program into functions.
 CO5: Represent compound data using Python lists, tuples, dictionaries etc.
 CO6: Read and write data from/to files in Python programs.

TEXT BOOKS:

REFERENCES:
5. https://www.python.org/
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**TIEE3111**  **PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY**  **LT P C 0 0 4 2**

**COURSE OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter’s age validity, student mark range validation)
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
On completion of the course, students will be able to:
CO1: Develop algorithmic solutions to simple computational problems
CO2: Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems.
CO4: Deploy functions to decompose a Python program.
CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:

REFERENCES:
5. https://www.python.org/

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COURSE OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 9 + 3
Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 9 + 3
One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9 + 3

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9 +3
Lagrange’s and Newton’s divided difference interpolations – Newton’s forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson’s 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9 +3

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2: Apply the basic concepts of classifications of design of experiments in the field of agriculture.
CO3: Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
**CO4:** Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

**CO5:** Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**TEXT BOOKS:**

**REFERENCES:**

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COURSE OBJECTIVES:
- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of
  - Electrostatic fields, electric potential, energy density and their applications.
  - Magneto static fields, magnetic flux density, vector potential and its applications.
  - Different methods of emf generation and Maxwell’s equations
  - Electromagnetic waves and characterizing parameters

UNIT I ELECTROSTATICS – I 12
Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields – Gradient, Divergence, Curl – theorems and applications – Coulomb’s Law – Electric field intensity – Field due to discrete and continuous charges – Gauss’s law and applications.

UNIT II ELECTROSTATICS – II 12
Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization – Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson’s and Laplace’s equations, Capacitance, Energy density, Applications.

UNIT III MAGNETOSTATICS 12
Lorentz force, magnetic field intensity (H) – Biot–Savart’s Law - Ampere’s Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, 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, Energy density, Applications.

UNIT IV ELECTRODYNAMIC FIELDS 12

UNIT V ELECTROMAGNETIC WAVES 12
Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: Visualize and explain Gradient, Divergence, and Curl operations on electromagnetic vector fields and identify the electromagnetic sources and their effects.
CO2: Compute and analyse electrostatic fields, electric potential, energy density along with their applications.
CO3: Compute and analyse magneto static fields, magnetic flux density, vector potential along with their applications.
CO4: Explain different methods of emf generation and Maxwell’s equations
CO5: Explain the concept of electromagnetic waves and characterizing parameters

**TEXT BOOKS:**

**REFERENCES**

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COURSE OBJECTIVES:

- To understand the structure of basic electronic devices.
- To be exposed to active and passive circuit elements.
- To familiarize the operation and applications of transistor like BJT and FET.
- To explore the characteristics of amplifier gain and frequency response.
- To learn the required functionality of positive and negative feedback systems.

UNIT I  PN JUNCTION DEVICES  9
PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance –

UNIT II  TRANSISTORS AND THYRISTORS  9
BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT -
Structure and characteristics.

UNIT III  AMPLIFIERS  9
BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET
small signal model– Analysis of CS and Source follower – Gain and frequency response- High
frequency analysis.

UNIT IV  MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER  9
BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET
input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods,
power amplifiers –Types (Qualitative analysis).

UNIT V  FEEDBACK AMPLIFIERS AND OSCILLATORS  9
Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback –
Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

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

CO1: Explain the structure and operation of PN junction devices (diode, Zener diode, LED and Laser diode)

CO2: Design clipper, clamper, half wave and full wave rectifier, regulator circuits using PN junction diodes

CO3: Analyze the structure and characteristics BJT, FET, MOSFET, UJT, Thyristor and IGBT

CO4: Analyze the performance of various configurations of BJT and MOSFET based amplifier

CO5: Explain the characteristics of MOS based cascade and differential amplifier

CO6: Explain the operation of various feedback amplifiers and oscillators

TEXT BOOKS:
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TIEE3203 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY L T P C 2 0 0 2

COURSE OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:
• To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
• To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
• To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
• To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
• To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS:
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.

**REFERENCES**


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**TIEE3211 BASIC ELECTRONICS AND ELECTRICAL CIRCUITS LABORATORY**

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**COURSE OBJECTIVES:**

- To enable the students to understand the behavior of semiconductor device based on experimentation.
- Be exposed to active and passive circuit elements.
- Familiarize the operation and characteristics of transistor like BJT and FET.
- Explore the characteristics of amplifier gain and frequency response.
- Learn the required functionality of positive and negative feedback systems.

**Electrical Experiments:**

1. Verification of series and parallel electrical circuit using fundamental laws.
2. Simulation and experimental verification of electrical circuit problems using Thevenin’s theorem.
3. Verification of electrical circuit problems using Superposition theorem.
4. Validation of R-C, R-L and RLC electric circuit transients.
5. Simulation and Experimental validation of Frequency response of RLC electric circuit.
6. Verification of three phase balanced and unbalanced star, delta networks circuit (Power and Power factor calculations).

**Electronics experiments:**

1. V-I Characteristics of Semiconductor diode, Zener diode, photodiode, and phototransistor
2. V-I Characteristics of MOSFET
3. V-I Characteristics of UJT and generation of sawtooth waveforms
4. Design and frequency response characteristics of a Common Emitter amplifier
5. Design and testing of RC phase shift and LC oscillators
6. Single-Phase half-wave and full-wave rectifiers with capacitive filters

**COURSE OUTCOMES:**

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

CO1: Verify the fundamental laws pof electric circuits.
CO2: Verify the theorems (Thevenin’s superposition) via simulation and experimental studies.
CO3: Verify and validate the responses in PLC, RL and RLC transients and resonant circuit.
CO4: Compute power and power factor for a balanced unbalanced three phase circuits.
CO5: Analyze the characteristics of PN, Zener diode, photodiode, photo transistor and BJT in CE, configurations experimentally.
CO6: Analyze the characteristics of JFET and UJT experimentally.
CO7: Analyze the characteristics of RC phase shift and LC oscillators experimentally.
CO8: Analyze the characteristics of half-wave and full-wave rectifier with and without filters experimentally.

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TIEE3301  ELECTRICAL MACHINES - I  

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COURSE OBJECTIVES:
- To understand the concept of electromechanical energy conversion system.
- To identify the appropriate machine for a given application based on its characteristics.
- To identify the appropriate test to determine the performance parameters of a given machine.
- To familiarize with the procedure for parallel operation of generators and transformers.
- To deliberate the working of auto transformer and three phase transformers.

UNIT I  ELECTROMECHANICAL ENERGY CONVERSION  
Fundamentals of Magnetic circuits- Statically and dynamically induced EMF - Principle of electromechanical energy conversion forces and torque in magnetic field systems- energy balance in magnetic circuits- magnetic force- co-energy in singly excited and multi excited magnetic field system mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines- magnetic saturation and leakage fluxes. Introduction to Indian Standard Specifications (ISS) - Role and significance in testing.

UNIT II  DC GENERATORS  
Principle of operation, constructional details, armature windings and its types, EMF equation, wave shape of induced emf, armature reaction, demagnetizing and cross magnetizing Ampere turns, compensating winding, commutation, methods of improving commutation, interpoles, OCC and load characteristics of different types of DC Generators. Parallel operation of DC Generators, equalizing connections- applications of DC Generators.

UNIT III  DC MOTORS  
Principle of operation, significance of back emf, torque equations and power developed by armature, speed control of DC motors, starting methods of DC motors, load characteristics of DC motors, losses and efficiency in DC machine, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne’s test, Hopkinson’s test, Field test, Retardation test, Separation of core losses-applications of DC motors.

UNIT IV  SINGLE PHASE TRANSFORMER  
Construction and principle of operation, equivalent circuit, phasor diagrams, testing - polarity test, open circuit and short circuit tests, voltage regulation, losses and efficiency, all day efficiency, back-to-back test, separation of core losses, parallel operation of single-phase transformers, applications of single-phase transformer.

UNIT V  AUTOTRANSFORMER AND THREE PHASE TRANSFORMER  
Construction and working of auto transformer, comparison with two winding transformers, applications of autotransformer. Three Phase Transformer- Construction, types of connections and their comparative features, Scott connection, applications of Scott connection.

TOTAL : 45 PERIODS
TEXT BOOKS

REFERENCES

COURSE OUTCOMES:
At the end of the course students will be able to:
CO1: Apply the laws governing the electromechanical energy conversion for singly and multiple excited systems.
CO2: Explain the construction and working principle of DC machines.
CO3: Interpret various characteristics of DC machines.
CO4: Compute various performance parameters of the machine, by conducting suitable tests.
CO5: Draw the equivalent circuit of transformer and predetermine the efficiency and regulation.
CO6: Describe the working principle of auto transformer, three phase transformer with different types of connections.

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COURSE OBJECTIVES:
To impart knowledge on the following topics
- Signal analysis using Op-amp based circuits.
- Applications of Op-amp.
- Functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits.
- IC fabrication procedure.

UNIT I  IC FABRICATION
IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realisation of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance, FETs and PV Cell.

UNIT II  CHARACTERISTICS OF OPAMP
Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Voltage-shunt feedback and inverting amplifier - Voltage series feedback: and Non-Inverting Amplifier - Basic applications of op-amp –, summer, differentiator and Integrator-V/I & I/V converters.

UNIT III  APPLICATIONS OF OPAMP
Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers- Analog multiplier & Divider, first and second order active filters, comparators, multi vibrators, waveform generators, clips, clamps, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using OP-AMPS.

UNIT IV  SPECIAL ICs
Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltage controlled oscillator IC; 565-phase locked loop IC, AD633 Analog multiplier ICs.

UNIT V  APPLICATION ICs
AD623 Instrumentation Amplifier and its application as load cell weight measurement - IC voltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators, switching regulator- SMPS - ICL 8038 function generator IC.

