EE3301 **ELECTROMAGNETIC FIELDS** **L T P C**
3 1 0 4

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**

Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current –Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

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 fieldsand 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:

1. Mathew N. O. Sadiku, S.V. Kulkarni 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.

REFERENCES

1. V.V.Sarwate, 'Electromagnetic fields and waves', Second Edition, Newage Publishers, 2018.
2. J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition, Khanna Publishers 2013.
3. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Fifth Edition (Schaum's Outline Series), McGraw Hill, 2018.
4. S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education(India) Private Limited, 2017.
5. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Sixteenth Edition Eighth Reprint :2015

EE3302 **DIGITAL LOGIC CIRCUITS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the fundamentals of combinational and sequential digital circ
- To study various number systems and to simplify the mathematical expressions
- 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 9

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 9

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 LOGIC DEVICES 9

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 9

RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages - Subprograms - Test bench. (Simulation /Tutorial Examples: adders, counters, flip flops, Multiplexers & De multiplexers).

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:

1. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rdEdition, 2005.
2. Donald D.Givone, 'Digital Principles and Design', Tata McGraw Hill,1st Edition, 2003
3. Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11th Edition, 2018

REFERENCES:

1. Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 12th Edition, 2017.
2. Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.

EC3301 ELECTRON DEVICES AND CIRCUITS L T P C3 0 0 3

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 – Clipping & Clamping circuits - Rectifiers – Half Wave and Full Wave Rectifier– Display devices- LED, Laser diodes, Zener diode characteristics- Zener diode Reverse characteristics – Zener diode as regulator.

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.

TOTAL: 45

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:

1. David A. Bell , ”Electronic devices and circuits”, Oxford University higher education, 5th edition 2008.

2. Sedra and smith, “Microelectronic circuits”,7th Edition., Oxford University Press, 2017

REFERENCES:

1. Balbir Kumar, Shail.B.Jain, “Electronic devices and circuits” PHI learning private limited, 2nd edition 2014.
2. Thomas L.Floyd, “Electronic devices” Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd Edition, 2003.
4. Robert L.Boylestad, “Electronic devices and circuit theory”, 11th edition, Pearson prentice Hall 2013.
5. Robert B. Northrop, “Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation”, CRC Press, Second edition, 2012.

EE3303	ELECTRICAL MACHINES - I	L	T	P	C
		3	0	0	3

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 9

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 9

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 9

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 9

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 9

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

1. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5th Edition, 2017.

2. P. S. Bimbhra, “Electric Machinery”, Khanna Publishers, 2nd Edition, 2021.

REFERENCES

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 6th Edition 2017.
2. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2018.
3. M. G. Say, “Performance and design of AC machines”, CBS Publishers, First Edition 2008.
4. Sahdev S. K. “Electrical Machines”, Cambridge University Press, 2018.

CS3353	C PROGRAMMING AND DATA STRUCTURES	L	T	P	C
		3	0	0	3

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) 9

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Functions - Recursive Functions - Arrays - Single and Multi-Dimensional Arrays.

UNIT II C PROGRAMMING - ADVANCED FEATURES (8+1 SKILL) 9

Structures - Union - Enumerated Data Types - Pointers: Pointers to Variables, Arrays and Functions - File Handling – Preprocessor Directives.

UNIT III LINEAR DATA STRUCTURES (8+1 SKILL) 9

Abstract Data Types (ADTs) - List ADT - Array-Based Implementation - Linked List - Doubly- Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues - Queue Implementation - Applications.

UNIT IV NON-LINEAR DATA STRUCTURES (8+1 SKILL) 9

Trees - Binary Trees - Tree Traversals - Expression Trees - Binary Search Tree - Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing- Quadratic Probing – Double Hashing – Rehashing.

UNIT V SORTING AND SEARCHING TECHNIQUES (8+1 SKILL) 9

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:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 1997.
2. ReemaThareja, "Programming in C", Second Edition, Oxford University Press, 2016.

EC3311 ELECTRONIC DEVICES AND CIRCUITS LABORATORY L T P C
0 0 3 1.5

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.

LIST OF EXPERIMENTS

1. Characteristics of Semiconductor diode, Zener diode , photo diode , and photo transistor,
2. Characteristics of NPN Transistor under common emitter , common collector and common base configurations
3. Characteristics of JFET and draw the equivalent circuit
4. Characteristics of UJT and generation of saw tooth waveforms
5. Design and frequency response characteristics of a Common Emitter amplifier
6. Characteristics of light activated relay circuit
7. Design and testing of RC phase shift and LC oscillators
8. Characteristics of Single Phase half-wave and full wave rectifiers with inductive and capacitive filters
9. Design of Differential amplifiers using FET
10. Measurement of frequency and phase angle using CRO
11. Realization of passive filters

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the characteristics of PN, Zener diode and BJT in CE,CC,CB configurations experimentally