TOTAL :45 PERIODS

COURSE OUTCOMES:
Upon successful completion of the course, the students will be able to:
CO1  Explain monolithic IC fabrication process
CO2  Explain the fabrication of diodes, capacitance, resistance, FETs and PV Cell.
CO3  Analyze the characteristics and basic applications (inverting/non-inverting amplifier, summer, differentiator, integrator, V/I and I/V converter) of Op-Amp
CO4  Explain circuit and applications of op-amp based instrumentation amplifier, log/antilog amplifier, analog multiplier /divider, active filters, comparators, waveform generators, A/D and D/A converters
CO5  Explain Functional blocks, characteristics and applications of Timer, PLL, analog multiplier ICs.
CO6  Explain the applications of ICs in Instrumentation amplifier, fixed and variable voltage regulator, SMPS and function generator

TEXT BOOKS:

REFERENCES

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COURSE OBJECTIVES:
- To introduce the basics of C programming language.
- To learn the concepts of advanced features of C.
- To understand the concepts of ADTs and linear data structures.
- To know the concepts of non-linear data structure and hashing.
- To familiarize the concepts of sorting and searching techniques.

UNIT I C PROGRAMMING FUNDAMENTALS (8+1 SKILL)

UNIT II C PROGRAMMING - ADVANCED FEATURES (8+1 SKILL)

UNIT III LINEAR DATA STRUCTURES (8+1 SKILL)

UNIT IV NON-LINEAR DATA STRUCTURES (8+1 SKILL)

UNIT V SORTING AND SEARCHING TECHNIQUES (8+1 SKILL)
Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5

COURSE OUTCOMES:
CO1 Develop C programs for any real world/technical application.
CO2 Apply advanced features of C in solving problems.
CO3 Write functions to implement linear and non-linear data structure operations.
CO4 Suggest and use appropriate linear/non-linear data structure operations for solving a given problem.
CO5 Appropriately use sort and search algorithms for a given application.
CO6 Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.

TEXT BOOKS:
REFERENCES:


List of Open Source Software/ Learning website:
https://www.coursera.org/specializations/data-structures-algorithms
https://nptel.ac.in/courses/112107243
https://nptel.ac.in/courses/112105598

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TIE3311 LINEAR AND DIGITAL CIRCUITS LABORATORY

COURSE OBJECTIVES:
- To learn design, testing and characterizing of circuit behavior with combinational logic gate ICs.
- To learn design, testing and characterizing of circuit behavior with register/counter and sequential logic ICs.
- To learn design, testing and characterizing of circuit behavior with OPAMP ICs.
- To learn design, testing and characterizing of circuit behavior with analog Ics like 555 timer VCO and regulators.
- To learn design, testing and characterizing of circuit behavior with digital Ics like decoders, multiplexers.

LIST OF EXPERIMENTS
1. Implementation of Boolean Functions, Adder and Subtractor circuits.
2. Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa.
3. Parity generator and parity checking.
4. Encoders and Decoders.
5. Counters: Design and implementation of 3-bit modulo counters as synchronous and asynchronous types using FF IC’s and specific counter IC.
6. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitability IC’s.
7. Study of multiplexer and de multiplexer
8. Timer IC application: Study of NE/SE 555 timer in Astability, Monostability operation.
10. Voltage to frequency characteristics of NE/SE 566 IC.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student should have the:
CO1: Ability to understand and implement Boolean Functions.
CO2: Ability to understand the importance of code conversion
CO3: Ability to Design and implement circuits with digital ICs like decoders, multiplexers, register.
CO4: Ability to acquire knowledge on Application of Op-Amp
CO5: Ability to Design and implement counters using analog ICs like timers, VCOs and digital ICs like Flip-flops and counters.

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PROGRESS THROUGH KNOWLEDGE
COURSE OBJECTIVES:
- To develop applications in C
- To implement linear and non-linear data structures
- To understand the different operations of search trees
- To get familiarized to sorting and searching algorithms

LIST OF EXPERIMENTS
1. Practice of C programming using statements, expressions, decision making and iterative statements
2. Practice of C programming using Functions and Arrays
3. Implement C programs using Pointers and Structures
4. Implement C programs using Files
5. Development of real time C applications
6. Array implementation of List ADT
7. Array implementation of Stack and Queue ADTs
8. Linked list implementation of List, Stack and Queue ADTs
9. Applications of List, Stack and Queue ADTs
10. Implementation of Binary Trees and operations of Binary Trees
11. Implementation of Binary Search Trees
12. Implementation of searching techniques
13. Implementation of Sorting algorithms: Insertion Sort, Quick Sort, Merge Sort

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1 Use different constructs of C and develop applications
CO2 Write functions to implement linear and non-linear data structure operations
CO3 Suggest and use the appropriate linear / non-linear data structure operations for a given problem
CO4 Apply appropriate hash functions that result in a collision free scenario for data storage and Retrieval
CO5 Implement Sorting and searching algorithms for a given application

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COURSE OBJECTIVES:

To impart knowledge on the following Topics
- Construction and performance of salient and non-salient type synchronous generators.
- Principle of operation and performance of synchronous motor.
- Construction, principle of operation and performance of induction machines.
- Starting and speed control of three-phase induction motors.
- Construction, principle of operation and performance of single phase induction motors and special machines.

UNIT I  SYNCHRONOUS GENERATOR  9

UNIT II  SYNCHRONOUS MOTOR  9

UNIT III  THREE PHASE INDUCTION MOTOR  9

UNIT IV  STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR  9

UNIT V  SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will have the:
CO1: Ability to understand the construction and working principle of Synchronous generator
CO2: Ability to understand the construction and working principle of Synchronous Motor
CO3: Ability to understand the construction and working principle of Three Phase Induction Motor

CO4: Acquire knowledge about the starting and speed control of induction motors.

CO5: To gain knowledge about the basic principles and working of Single phase induction motors and Special Electrical Machines.

TEXT BOOKS:

REFERENCES

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COURSE OBJECTIVES:

- To impart knowledge about the configuration of the electrical power systems.
- To study the line parameters and interference with neighboring circuits.
- To understand the mechanical design and performance analysis of transmission lines.
- To learn about different insulators and underground cables.
- To understand and analyze the distribution system.

UNIT I  TRANSMISSION LINE PARAMETERS 9
Structure of electric power system - Parameters of single and three phase transmission lines with single and double circuits - Resistance, inductance, and capacitance of solid, stranded, and bundled conductors - Typical configuration, conductor types - Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects - Effects of earth on the capacitance of the transmission line - interference with neighboring communication circuits.

UNIT II  MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9
Performance of Transmission lines – short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance – transmission efficiency and voltage regulation, real and reactive power flow in lines – Power Circle diagrams – Ferranti effect – Formation of Corona – Critical Voltages – Effect on line Performance.

UNIT III  SAG CALCULATION AND LINE SUPPORTS 9
Mechanical design of overhead lines – Line Supports –Types of towers – Tension and Sag Calculation for different weather conditions – Methods of grounding - Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators.

UNIT IV  UNDERGROUND CABLES 9

UNIT V  DISTRIBUTION SYSTEMS 9

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCE BOOKS:

COURSE OUTCOMES
On the successful completion of the course, students will be able to:
CO1: Understand the structure of power system, computation of transmission line parameters for different configurations.
CO2: Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona on line performance.
CO3: Do Mechanical design of transmission lines, grounding and to understand about the insulators in transmission system.
CO4: Design the underground cables and understand the performance analysis of underground cable.
CO5: Understand the modelling, performance analysis and modern trends in distribution system.

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COURSE OBJECTIVES:
- To study the addressing modes & instruction set of 8085 & 8051
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/interfacing ICs.
- To study and understand typical applications of micro-processors.
- To study and understand the typical applications of micro-controllers

UNIT I INTRODUCTION TO 8085 ARCHITECTURE

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

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

UNIT IV INTRODUCTION TO 8051 MICROCONTROLLER

UNIT V INTRODUCTION TO RISC BASED ARCHITECTURE

COURSE OUTCOMES:
Upon successful completion of the course, the students should have the:
CO1: Ability to write assembly language program for microprocessor and microcontroller
CO2: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller
CO3: Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.
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 field

TEXTBOOKS:
REFERENCES:

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TIEE3411 ELECTRICAL MACHINES LABORATORY LTPC
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COURSE OBJECTIVES:
- To expose the students to determine the characteristics of DC machines and transformers by performing experiments on these machines.
- To provide hands on experience to evaluate the performance parameters of DC machines and transformer by conducting suitable tests.

LIST OF EXPERIMENTS:
1. Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2. Load test on DC series motor.
3. Swinburne’s test and speed control of DC shunt motor.
4. Load test on single-phase transformer and three phase transformers.
5. Open circuit and short circuit tests on single phase transformer.
6. Regulation of three phase alternator by EMF and MMF methods.
7. V and Inverted V curves of Three Phase Synchronous Motor.
8. Load test on three-phase induction motor.
9. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
10. Load test on single-phase induction motor.
11. No load and blocked rotor test on single-phase induction motor.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course students will be able to:

CO1: Ability to understand and analyse predetermination methods of calculating regulation for synchronous generations.

CO2: Acquire hands on experience of conducting various tests on transformers, three phase induction motor and single phase induction motor.

CO3: Ability to acquire knowledge on separation of losses for static and induction motors.

CO4: Ability to understand the concepts related with encitating current, armature current and power factor for a synchronous motor.

CO5: Ability to understand the performance characterizes of AC and DC machines.

CO6: Capability to understand the parameters that control the speed of DC motor.

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TIEE3412 MICROPROCESSOR AND MICROCONTROLLER LABORATORY L T P C 0 0 3 1.5

COURSE OBJECTIVES:

• To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8085 & 8051
• To develop skills in simple program writing in assembly languages
• To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.
• To perform interfacing experiments with µP8085
• To perform interfacing experiments with µC8051.

PROGRAMMING EXERCISES / EXPERIMENTS WITH µP8085:

1. Simple arithmetic operations: Multi precision addition / subtraction /multiplication / division.
5. Displaying a moving/ rolling message in the student trainer kit’s output device.
PROGRAMMING EXERCISES / EXPERIMENTS WITH µC8051:

8. Interface Experiments: A/D Interfacing, D/A Interfacing, Traffic light controller
10. Displaying a moving/ rolling message in the student trainer kit’s output device.
11. Programming PIC architecture with software tools.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
After studying the above subject, students should have the:
CO1: Ability to write assembly language program for microprocessor.
CO2: Ability to write assembly language program for microcontroller
CO3: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller
CO4: Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring
CO5: Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

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COURSE OBJECTIVES:

- Impact knowledge on need for operational studies, and To model the power system under steady state operating condition.
- To understand and apply iterative techniques for power flow analysis.
- To model of carry out short circuit studies for power system during symmetrical fault.
- To model of carry out short circuit – studies during
- To study about the various methods for analyzing power system stability

UNIT I  POWER SYSTEM


UNIT II  POWER FLOW ANALYSIS


UNIT III  SYMMETRICAL FAULT ANALYSIS

Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin’s theorem - Bus Impedance matrix 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 networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system.

UNIT V  STABILITY ANALYSIS


COURSE OUTCOMES:

Upon the successful completion of the course, students should have the:

CO1: Ability to model the power system under steady state operating condition.
CO2: Ability to carry out power flow analysis using.
CO3: Ability to infer the significance of short circuit studies in designing circuit breakers.
CO4: Ability to analyze the state of the power system for various unsymmetrical faults.
CO5: Ability to analyze the stability of power system using different methods.

TEXT BOOKS:


REFERENCES

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TIEE3502 MEASUREMENTS AND INSTRUMENTATION LT P C 3 0 0 3

COURSE OBJECTIVES
- To educate the fundamental concepts and characteristics of measurement and errors
- To impart the knowledge on the functional aspects of measuring instruments
- To infer the importance of various bridge circuits used with measuring instruments.
- To educate the fundamental working of sensors and transducers and their applications
- To summarize the overall measurement and instrumentation with the knowledge on digital instrumentation principles.

UNIT I CONCEPTS OF MEASUREMENTS
Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data.

UNIT II MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS
UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS

UNIT IV TRANSUDCERS FOR MEASUREMENT OF NON-ELECTRICAL PARAMETERS

UNIT V DIGITAL INSTRUMENTATION

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon successful completion of the course, the students should have the:
CO1: Ability to understand the fundamental art of measurement in engineering.
CO2: Ability to understand the structural elements of various instruments.
CO3: Ability to understand the importance of bridge circuits.
CO4: Ability to understand about various transducers and their characteristics by experiments.
CO5: Ability to understand the concept of digital instrumentation and virtual instrumentation by experiments.

TEXT BOOKS:

REFERENCES:

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COURSE OBJECTIVES:
- To make the students to familiarize with various representations of systems.
- To make the students to analyze the stability of linear systems in the time domain and frequency domain.
- To make the students to analyze the stability of linear systems in the frequency domain.
- To make the students to design compensator based on the time and frequency domain specifications.
- To develop linear models: mainly state variable model and Transfer function model

UNIT I  MODELING OF LINEAR TIME IN Variant SYSTEM (LTIV)  9
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  9

UNIT III  FREQUENCY DOMAIN ANALYSIS  9

UNIT IV  STATE VARIABLE ANALYSIS  9

UNIT V  DESIGN OF FEED BACK CONTROL SYSTEM  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
- CO1: Represent simple systems in transfer function and state variable forms.
- CO2: Analyze simple systems in time domain.
- CO3: Analyze 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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COURSE OBJECTIVES:
- To make the students familiarize with various representations of systems.
- To make the students analyze the stability of linear systems in the time domain and frequency domain.
- To make the students design compensator based on the time and frequency domain Specifications.
- To develop linear models mainly state variable model and transfer function model.
- To make the students to design a complete closed loop control system for the physical systems.

LIST OF EXPERIMENTS:
1. Analog (op amp based) simulation of linear differential equations.
3. Real time simulation of differential equations.
4. Mathematical modeling and simulation of physical systems in at least two fields.
   - Mechanical
   - Electrical
   - Chemical process
5. System Identification through process reaction curve.
7. Root Locus based analysis in simulation platform.
8. Determination of transfer function of a physical system using frequency response and Bode’s asymptotes.
11. Discretization of continuous system and effect of sampling.
12. Test of controllability and observability in continuous and discrete domain in simulation platform.
14. Mini Project 1: Simulation of complete closed loop control systems including sensor and actuator dynamics.
15. Mini Project 2: Demonstration of a closed loop system in hardware.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability

CO1: To model and analyze simple physical systems and simulate the performance in analog and digital platform.

CO2: To design and implement simple controllers in standard forms.

CO3: To design compensators based on time and frequency domain specifications.

CO4: To design a complete closed control loop and evaluate its performance for simple physical systems.

CO5: To analyze the stability of a physical system in both continuous and discrete domains.

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COURSE OBJECTIVES:
- To understand the various applications of power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers
- To study the operation, switching techniques and basic topologies of DC-DC switching regulators.
- To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To study the operation of AC voltage controller and various configurations of AC voltage controller.

UNIT I  SWITCHING POWER SUPPLIES  9
MOSFET dynamic behavior - 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 and dynamic behavior - single phase half bridge and full bridge inverters - VSI (1phase 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  UNCONTROLLED RECTIFIERS  9

UNIT IV  CONTROLLED RECTIFIERS  9
SCR-Two transistor analogy based turn- ON – turn ON losses – thermal protection – controlled converters (1 pulse, 2 pulse, 3 pulse, 6 pulse) - displacement factor – ripple and harmonic factor - power factor mitigation, performance parameters – effect of source inductance - inverter angle limit.

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:
Upon the successful completion of the course, students will be able to:
CO1: Understand the operation of semiconductor devices and dynamic characteristics and to design & analyze the 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 the operation of AC voltage controllers and its applications.
TEXT BOOKS:

REFERENCES:

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PROGRESS THROUGH KNOWLEDGE
COURSE OBJECTIVES:

- To understand the significance of protection, protection schemes and role of earthing.
- To study the characteristics, functions and application areas of various relays.
- To acquire practical knowledge about common faults in power system apparatus and applying suitable protective schemes.
- To understand the functioning of static relays and Numerical protection concepts.
- To understand the problems associated with circuit breaking and to discuss about various circuit breakers.

UNIT I  PROTECTION SCHEMES
Significance and need for protective schemes – nature and causes of faults – types of faults
Effects of faults - Zones of protection and essential qualities of protection – Types of Protection
schemes - Power system Grounding and Methods of Grounding.

UNIT II  BASICS OF RELAYS
Operating principles of relays – Universal torque equation - R-X diagram – Electromagnetic
Relays – Over current, Directional and non-directional, Distance, Differential, Negative sequence
and Under frequency relays.

UNIT III  OVERVIEW OF EQUIPMENT PROTECTION
Current transformers and Potential transformers and their applications in protection schemes -
Protection of transformer, generator, motor, bus bars 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, and distance 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 - rate of rise of recovery voltage - current chopping - interruption of
capacitive current - resistance switching - Types of circuit breakers – air blast, oil, SF6 and
vacuum circuit breakers – comparison of different circuit breakers – HVDC Breaker.

COURSE OUTCOMES:

Upon the successful completion of the course, students will have the ability to:

- CO1: Understand and select proper protective scheme and type of earthing.
- CO2: Explain the operating principles of various relays.
- CO3: Suggest suitable protective scheme for the protection of various power system
  apparatus.
- CO4: Analyze the importance of static relays and numerical relays in power system
  protection.
- CO5: Summarize the merits and demerits and application areas of various circuit breakers.

TOTAL : 45 PERIODS
TEXT BOOKS:

REFERENCES

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COURSE OBJECTIVES:
To impart knowledge on,
- The significance of power system operation and control.
- Real power– frequency interaction and design of power– frequency controller.
- Reactive power– voltage interaction and the compensators for maintaining the voltage profile.
- The generation scheduling and economic operation of power system.
- SCADA and its application for real time operation and control of power systems.

UNIT I     INTRODUCTION
Power scenario in Indian grid – National and Regional load dispatching centres – Requirements of good power system – Necessity of voltage and frequency regulation – real power vs frequency and reactive power vs voltage control loops - System load variation, load curves – Load forecasting – Computational methods in load forecasting – Load shedding and Islanding – deregulation - Basics of electrical energy tariff.

UNIT II     REAL POWER FREQUENCY CONTROL
Basics of speed governing mechanisms and modelling – 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 modelling – 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
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

UNIT V     COMPUTER AIDED CONTROL OF POWER SYSTEM
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 – State estimation – Measurements and errors – Weighted least square estimation – Various operating states – State transition diagram.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
On the successful completion of the course, students will be able to:
CO1: Understand the day – to – day operation of power system.
CO2: Model and analyse the control actions that are implemented to meet the minute-to-minute variation of system real power demand.
CO3: Model and analyze the compensators for reactive power control and various devices used for voltage control.
CO4: Prepare day ahead and real time economic generation scheduling.
CO5: Understand the necessity of computer control of power systems.

TEXTBOOKS:

REFERENCE BOOKS:

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COURSE OBJECTIVES:
- To study the VI characteristics of SCR, TRIAC, MOSFET and IGBT.
- To analyze the performance of semi converter, full converter, step up, step down choppers by simulation and experimentation.
- To study the behavior of voltage waveforms of PWM inverter applying various modulation techniques.
- To design and analyze the performance of SMPS.
- To study the performance of AC voltage controller by simulation and Experimentation.

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 :45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: Determine the characteristics of SCR, IGBT, TRIAC, MOSFET and IGBT
CO2: Find the transfer characteristics of full converter, semi converter, step up and step down choppers by simulation 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.
CO5: Understand the performance of AC voltage controllers by simulation and experimentation

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COURSE OBJECTIVES:

- Various types of over voltages in power system and protection methods.
- Generation of over voltages in laboratories.
- Measurement of over voltages.
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
- Testing of power apparatus and insulation coordination.

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, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment.

UNIT III  GENERATION AND MEASUREMENTS OF HIGH VOLTAGES AND HIGH CURRENTS  9

UNIT IV  HIGH VOLTAGE TESTING & INSULATION COORDINATION  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 - Insulation Coordination.

UNIT V  APPLICATION IN INDUSTRY  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain various overvoltage’s and its effects on power systems.

CO2: Understand the breakdown phenomena in different 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 Electrostatic Fields.

TEXT BOOKS

REFERENCES

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COURSE OBJECTIVES:

- To know various electric drives and traction motors with applications
- To introduce the energy saving concept by different ways of illumination.
- To understand the different methods of electric heating and electric welding.
- To know the conversion of solar and wind energies into electrical energy for different applications.
- To study the domestic utilization of electrical energy.

UNIT I          ELECTRIC DRIVES AND TRACTION (7+2 Skill) 9

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.