CO2: Analyze the characteristics of JFET and UJT experimentally

CO3: Analyze frequency response characteristics of a Common Emitter amplifier experimentally

CO4: Analyze the characteristics of RC phase shift and LC oscillators experimentally

CO5: Analyze the characteristics of half-wave and full-wave rectifier with and without filters experimentally

CO6: Analyze the characteristics of FET based differential amplifier experimentally

CO7: Calculate the frequency and phase angle using CRO experimentally

CO8: Analyze the frequency response characteristics of passive filters experimentally

EE3311 **ELECTRICAL MACHINES LABORATORY - I** **L T P C**
0 0 3 1.5

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 characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swinburne's test and speed control of DC shunt motor.
7. Hopkinson's test on DC motor – generator set.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Separation of no-load losses in single phase transformer.
12. Study of starters and 3-phase transformers connections.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Construct the circuit with appropriate connections for the given DC machine/transformer.
CO2: Experimentally determine the characteristics of different types of DC machines.
CO3: Demonstrate the speed control techniques for a DC motor for industrial applications.
CO4: Identify suitable methods for testing of transformer and DC machines.
CO5: Predetermine the performance parameters of transformers and DC motor.
CO6: Understand DC motor starters and 3-phase transformer connections.

CS3362 C PROGRAMMING AND DATA STRUCTURES LABORATORY L T P C

0 0 3 1.5

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
14. Implementation of Hashing – any two collision techniques

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

GE3361 **PROFESSIONAL DEVELOPMENT** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

MS WORD: **10 Hours**

Create and format a document
Working with tables
Working with Bullets and Lists
Working with styles, shapes, smart art, charts
Inserting objects, charts and importing objects from other office tools
Creating and Using document templates
Inserting equations, symbols and special characters
Working with Table of contents and References, citations

Insert and review comments
Create bookmarks, hyperlinks, endnotes footnote
Viewing document in different modes
Working with document protection and security
Inspect document for accessibility

MS EXCEL: **10 Hours**

Create worksheets, insert and format data
Work with different types of data: text, currency, date, numeric etc.
Split, validate, consolidate, Convert data
Sort and filter data
Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
Work with Lookup and reference formulae
Create and Work with different types of charts
Use pivot tables to summarize and analyse data
Perform data analysis using own formulae and functions
Combine data from multiple worksheets using own formulae and built-in functions to generate results
Export data and sheets to other file formats
Working with macros
Protecting data and Securing the workbook

MS POWERPOINT: **10 Hours**

Select slide templates, layout and themes
Formatting slide content and using bullets and numbering
Insert and format images, smart art, tables, charts
Using Slide master, notes and handout master Working with animation and transitions

Organize and Group slides
Import or create and use media objects: audio, video, animation
Perform slideshow recording and Record narration and create presentable videos

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion the students will be able to

- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
- Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
- Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

GE3451	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 **6**

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 biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION **6**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

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**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

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:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

EE3401	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

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

Underground cables – Types of cables – Construction of single-core and 3-core belted cables – Insulation Resistance – Potential Gradient – Capacitance of single-core and 3-core belted cables – Grading of cables – Power factor and heating of cables– DC cables.

UNIT V DISTRIBUTION SYSTEMS 9

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions –Concentrated and Distributed loading- Techniques of Voltage Control and Power factor improvement – Distribution Loss – Types of Substations – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS (Qualitative treatment only).

TOTAL: 45 PERIODS

TEXT BOOKS:

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
2. C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008.

REFERENCE BOOKS:

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Sixth Edition, 2011.
2. Luces M.Fualken berry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.

3. Arun Ingole, "Power transmission and distribution" Pearson Education, first edition, 2018
4. J.Brian Hardy and Colin R.Bayliss ‘Transmission and Distribution in Electrical Engineering’, Newnes; Fourth Edition, 2011.
5. G.Ramamurthy, “Handbook of Electrical power Distribution,” Universities Press, 2013.
6. V.K.Mehta, Rohit Mehta, ‘Principles of power system’, S. Chand & Company Ltd, New Delhi,

EE3402	LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

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 9

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 9

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 9

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, clippers, clampers, 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 9

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 9

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:

1. David A. Bell, 'Op-amp & Linear ICs', Oxford, Third Edition, 2011
2. D. Roy Choudhary, Sheil B. Jani, 'Linear Integrated Circuits', , New Age, Fourth Edition, 2018.
3. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, PHI 2021.

REFERENCES

1. Fiore,"Opamps& Linear Integrated Circuits Concepts & applications", Cengage, 2010.
2. Floyd ,Buchla,"Fundamentals of Analog Circuits, Pearson, 2013.
3. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system', McGraw Hill, 2nd Edition, 2017.
4. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition,2012.
5. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill.