UNIT II         ILLUMINATION (7+2 Skill) 9

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED

UNIT III        HEATING AND WELDING (7+2 Skill) 9


Unit IV         ENERGY CONSERVATION AND ITS IMPORTANCE (7+2 Skill) 9


UNIT V          DOMESTIC UTILIZATION OF ELECTRICAL ENERGY (7+2 Skill) 9

House wiring - working principle of air conditioning system, Induction based appliances, Online an OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

TOTAL: 45 PERIODS

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

1. Choosing electrical motors for drives and traction applications.
2. A general design procedure for lighting schemes.
3. Design of heating element and study of welding methods.
4. Practical case studies of energy conservation.
5. Power requirement for different domestic appliances.
COURSE OUTCOMES:

At the end of the course, students should have the:

CO1   Ability to choose suitable electric drives for different applications
CO2   Ability to design the illumination systems for energy saving
CO3   Ability to demonstrate the utilization of electrical energy for heating and welding purposes
CO4   Ability to know the effective usage of solar and wind energies for electrical applications
CO5   Ability to do electric connection for any domestic appliance like refrigerator, battery charging circuit for a specific household application.
CO6   To illustrate the need for energy conservation and to simulate three phase power control.

TEXT BOOKS:

REFERENCES:

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COURSE OBJECTIVES:

- To learn the structure of Electric Vehicle, Hybrid Electric Vehicle
- To study about the EV conversion components
- To know about the details and specifications for Electric Vehicles
- To understand the concepts of Plug-in Hybrid Electric Vehicle
- To model and simulate all types of DC motors

UNIT I VEHICLE ARCHITECTURE and SIZING (7+2 Skill) 9

UNIT II VEHICLE MECHANICS (7+2 Skill) 9

UNIT III POWER COMPONENTS AND BRAKES (7+2 Skill) 9
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 (7+2 Skill) 9
Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE (7+2 Skill) 9
Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) Basics of MATLAB simulation 10

1. Variables and Expressions Formats, Vectors and Matrices,
2. Arrays, Vectors,
3. Matrices, Built-in functions, Trigonometric functions,
4. Data types and Plotting.
5. Simulation of drive cycles.

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:
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021

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PROGRESS THROUGH KNOWLEDGE
COURSE OBJECTIVES:

The student should be made to learn methodology to select a good project and able to work in a team leading to development of hardware/software product. Prepare a good technical report. Gain Motivation to present the ideas behind the project with clarity.

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The aim of the project work is to deepen Comprehension of principles by applying them to a new problem which may be the design/fabrication of any power component / circuit / sensor / Activator / Controller, a research investigation, a computer or management project or a design problem. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

TOTAL : 90 PERIODS

COURSE OUTCOMES:

CO1 Ability to identify, formulate, design, interpret, analyze and provide solutions to complex engineering and societal issues by applying knowledge gained on basics of science and Engineering.

CO2 Ability to choose, conduct and demonstrate a sound technical knowledge of their selected project topics in the field of power components, protection, highvoltage, electronics, process automation, power electronics and drives instrumentation and control by exploring suitable engineering and IT tools.

CO3 Ability to understand, formulate and propose new learning algorithms to solve engineering and societal problems of moderate complexity through multidisciplinary projects understanding commitment towards sustainable development.

CO4 Ability to demonstrate, prepare reports, communicate and work in a team as a member/leader by adhering to ethical responsibilities.

CO5 Ability to acknowledge the value of continuing education for oneself and to stay up with technology advancements.

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COURSE OBJECTIVES:

To impart knowledge on the following topics
- Understanding Power Cable Characteristics and Applications.
- Cable Manufacturing.
- Installation of underground power cables
- Underground cable System Fault Locating.
- Testing and maintenance of Underground cable system.
- Cable Performance and Field Assessment of Power Cables

UNIT I
INTRODUCTION TO ELECTRICAL POWER CABLES (7+2 SKILL) 9

UNIT II
CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS (7+2 SKILL) 9

UNIT III
SUPPLY DISTRIBUTION SYSTEMS AND CABLES(7+2 SKILL) 9

UNIT IV
TRANSMISSION SYSTEMS AND CABLES(7+2 SKILL) 9

UNIT V
CABLE INSTALLATION, TESTING, MAINTENANCE(7+2 SKILL) 9

TOTAL : 45 PERIODS
SKILL DEVELOPMENT ACTIVITIES (GROUP SEMINAR/ MINI PROJECT/ ASSIGNMENT/ CONTENT PREPARATION/ QUIZ/ SURPRISE TEST /SOLVING GATE QUESTIONS /ETC.

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

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

TEXT BOOKS:

REFERENCES:
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TIEE3002 SUBSTATION ENGINEERING AND AUTOMATION L T P C 3 0 0 3

COURSE OBJECTIVES:

- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.
- The course aims to give an exposure to the students to the requirements of practical aspects including an overview of civil and mechanical aspects.
- Course aims to enhance the knowledge, and give the practical guidelines for site selection, construction, protection along with maintenance, safety in a substation.
- It also aims at providing knowledge about state-of-the-art technology in substation automation system

UNIT I SUBSTATION DESIGN DEVELOPMENT (7+2 SKILL) 9

UNIT II SUBSTATION EQUIPMENT (7+2 SKILL) 9

UNIT III PROTECTION AND SUBSTATION AUTOMATION (7+2 SKILL) 9
UNIT IV  SUBSTATION DESIGN & LAYOUT ENGINEERING (7+2 SKILL)  
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 (7+2 SKILL)  
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.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (GROUP SEMINAR/ MINI PROJECT/ ASSIGNMENT/ CONTENT PREPARATION/ QUIZ/ SURPRISE TEST /SOLVING GATE QUESTIONS /ETC.  
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- A case study

COURSE OUTCOMES:
On successful completion of the course student will be able to:
CO 1: Understand the key deciding factors involved in substation design and operation  
CO 2: Know about the sizing and selection of equipment which forms part of substation  
CO 3: Know about composite layout design aspects of the substation with different services and the challenges including statutory clearances.  
CO 4: Understand about Interdisciplinary aspects involved in substation design  
CO 5: Understand different protection and control scheme involved in substation design  
CO 6: Know about substation automation system and different communication protocol involved for efficient operation of a substation

REFERENCES:
COURSE OBJECTIVES:
To understand:
- The problems in AC transmission systems and DC transmission systems
- The operation and control of SVC and TCSC
- The concepts of IGBT based FACTS controllers
- The basic operation Line Commutated Converter (LCC) based HVDC links
- The features of voltage source converter based HVDC links

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  

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.
TOTAL: 45 PERIODS

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 in simulation.
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 understand

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:

REFERENCES:

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COURSE OBJECTIVES:
- To study the concepts behind economic analysis and Load management.
- To understand the basics of materials and energy balance.
- To analyze the energy efficiency in thermal utilities.
- To know the concept of compressed air system.
- To illustrate the concept of lighting systems and cogeneration.

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT (7+2 Skill) 9

UNIT II MATERIAL AND ENERGY BALANCE (7+2 Skill) 9
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 - Case Study.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES (7+2 Skill) 9

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM (7+2 Skill) 9
UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES (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. Study of energy conservation and audit
2. Performance study of Electric Motors.
3. Analysis on fan characteristic curves at different operating points
4. Case study of illumination system
5. Performance analysis of Compressors

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

CO1 Students able to acquire knowledge in the field of energy management and auditing process.
CO2 Learned the about basic concepts of economic analysis and load management.
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:

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TIEE3005 POWER QUALITY L T P C 3 0 0 3

COURSE OBJECTIVES:
- To learn the basic definitions in Power Quality.
- To study the power quality issues in Single Phase and Three Phase Systems.
- To understand the principles of Power System Harmonics.
- To know the way to use DSTATCOM for Harmonic Mitigation.
- To learn the concepts related with Series Compensation.

UNIT I INTRODUCTION (7+2 Skill) 9

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM (7+2 Skill) 9


UNIT III MITIGATION OF POWER SYSTEM HARMONICS (7+2 Skill) 9


UNIT IV LOAD COMPENSATION USING DSTATCOM (7+2 Skill) 9


UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM (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. Harmonic analysis of single phase power converters (Semi converters and Full Converters) with R and RL load via simulation
2. Harmonic analysis of three phase power converters (Semi converters and Full Converters) 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

List of Open Source Software/ Learning website:

1. http://nptel.iitm.ac.in/courses.php
3. https://electricalacademia.com/electric-power
4. https://www.intechopen.com/books/6214
6. https://www.academia.edu/43237017/Use_Series_Compensation_in_Distribution_Networks_33_KV
COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 Use various definitions of power quality for power quality issues
CO2 Describe the concepts related with single phase / three phase, linear / nonlinear loads and single phase / three phase sinusoidal, non-sinusoidal source
CO3 Solve problems related with mitigation of Power System Harmonics
CO4 Use DSTATCOM for load compensation
CO5 Demonstrate the role of DVR, SAFs UPQC in power distribution systems

TEXTBOOKS:

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COURSE OBJECTIVES:

- To understand the evolution of Smart and Interconnected energy systems.
- To understand the various challenges and benefits of smart grid and the national and international initiatives taken.
- To understand the concepts related with transmission and distribution in smart grid technologies.
- To get an insight of the various smart measurement technologies.
- To understand the various computing technologies for Smart Operation of the Grid.

UNIT I       INTRODUCTION (7+2 SKILL) 9
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 (7+2 SKILL) 9
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) (7+2 SKILL) 9
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) (7+2 SKILL) 9
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 (7+2 SKILL) 9
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.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)  10
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.
COURSE OUTCOMES:
After completion the above subject, students will be able to understand
CO1: To be able to understand the importance and objectives of Power System Grid.
CO2: To be able to know and understand the concept of a smart grid;
CO3: To identify and discuss smart metering devices and associated technologies.
CO4: To be able to get an overview of Microgrid and Electric Vehicle Technology.
CO5: To be able to 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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COURSE OBJECTIVES:
Students will be able to:
- Describe various types of deregulated markets in power system.
- Describe the technical and non-technical issues in deregulated power industry.
- Classify different market mechanisms and summarize the role of various entities in the market.
- Analyze the energy and ancillary services management in deregulated power industry.
- Understand the restructuring framework US and Indian power sector

UNIT I  INTRODUCTION (7+2 SKILL) 9
Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture .

UNIT II  TRANSMISSION CONGESTION MANAGEMENT (7+2 SKILL) 9
Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

UNIT III  LOCATIONAL MARGINAL PRICES(LMP) AND FINANCIAL TRANSMISSION RIGHTS (7+2 SKILL) 9

UNIT IV  ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK (7+2 SKILL) 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 - International comparison. Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods.

UNIT V  MARKET EVOLUTION (7+2 SKILL) 9

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) 10
1. Analysis of ATC calculations using any one of the relevant software tool.
2. DCOPF based LMP calculations using any one of the relevant software tool.
3. ACOPF based LMP calculations using any one of the relevant software tool.
4. Analysis of social welfare maximization with different objectives.
5. Analysis of ABT components.

**COURSE OUTCOMES:**
Students will be able to:
CO1: describe the requirement for deregulation of the electricity market and the philosophy of various market models
CO2: analyze the various methods of congestion management in deregulated power system
CO3: analyze the locational marginal pricing and financial transmission rights
CO4: analyze the ancillary service management
CO5: analyze transmission pricing paradigm
CO6: understand the evolution of deregulation in Indian power sector

**TEXT BOOKS:**

**REFERENCES:**

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

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COURSE OBJECTIVES:

- To understand the working of special machines like stepper motor, switched reluctance motor, BLDC motor & PMSM
- To derive torque equation and study the characteristics of special machines
- To design the controller for special machines
- To study the working principle of synchronous reluctance motor
- To simulate closed loop operation of BLDC motor

UNIT I  STEPPER MOTORS

Constructional features – Principle of operation – Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control – Applications

UNIT II  SWITCHED RELUCTANCE MOTORS


UNIT III  PERMANENT MAGNET BRUSHLESS DC MOTORS


UNIT IV  PERMANENT MAGNET SYNCHRONOUS MOTORS


UNIT V  STUDY OF OTHER SPECIAL ELECTRICAL MACHINES

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

30 PERIODS

LAB COMPONENT:

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

**OURSE OUTCOMES:**

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

**REFERENCES:**

4. T.Kenjo, 'Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000

**MAPPING OF COs WITH POs AND PSOs**

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**TIEE3009**

ANALYSIS OF ELECTRICAL MACHINES

COURSE OBJECTIVES:

- To model & simulate all types of DC machines
- To develop reference frame equations for various elements like R, L and C
- To model an induction (three phase and ‘n’ phase) and synchronous machine
- To drive reference frame equations for induction and synchronous machine
- To study the need and working of multiphase induction and synchronous machine
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


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  6


LAB COMPONENT:  30 PERIODS

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.

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students should be able to:
CO1: Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separately excited 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 synchronous motor 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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TIEE3010 MULTILEVEL POWER CONVERTERS  

COURSE OBJECTIVES:
- To learn multilevel topology (Symmetry & Asymmetry) with common DC bus link.
- To study the working of cascaded H Bridge, Diode Clamped and Flying Capacitor MLI.
- To study the working of MLI with reduced switch count.
- To simulate three level diode clamped MLI and three level flying capacitor based MLI with resistive and reactive load.
- To simulate the MLI with reduced switch count.

UNIT I MULTILEVEL TOPOLOGIES

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

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes-
UNIT III  DIODE CLAMPED MULTILEVEL CONVERTER 6

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

UNIT V  MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT 6
Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

30 PERIODS

LAB COMPONENT: 30 PERIODS

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: 30+30 = 60  PERIODS

COURSE OUTCOMES:
At the end of the course, students should be able to:
CO1: Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
CO2: Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation
CO3: Demonstrate 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.
CO6: Simulate MLI with reduced switch configuration using fundamental switching scheme

TEXT BOOKS:

REFERENCE BOOKS:

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### TIEE3011 ELECTRICAL DRIVES L T P C 2023

**COURSE OBJECTIVES:**
At the end of the course, students should have the:
- To understand steady state operation and transient dynamics of a motor load system.
- To study and analyze the operation of the converter / chopper fed dc drive, both qualitatively and quantitatively.
- To study and understand the operation and performance of AC Induction motor drives.
- To study and understand the operation and performance of AC Synchronous motor drives.
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drives.

**UNIT I DRIVE CHARACTERISTICS**
6

**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,

88
UNIT IV  SYNCHRONOUS MOTOR DRIVES  
V/f control and self-control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

UNIT V  DESIGN OF CONTROLERS FOR DRIVES  
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.

30 PERIODS

LAB COMPONENT:  

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: 30+30 = 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:

REFERENCES:

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COURSE OBJECTIVES:
- To learn the working of isolated & non-isolated DC-DC converters
- To design isolated & non-isolated DC-DC converters.
- To drive the equations related with converter dynamics.
- To design and simulate P, PI & PID controller for buck, boost and buck-boost converters.
- To identify and study different configurations of the UPS.

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

30 PERIODS

LAB COMPONENT:  30 PERIODS

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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students should have the following capabilities:
CO1: Demonstrate 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: Demonstrate 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:

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TIEE3013 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS L T P C 2 0 2 3

COURSE OBJECTIVES:
- To learn the various types of renewable sources of energy.
- To understand the electrical machines to be used for wind energy conversion systems.
- To learn the principles of power converters used in solar PV system.
- To study the principle of power converters used in Wind system.
- To simulate the AC-DC, AC-AC Converters, Matrix Converters and PWM Inverters.

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

UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 6

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9
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).

30 PERIODS

LAB COMPONENT: 30 PERIODS
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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students should be able to:
CO1: Examine the available renewable energy sources.
CO2: Demonstrate the working principles of electrical machines and power converters used for wind energy conversion system
CO3: Demonstrate 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.
REFERENCES:

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TIEE3014 CONTROL OF POWER ELECTRONICS CIRCUITS

COURSE OBJECTIVES:
- To learn the basics of control system simulation.
- To do symbolic calculation.
- To study the principles of sliding mode control and the way of apply smc for buck converter.
- To learn the concept of power factor correction.
- To design simulate smc for buck converter and power factor correction circuit with controller.

UNIT I SIMULATION BASICS IN CONTROL SYSTEMS
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 II象征性计算
UNIT III  SLIDING MODE CONTROL BASICS  6

UNIT IV  POWER FACTOR CORRECTION CIRCUITS  6
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  6
Power factor correction circuit using other SMPS topologies: C’uk and SEPIC converter - PFC circuits employing bridgeless topologies.

30 PERIODS

LAB COMPONENT:  30 PERIODS
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 C’uk converters.

TOTAL: 30+30 = 60 PERIODS

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

TEXT BOOKS:

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EMBEDDED SYSTEMS

TIEE3015 EMBEDDED SYSTEM DESIGN LT P C 2023

COURSE OBJECTIVES:
- To introduce the Building Blocks of an embedded System and Software Tools
- To emphasize the role of Input/output interfacing with Bus Communication protocol.
- To illustrate the ISR and scheduling for the multitasking process.
- To explain the basics of a Real-time operating system
- To analyze the applications based on embedded design approaches

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

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

Embedded Product Development Life Cycle - Case Study: Precision Agriculture- Autonomous car.

30 PERIODS

LAB COMPONENT:

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: 30+30 = 60 PERIODS

COURSE OUTCOMES:

After completion of the above subject, students will be able to understand

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:
1. https://nptel.ac.in/courses/108102045

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TIEE3016 EMBEDDED C- PROGRAMMING LT P C 2 0 2 3

COURSE OBJECTIVES:
- To expose the students to the fundamentals of embedded Programming
- To Introduce the GNU C Programming Tool Chain.
- To study the basic concepts of embedded C.
- To teach the basics of 8051 Programming
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT I BASIC C PROGRAMMING 6
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 6

UNIT III 8051 Programming in C 6
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  6
Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.

UNIT V  8051 INTERFACING  6
8051: ADC interfacing , DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing.

LAB COMPONENT:  30 PERIODS
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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
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://onlinecourses.nptel.ac.in/noc19_cs42/preview
- https://microcontrollerslab.com/8051-microcontroller-tutorials-c/

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TIEE3017 EMBEDDED PROCESSORS

COURSE OBJECTIVES:
- To introduce the architecture of the ARM processor.
- To train students in ARM programming.
- To discuss memory management, append location development with an ARM processor.
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts
- To impart the knowledge on single board embedded processors.

UNIT I ARM ARCHITECTURE
6

UNIT II ARM MICROCONTROLLER PROGRAMMING
6
ARM general Instruction set – Thumb instruction set – Introduction to DSP on ARM – basic programming.

UNIT III PERIPHERALS OF ARM
6
UNIT IV     ARM COMMUNICATION  
ARM With CAN, I²C, and SPI protocols

UNIT V     INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR  
Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands - Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi

100 PERIODS

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 motor control.  
   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: 100 PERIODS

COURSE OUTCOMES:  
At the end of this course, the students will have the ability to  
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 up gradation on recent trends in commercial embedded processors.

TEXTBOOKS:  

REFERENCES:  

List of Open Source Software/ Learning websites:  
1. https://nptel.ac.in/courses/117106111  
2. https://onlinecourses.nptel.ac.in/noc20_cs15/preview
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COURSE OBJECTIVES:
- To provide the control concept for electrical drives
- To emphasize the need of embedded systems for controlling the electrical drives
- To provide knowledge about various embedded system-based control strategies for electrical drives
- To impart the knowledge of optimization and machine learning techniques used for electrical drives
- To familiarize the high-performance computing for electrical drives.

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 BDLC motor speed control.
UNIT V  SRM MOTOR CONTROL
Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.  
30 PERIODS

LAB COMPONENTS:  
30 PERIODS
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
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
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/
2) https://www.embedded.com/mcus-or-dspss-which-is-in-motor-control/
4) https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
5) http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf
MAPPING OF COs WITH POs AND PSOs

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COURSE OBJECTIVES:
- To introduce the smart system technologies and its role in real time applications
- To teach the architecture and requirements of Home Automation.
- To provide an insight into smart appliances and energy management concepts.
- To familiarize the design and needs of smart wearable devices
- To teach the basics of robotics and its role for automation.

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

UNIT II HOME AUTOMATION

UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT

UNIT IV SMART WEARABLE DEVICES

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

30 PERIODS
LAB COMPONENTS:

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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
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:

2. https://www.learnrobotics.org/blog/simple-robot/
MAPPING OF COs WITH POs AND PSOs

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TIEE3020 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS LT P C 2023

COURSE OBJECTIVES:
- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on sensor functional components for vehicles.
- To discuss on programmable controllers for vehicles management systems.
- To teach logics of automation & communication techniques for vehicle communication.
- To introduce the infotainment system development.

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.

30 PERIODS
LAB COMPONENTS:

1. Laboratory exercise: Use MATLAB SIMULINK /equivalent simulation /open source tools
   a) Simulation study of automotive sensors and actuators components
   b) Adaptive cruise control, Anti-Lock Braking System
   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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability in
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 up gradation 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/
4) https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/
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TIEE3021 VLSI DESIGN LT P C 2 0 2 3

COURSE OBJECTIVES

- To explain the basic concepts of CMOS and
- To introduce the IC fabrication methods
- To introduce the Reconfigurable Processor technologies
- To introduce the basics of analog VLSI design and its importance.
- To learn about the programming of Programmable device using Hardware description Language.

UNIT I CMOS BASICS 6
MOSFET Scaling - CMOS logic design - Dynamic CMOS - Transmission Gates - BiCMOS

UNIT II IC FABRICATION 6
CMOS IC Fabrications: n well, p well, twin tub, SoI - Design Rules and Layout.

UNIT III PROGRAMABLE LOGIC DEVICES 6
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 - Carry Look ahead adders, ALU, Shift Registers.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

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
2. Assignment : Low Power VLSI.
3. FPGA based Mini project.

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
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:
1) https://archive.nptel.ac.in/courses/108/107/108107129/
4) https://kanchiuniv.ac.in/coursematerials/GSK_Notes_on_PLD_in_VLSI_design.pdf
7) https://www.tutorialspoint.com/vlsi_design/vlsi_design_vhdl_introduction.htm#:~:text=VHDL%20stands%20for%20very%20high,DoD)%20under%20the%20VHSIC%20program.
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COURSE OBJECTIVES:

- To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro and nano sensors, actuators.
- To emphasis the need for NEMS technology.
- To update the ongoing trends and real time applications of MEMS and NEMS technology.

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.

30 PERIODS

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

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
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 upgradation on MEMS and NEMS technology.

TEXTBOOKS:

REFERENCES:

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

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COURSE OBJECTIVES:
- To introduce the concept of analyzing discrete time signals & systems in the time and frequency domain through mathematical representation.
- To study the various time to frequency domain transformation techniques.
- To Understand the computation algorithmic steps for Fourier Transform.
- To study about filters and their design for digital implementation.
- To introduce the programmable digital signal processor & its application.

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
Introduction – Architecture of one DSP processor for motor control – Features – Addressing Formats– Functional modes - Introduction to Commercial Processors

LAB COMPONENTS:  30 PERIODS
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: 30+30 = 60 PERIODS
COURSE OUTCOMES:
At the end of this course, the students will have the ability to
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:

REFERENCES:

List of Open Source Software/ Learning website:
1. https://nptel.ac.in/courses/117102060
5. https://www.electronicshub.org/introduction-to-fpga/

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COURSE OBJECTIVES:

- To review the drive cycles and requirements of EVs
- To know the working of motors used in Electric Vehicle
- To analyze and model the buck/boost converter operation and to design the same
- To learn the simulation basics of control systems
- To derive transfer functions for DC-DC converters

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  6
Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

UNIT V   POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS  6

LAB COMPONENT:  30 PERIODS

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: 30+30 = 60 PERIODS
COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1: To use appropriate electric machine for electric vehicle application
CO2: To compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)
CO3: To compute transfer function from state models
CO4: To design buck, boost and buck-boost converter.
CO5: To compute a power stage transfer functions for DC-DC converters
CO6: To simulate DC-DC converters and to obtain gain margin and phase margin.

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TIEE3025 ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL L T P C
2 0 2 3

COURSE OBJECTIVES:
- To learn the basics of EV and vehicle mechanics
- To know the EV architecture
- To study the energy storage system concepts
- To derive model for batteries and to know the different types of batteries and its charging methods
- To learn the control preliminaries for DC-DC converters.
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<th>ELECTRIC VEHICLES AND VEHICLE MECHANICS</th>
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<td>Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.</td>
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<td>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.</td>
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<th>UNIT V</th>
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<td>Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.</td>
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**30 PERIODS**

**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: 30+30 = 60 PERIODS

**COURSE OUTCOMES:**

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

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

**REFERENCES:**

4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press,

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TIEE3026 Design of Electric Vehicle Charging System

COURSE OBJECTIVES:
- To know the charging station and standards
- To learn the concepts of power converters in charging
- To find the charging scheme in renewable based EV charging
- To demonstrate the wireless power transfer technique
- To design & simulate power factor correction circuits

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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
CO1: To illustrate various charging techniques and to know charging standards and regulations. 
CO2: To demonstrate the working of DC-DC converters used for charging systems and principles 
CO3: To illustrate the advantages of renewable system based charging systems 
CO4: To demonstrate the principles of wireless power transfer. 
CO5: To analyze the standards for wireless charging 
CO6: To design and simulate boost converter based power factor correction.

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COURSE OBJECTIVES:

- To know various standardization procedures
- To learn the testing procedures for EV & HEV components
- To know the functional safety and EMC
- To realize the effect of EMC in EVs
- To study the effect of EMI in motor drives and in DC-DC converter system

UNIT I  EV STANDARDIZATION
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

UNIT III  FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC

UNIT IV  EMC IN ELECTRIC VEHICLES
Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements-

UNIT V  EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM

30 PERIODS

LAB COMPONENT:

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

TOTAL: 30+30 = 60 PERIODS

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

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TIEE3028 GRID INTEGRATION OF ELECTRIC VEHICLES

L T P C

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COURSE OBJECTIVES:

- To know the basic details of V2G
- To study the benefits & challenges of V2G
- To learn EV & V2G on the smart grids renewable energy systems
- To know the grid integration

UNIT I DEFINITION, AND STATUS OF V2G (7+2 Skill) 9
Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications, Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid: Other Concepts Related to V2G.

UNIT II BENEFITS AND CHALLENGES OF V2G (7+2 Skill) 9
UNIT III  CHALLENGES TO V2G  (7+2 Skill) 9


UNIT IV  IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS  (7+2 Skill) 9


UNIT V  GRID INTEGRATION AND MANAGEMENT OF EVS  (7+2 Skill) 9

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.

TOTAL : 45 PERIODS

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

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.

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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**COURSE OBJECTIVES:**
- To design and drive the mathematical model of a BLDC motor and its characteristics
- To learn the different control schemes for BLDC motor
- To study the basics of fuzzy logic
- To study the FPGA & VHDL basics
- To implement fuzzy logic control of BLDC motor in real time

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


**UNIT II SPEED CONTROL FOR ELECTRIC DRIVES**


**UNIT III FUZZY LOGIC**


**UNIT IV FPGA AND VHDL BASICS**

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

30 PERIODS

LAB COMPONENT: 30 PERIODS

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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: To design the mathematical model of a BLDC motor and to discuss about its characteristics
CO2: To demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.
CO3: To illustrate the basics of fuzzy logic system
CO4: To describe the basics of VHDL & FPGA applied to control of EVs.
CO5: To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

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COURSE OBJECTIVES:

- To understand the important of mathematical models for Industrial processes.
- To acquaint students with different forms of mathematical models.
- To develop and simulate mathematical models for different Industrial processes.
- To apply Mathematical tools while developing mathematical models.
- To analyze the graphical response of developed mathematical models.

UNIT I GENERAL PRINCIPLES OF MODELLING

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

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

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, PersistentRecycle.

UNIT IV MODELLING OF INDUSTRIAL PROCESSES

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

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:
CO1 Will be able to understand different methods of developing models for industrial processes.
CO2 Able to build mathematical models by applying relevant mathematics.
CO3 Able to implement mathematical models using relevant software.
CO4 Effectively perform analysis and subsequent conclusion for the developed mathematical models.
CO5 Able to interpret the results obtained from the mathematical model in terms of original real world problem

TEXT BOOKS:

REFERENCES:

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

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COURSE OBJECTIVES:
- To represent the linear time invariant System in discrete State Space form
- To analyze the controllability, observability and stability of a Discrete time System.
- To estimate model parameters from input/output measurements
- To Design Digital Controllers
- To Design Multi-loop and Multivariable Controllers for multivariable system

UNIT I DISCRETE STATE-VARIABLE TECHNIQUE (7+2 SKILL) 9
State equation of discrete data system with sample and hold – State transition equation –
Methods of computing the state transition matrix – Decomposition of discrete data transfer
functions – State diagrams of discrete data systems – System with zero-order hold –
Controllability and observability of linear time invariant discrete data system–Stability tests of
discrete-data system.

UNIT II SYSTEM IDENTIFICATION (7+2 SKILL) 9
Identification of Non-Parametric Input-Output Models: -Transient analysis–Frequency analysis–
Correlation analysis– Spectral analysis – Identification of Parametric Input-Output Models: -

UNIT III DIGITAL CONTROLLER DESIGN (7+2 SKILL) 9
Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller
– Dead-beat controller and Dahlin's controller – Kalman’s algorithm, Pole Placement Controller

UNIT IV MULTI-LOOP REGULATORY CONTROL (7+2 SKILL) 9
Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs -The
Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller –
Biggest Log Modulus Tuning Method – De-coupler.

UNIT V MULTIVARIABLE REGULATORY CONTROL (7+2 SKILL) 9
Introduction to Multivariable control –Multivariable PID Controller – Multivariable Dynamic Matrix
Controller – Case Studies: - Distillation Column, CSTR and Four-tank system.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content 10
Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)
1. Calculate the RGA to determine the recommended pairing between controlled and
manipulated variables for any system.
2. Seminar on LS, RLS methods.
3. Design of DMC for distillation Column, CSTR and Four-tank system in MATLAB.
4. Design a Multi-loop & Multivariable controller for MIMO system.
5. Design a model for any industrial process using parametric & non-parametric system.

COURSE OUTCOMES:
CO1 Develop mathematical models for discrete time systems using state variable techniques
and analyze the stability of the systems. L4
CO2 Construct models from input-output data by least square and recursive least square
CO3 Ability to design different digital controllers to satisfy the required criterion. L5
CO4 Design a multi-loop controller and multivariable controller for multi-variable systems. L5
CO5 Ability to design multivariable dynamic matrix controller for industrial processes. L5

TEXT BOOKS:

REFERENCE

List of Open Source Software/ Learning website:
https://nptel.ac.in/courses/103104050
https://in.mathworks.com/help/ident/
https://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlDigital

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TIEE3032 SYSTEM IDENTIFICATION

COURSE OBJECTIVES:
- To elaborate the concept of estimating the state variables of a system using state estimation algorithms.
- To elaborate the concept of estimating the parameters of the Input-output models using parameter estimation algorithms.
- To make the student understand the various closed loop system identification techniques.
- To provide the background on the practical aspects of conducting experiments for real time system identification.

UNIT I NON PARAMETRIC METHODS (7+2 SKILL) 9
Nonparametric methods: Transient analysis - frequency analysis - Correlation analysis - Spectral analysis.

UNIT II PARAMETRIC METHODS (7+2 SKILL) 9

UNIT III RECURSIVE IDENTIFICATION METHODS (7+2 SKILL) 9

UNIT IV CLOSED-LOOP IDENTIFICATION (7+2 SKILL) 9

UNIT V NONLINEAR SYSTEM IDENTIFICATION (7+2 SKILL) 9
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.

TOTAL : 45 PERIODS

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

COURSE OUTCOMES:
- CO1 Ability to design and implement state estimation schemes. L5
- CO2 Ability to develop various models (Linear & Nonlinear) from the experimental data. L5
- CO3 Be able to choose a suitable model and parameter estimation algorithm for the
identification of systems. L3

**CO4**  Be able to illustrate verification and validation of identified model. L3

**CO5**  Ability to develop the model for prediction and simulation purposes using suitable control schemes. L5

**TEXT BOOKS:**

**REFERENCE**

**List of Open Source Software/ Learning website:**
https://in.mathworks.com/help/ident/
https://nptel.ac.in/courses/103106149
https://in.mathworks.com/help/curvefit/nonparametric-fitting.html
https://nptel.ac.in/courses/111102143

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COURSE OBJECTIVES:
- To introduce the Knowledge about Multivariable and Multiloop systems.
- To understand the Model predictive control schemes and its elements.
- Get exposed to state space MPC along with case studies.
- To acquire knowledge on various constrained MPC.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems

UNIT I  INTRODUCTION TO MIMO CONTROL  (7+2 SKILL)  9
Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPID-
Case studies

UNIT II  MODEL PREDICTIVE CONTROL SCHEMES  (7+2 SKILL)  9
Introduction to Model Predictive Control - Model Predictive Control Elements - Generalized
Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple
Model based Model Predictive Control Scheme Case Studies

UNIT III  STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL)  9
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)  9
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)  9
Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model
Predictive Control Scheme –Case Studie

TOTAL: 45 PERIODS

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

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:
Students able to
CO1  Ability to apply engineering knowledge to understand the control schemes on MIMO
      systems L3.
CO2  Ability to design controller for MIMO system L5.
CO3 Ability to analyze the control schemes available in industries L4.
CO4 Ability to design MPC, Adaptive controllers for practical engineering problems L5.
CO5 Ability to choose suitable controllers for the given problems L5.

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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COURSE OBJECTIVES:

- To provide knowledge on design in state variable form
- To provide knowledge in phase plane analysis.
- To give basic knowledge in describing function analysis.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter

UNIT I STATE VARIABLE DESIGN (7+2 SKILL) 9
Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle- servo design: -State Feedback with integral control

UNIT II PHASE PLANE ANALYSIS (7+2 SKILL) 9

UNIT III DESCRIBING FUNCTION ANALYSIS (7+2 SKILL) 9

UNIT IV OPTIMAL CONTROL (7+2 SKILL) 9
Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti’s equation – Application examples.

UNIT V OPTIMAL ESTIMATION (7+2 SKILL) 9
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:

Students able to

CO1 Able to apply the knowledge gained on state feedback control and nonlinear control. (L3)
CO2 Ability to 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. (L2)

TEXT BOOKS:
REFERENCES:

List of Open Source Software/ Learning website:
https://in.mathworks.com/discovery/kalman-filter.html
https://onlinecourses.nptel.ac.in/noc22_ee24/preview

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COURSE OBJECTIVES:

- To provide an exposure to different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems.
- To impart knowledge and skills needed to design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems).
- To introduce concepts needed to design optimal controller using Dynamic Programming Approach and H-J-B equation.
- To provide an exposure to various types of fault tolerant control schemes such as Passive and active approaches.
- To introduce concepts needed to design optimal controller in the presence of state constraints and time optimal controller.

UNIT I  CALCU LUS OF VARIATIONS AND OPTIMAL CONTROL     (7+2 SKILL) 9


UNIT II  LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM       (7+2 SKILL) 9

Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case- Time-invariant case – Stability issues of Time-invariant regulator – Linear Quadratic Tracking system: Finite time case and Infinite time case

UNIT III  DISCRETE TIME OPTIMAL CONTROL SYSTEMS         (7+2 SKILL) 9

Variational calculus for Discrete time systems – Discrete time optimal control systems:- Fixedfinal state and open-loop optimal control and Free-final state and open-loop optimal control - Discrete time linear state regulator system – Steady state regulator system

UNIT IV  PONT RYAGIN MINIMUM PRINCIPLE                  (7+2 SKILL) 9


UNIT V  CONSTRAINED OPTIMAL CONTROL SYSTEMS            (7+2 SKILL) 9


TOTAL:45 PERIODS

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

1. Interactive MATLAB based project learning in an optimal control system.
2. Familiarize yourself with optimal control software tool boxes.
3. Arrange a group brainstorming process to generate new ideas and possible solutions to an optimal control problem in any field.
4. Analyse the difference between optimal control systems with other types of control system.
5. Homework assignment on optimal control.

COURSE OUTCOMES:
Students able to

**CO1** Explain different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems.

**CO2** Design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems)

**CO3** Design optimal controller using Dynamic Programming Approach and H-J-B equation.

**CO4** Explain the Pontryagin Minimum Principle.

**CO5** Design optimal controller in the presence of state constraints and time optimal controller.

**CO6** Understand the concepts of dynamic programming

TEXT BOOKS:

REFERENCE BOOKS

List of Open Source Software/ Learning website:
1. https://in.mathworks.com/discovery/optimal-control.html#qlqq
2. https://www.codeproject.com/Articles/863257/Simple-Software-for-Optimal-Control
5. https://www.vlab.co.in/

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COURSE OBJECTIVES:
- To impart knowledge on how to recursively estimate the parameters of discrete input–output models using recursive parameter estimation methods
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems using STR, MRAC and Gain scheduling

UNIT I INTRODUCTION (7+2 SKILL) 9

UNIT II GAIN SCHEDULING (7+2 SKILL) 9
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 (7+2 SKILL) 9
Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics

UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS (7+2 SKILL) 9

UNIT V MODEL – REFERENCE ADAPTIVE SYSTEM (7+2 SKILL) 9

TOTAL: 45 PERIODS

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 open source 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.

COURSE OUTCOMES:
Students able to
CO1 Ability to apply the estimation algorithm to estimate the parameters of the process.(L3)
CO2 Ability to apply the adaptive control concepts to control a process. (L3)
CO3 Use appropriate software tools for design of adaptive controllers and analysis of the process. (L5)
CO4 Identify, formulate, carry out research by designing suitable adaptive schemes for complex instrumentation problem. (L5)
CO5 Apply the concepts to design adaptive control for multidisciplinary problem(L3)
CO6 Choose the techniques for self and lifelong learning to keep in pace with the new technology(L3)
TEXT BOOKS:

REFERENCE BOOKS

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

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COURSE OBJECTIVES:
- To make the students familiarize with the concept of condition-based maintenance for effective utilization of machines.
- To Impart the knowledge of artificial intelligence for machinery fault diagnosis.
- To give basic knowledge on vibration monitoring.
- To study the machinery vibrations using signal processing techniques.
- To provide knowledge on FMECA.

UNIT I INTRODUCTION TO MACHINE CONDITION MONITORING (7+2 SKILL) 9
Machinery condition monitoring - Present status - Fault prognosis - Future needs.

UNIT II MACHINERY MAINTENANCE (7+2 SKILL) 9

UNIT III INTRODUCTION TO MACHINERY VIBRATION AND MONITORING (7+2 SKILL) 9

UNIT IV SIGNAL PROCESSING IN MACHINERY MONITORING (7+2 SKILL) 9

UNIT V MACHINE LEARNING FOR CONDITION MONITORING (7+2 SKILL) 9
Machine Learning: Feature extraction and feature selection methods – Feature reduction – Classification techniques – Case studies of condition monitoring in Nuclear plant components, Distillation column.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10
1. Survey of critical machinery that requires monitoring system.
2. Exposure to practical machinery vibration & monitoring system presently in use.
3. Carryout FMECA using software.
4. Analyze the health condition of any machinery.

COURSE OUTCOMES:
- CO1 Ability to identify the faults in machinery L1.
- CO2 Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine L3.
- CO3 Construct a classifier model for machine learning based fault diagnosis L5.
- CO4 Predict the faulty component in a machine by analyzing the acquired vibration signals L2.
- CO5 Ability to analyze & build a model using modern tools L4.

TEXT BOOKS:

REFERENCES:

List of Open Source Software/ Learning website:
1. https://onlinecourses.nptel.ac.in/noc22_cs29/preview

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DIVERSIFIED COURSES

TIEE3038 ENRGY STORAGE SYSTEMS LT P C 3 0 0 3

COURSE OBJECTIVES:
Students will be able to:

- understand the various types of energy storage technologies.
- analyze thermal storage system.
- analyze different battery storage technologies.
- analyze the thermodynamics of Fuel Cell
- study the various applications of energy storage systems.

UNIT I INTRODUCTION (7+2 SKILL) 9
Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM (7+2 SKILL) 9
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+2 SKILL) 9
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+2 SKILL) 9

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES (7+2 SKILL) 9

TOTAL: 45 PERIODS

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
COURSE OUTCOMES:
Upon the successful 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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TIEE3039  HYBRID ENERGY TECHNOLOGY  LT P C 3 0 0 3

COURSE OBJECTIVES:
- To provide knowledge about different types of hybrid energy systems.
- To analyze the various electrical Generators used for the Wind Energy Conversion Systems.
- To design the power converters used in SPV Systems.
- To analyze the various power converters used in hybrid energy systems and to understand the importance of standalone and grid-connected operation in Hybrid renewable energy systems.
- To analyze the performance of the various hybrid energy systems.

UNIT I  INTRODUCTION TO HYBRID ENERGY SYSTEMS  (7+2 Skill) 9

UNIT II  ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS)  (7+2 Skill) 9
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+2 Skill) 9
Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck-boost 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+2 Skill) 9

UNIT V  CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS  (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. 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_S
4. System_and_DC_DC_Converters
5. https://www.mdpi.com/journal/energies/special_issues/Power_Converter_Electric_Machines
6. _Renewable_Energy_Systems_Transportation
7. https://www.intechopen.com/chapters/64317
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TIEE3040 DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS

COURSE OBJECTIVES:

- To review the renewable energy systems and technology
- To learn the Single phase grid-connected photovoltaic systems and three phase photovoltaic systems
- To illustrate the small wind energy systems
- To simulate the Doubly-fed induction generator based WECS

UNIT I RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES (7+2 Skill) 9

Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends

UNIT II SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS (7+2 Skill) 9


UNIT III THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES (7+2 Skill) 9


UNIT IV SMALL WIND ENERGY SYSTEMS (7+2 Skill) 9

UNIT V  DOUBLY-FED INDUCTION GENERATOR-BASED WECS  
(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. Simulation of inverter for PV systems
2. Simulation of WECS with DFIG

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

COURSE OUTCOMES:
Upon completion of the course, 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:
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### COURSE OBJECTIVES:
- To study about the present power Scenario
- To model a micro grid system
- To model power converter for grid interconnection
- To integrate wind energy conversion system with grid
- To simulate power converters like three phase inverters and DC-DC converters

### 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 6
Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in
Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power
Devices- Power Quality Point of View.

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

30 PERIODS

LAB COMPONENT
30 PERIODS

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: 30+30 = 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, Students able to
CO1 Review the power sector scenario in India.
CO2 Model a microgrid 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:
8. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg,
List of Open Source Software/ Learning website:

1. https://www.academia.edu/14628492/Current_Power_Scenario_In_India
2. https://energyeducation.ca/encyclopedia/Electrical_grid

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COURSE OBJECTIVES:

- To Know about the products related with sustainable application.
- To learn about Green Gaseous, liquid solid insulators.
- To understand the standards for green insulation systems.

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

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

UNIT III ALTERNATE GREEN LIQUID INSULATORS
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 its properties.

UNIT IV ALTERNATE GREEN SOLID INSULATORS
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
Requirements, evolving standards of management, testing, usage and disposal of alternate...
insulation systems, Major applications and standards

TOTAL : 45 PERIODS

REFERENCES:

COURSE OUTCOMES:
Upon completion of the course, 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.

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TIEE3043 POWER SYSTEM TRANSIENTS LT P C 3 0 0 3

OBJECTIVES:
- To study the generation of switching transients and their control using circuit – theoretical concept.
- To study the mechanism of lighting strokes and the production of lighting surges.
- To study the propagation, reflection and refraction of travelling waves.
- To study the impact of voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

UNIT I INTRODUCTION AND SURVEY (7+2 Skill) 9
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 (7+2 Skill) 9
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 (7+2 Skill) 9
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 (7+2 Skill) 9
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 9
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.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 8
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

COURSE OUTCOMES:
After completing the course, the 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:
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**TIEE3044**

**PLC PROGRAMMING**

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**COURSE OBJECTIVES:**

To know about the basics of PLC and Automation
To understand the importance of Automation
To explore various types and manufactures of PLCs.
To introduce types of programming languages of PLC and some exercise few programs.

**UNIT I**

**INTRODUCTION**

(7+2 SKILL) 9
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**

(7+2 SKILL) 9
Rails- Rungs- 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**

(7+2 SKILL) 9
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**

(7+2 SKILL) 9
Introduction- Evolution of signal standards- HART communication protocol- communication
modes- HART networks- HART commands- HART and OSI model- Field bus- Architecture-
Basic requirements of field Busstandard- Field bus Topology- Interoperability- Interchangeability.
UNIT V PLC PROGRAMMING (7+2 SKILL) 9

TOTAL : 45 PERIODS

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

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.

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.

REFERENCES
2. List of Open-Source Software/ Learning website:
   1. https://nptel.ac.in/courses/108105062
   2. https://nptel.ac.in/courses/108105088
   4. https://nptel.ac.in/courses/108106022
   6. https://componentsearchengine.com/library/proteus?gclid=CjwKCAjw_ISWBhBkEiwAdqxb9o kU2ZZHcQoa9fSRK2Uq41Rq0GZxdGUP6_6GlBv77p4JqGt_iDAijhoCksEQAvD_BwE

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**TIEE3045   BIG DATA ANALYTICS**

**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

TOTAL:30 PERIODS

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

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.

LIST OF EXPERIMENTS: 30 PERIODS
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.

Software Requirements:
Cassandra, Hadoop, Java, Pig, Hive and HBase.

TOTAL:60 PERIODS

TEXT BOOKS:
3. Sadalage, Pramod J. “NoSQL distilled”, 2013

REFERENCES:
TIGE3801 PRINCIPLES OF MANAGEMENT

COURSE OBJECTIVES:

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

UNIT II PLANNING

UNIT III ORGANISING

UNIT IV DIRECTING
UNIT V  CONTROLLING
System and process of controlling – Budgetary and non-Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
CO2: Have same basic knowledge on international aspect of management.
CO3: Ability to understand management concept of organizing.
CO4: Ability to understand management concept of directing.
CO5: Ability to understand management concept of controlling.

TEXT BOOKS:

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TIGE3802 TOTAL QUALITY MANAGEMENT L T P C
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COURSE OBJECTIVES:
- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi’s Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.
UNIT I INTRODUCTION 9
Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Definition of TQM - Basic concepts of TQM - Gurus of TQM (Brief introduction) - TQM Framework - Barriers to TQM - Benefits of TQM.

UNIT II TQM PRINCIPLES 9

UNIT III TQM TOOLS & TECHNIQUES I 9

UNIT IV TQM TOOLS & TECHNIQUES II 9
Quality circles - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures - Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Ability to apply TQM concepts in a selected enterprise.
CO2: Ability to apply TQM principles in a selected enterprise.
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
CO4: Ability to understand Taguchi’s Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
CO5: Ability to apply QMS and EMS in any organization.

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TEXT BOOK:

REFERENCES:

TIGE3803 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING

COURSE OBJECTIVES:
- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

UNIT I DEMAND & SUPPLY ANALYSIS
Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. Demand - Types of demand - Determinants of demand - Demand function - Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

UNIT II PRODUCTION AND COST ANALYSIS

UNIT III PRICING
Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)
Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.
UNIT V  CAPITAL BUDGETING (ELEMENTARY TREATMENT)  
Investments - Risks and return evaluation of investment decision - Average rate of return 
- Payback Period - Net Present Value - Internal rate of return. 

TOTAL: 45 PERIODS

COURSE OUTCOMES: Students able to
CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions
CO2: Evaluate the economic theories, cost concepts and pricing policies
CO3: Understand the market structures and integration concepts
CO4: Understand the measures of national income, the functions of banks and concepts of globalization
CO5: Apply the concepts of financial management for project appraisal

TEXT BOOKS:

REFERENCES:
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

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TIGE3804  HUMAN RESOURCE MANAGEMENT  

OBJECTIVE:
- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.
UNIT I  
INTRODUCTION TO HUMAN RESOURCE MANAGEMENT  

UNIT II  
HUMAN RESOURCE PLANNING  

UNIT III  
TRAINING AND EXECUTIVE DEVELOPMENT  
Types of training and Executive development methods – purpose – benefits.

UNIT IV  
EMPLOYEE COMPENSATION  

UNIT V  
PERFORMANCE EVALUATION AND CONTROL  

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Students would have gained knowledge on the various aspects of HRM
CO2: Students will gain knowledge needed for success as a human resources professional.
CO3: Students will develop the skills needed for a successful HR manager.
CO4: Students would be prepared to implement the concepts learned in the workplace.
CO5: Students would be aware of the emerging concepts in the field of HRM

TEXT BOOKS:

REFERENCES:

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COURSE OBJECTIVES:

The student should be made to:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

UNIT I INTRODUCTION
Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING

UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS
Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV KNOWLEDGE MANAGEMENT APPLICATION
Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

UNIT V FUTURE TRENDS AND CASE STUDIES
Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

CO1: Understand the process of acquire knowledge from experts
CO2: Understand the learning organization.
CO3: Use the knowledge management tools.
CO4: Develop knowledge management Applications.
CO5: Design and develop enterprise applications.
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TEXT BOOK:

REFERENCE:

TIGE3806 INDUSTRIAL MANAGEMENT

COURSE OBJECTIVES

1. To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
2. To study the planning; organizing and staffing functions of management in professional organization.
3. To study the leading; controlling and decision making functions of management in professional organization.
4. To learn the organizational theory in professional organization.
5. To learn the principles of productivity and modern concepts in management in professional organization.

UNIT I INTRODUCTION TO MANAGEMENT
Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg’s Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT II FUNCTIONS OF MANAGEMENT - I
Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.
UNIT III Functions of Management - II
Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT IV Organization Theory
Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow’s hierarchy of needs theory; Herzberg’s motivation-hygiene theory; McClelland’s three needs motivation theory; Vroom’s valence-expectancy theory – Change Management: Concept of Change; Lewin’s Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNIT V Productivity and Modern Topics
Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to

CO1 Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.

CO2 Discuss the planning; organizing and staffing functions of management in professional organization.

CO3 Apply the leading; controlling and decision making functions of management in professional organization.

CO4 Discuss the organizational theory in professional organization.

CO5 Apply principles of productivity and modern concepts in management in professional organization.

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