EE3403 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 9

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 9

Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type watt meters – Energy meter – Megger – Instrument transformers (CT & PT).

UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS 9

Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges – Errors and compensation in A.C. bridges - Instrumentation Amplifiers.

UNIT IV TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS 9

Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.

UNIT V DIGITAL INSTRUMENTATION 9

A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - D/A converters: types and characteristics- DSO- Data Loggers – Basics of PLC programming and Introduction to Virtual Instrumentation - Instrument standards.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2011.
2. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

REFERENCES:

1. M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009
2. J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011
3. W.Bolton, Programmable Logic Controllers, 6th Edition, Elseiver, 2015.
4. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 3rd Edition 2014.
5. E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, New Delhi, 6th Edition 2017.
6. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016

EE3404 MICROPROCESSOR AND MICROCONTROLLER **L T P C**
3 0 0 3

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 9

Functional block diagram – Memory interfacing–I/O ports and data transfer concepts – Timing Diagram — Interrupt structure.

UNIT II 8085 INSTRUCTION SET AND PROGRAMMING 9

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

UNIT III INTERFACING BASICS AND ICS 9

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

.

UNIT IV INTRODUCTION TO 8051 MICROCONTROLLER 9

Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer – I/O ports – Serial communication, Simple programming –keyboard and display interface – Temperature control system –stepper motor control - Usage of IDE for assembly language programming.

UNIT V INTRODUCTION TO RISC BASED ARCHITECTURE 9

PIC16 /18 architecture, Memory organization – Addressing modes – Instruction set - Programming techniques – Timers – I/O ports – Interrupt programming.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Pen ram International (P)ltd., Mumbai, 6th Education, 2013.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The 8051 Micro Controller and Embedded Systems', Pearson Education, Second Edition 2011.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The PIC Micro Controller and Embedded Systems', 2010

REFERENCES:

1. Douglas V. Hall, "Micro-processors & Interfacing", Tata McGraw Hill 3rd Edition, 2017.
2. Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007.
3. Mike Predko, "8051 Micro-controllers", McGraw Hill, 2009
4. Kenneth Ayala, 'The 8051 Microcontroller', Thomson, 3rd Edition 2004.

EE3405 **ELECTRICAL MACHINES - II** **LT P C**
3 0 0 3

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

Constructional details – Types of rotors –winding factors- EMF equation – Synchronous reactance – Armature reaction – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF and A.S.A method – steady state power-angle characteristics- Two reaction theory –slip test -short circuit transients - Capability Curves.

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves - Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power Developed-Hunting – natural frequency of oscillations – damper windings- synchronous condenser.

UNIT III THREE PHASE INDUCTION MOTOR 9

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling- Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Double cage induction motors –Induction generators – Synchronous induction motor.

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

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star delta starters – Speed control – Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor- Servo motors- Stepper motors - introduction to magnetic levitation systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 6th Education 2017.
2. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 4th Edition 2017.
3. D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 5th Edition 2017
4. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, edition 2, 2021.

REFERENCES

1. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.
2. M.N. Bandyo padhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2011.
3. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers,3rd Edition, Reprint 2015.
4. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, First edition 2010.
5. Alexander S. Langsdorf, 'Theory of Alternating-Current Machinery', McGraw Hill Publications, 2001.

EE3411 **ELECTRICAL MACHINES LABORATORY - II** **L T P C**
0 0 3 1.5

COURSE OBJECTIVES:

- To expose the students to the operation of synchronous machines and induction motors and give them experimental skill.

LIST OF EXPERIMENTS

1. Regulation of three phase alternator by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF and ASA methods.
3. Regulation of three phase salient pole alternator by slip test.
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. V and Inverted V curves of Three Phase Synchronous Motor.
6. Load test on three-phase induction motor.
7. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
8. Separation of No-load losses of three-phase induction motor.
9. Load test on single-phase induction motor.
10. No load and blocked rotor test on single-phase induction motor.
11. Study of Induction Motor Starters

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Ability to understand and analyze EMF and MMF methods
CO2: Ability to analyze the characteristics of V and Inverted V curves
CO3: Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods. to understand the importance of Synchronous machines
CO4: Acquire hands on experience of conducting various tests on induction motors and obtaining their performance indices using standard analytical as well as graphical methods. to understand the importance of single and three phase Induction motors
CO5: Ability to acquire knowledge on separation of losses

EE3412 LINEAR AND DIGITAL CIRCUITS LABORATORY L T P C
0 0 3 1.5

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.
9. Application of Op-Amp: inverting and non-inverting amplifier, Adder, comparator, Integrator and Differentiator.
10. Voltage to frequency characteristics of NE/ SE 566 IC.
11. Variability Voltage Regulator using IC LM317.

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.

EE3413 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.
2. Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
3. Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
4. Stepper motor controller interface.
5. Displaying a moving/ rolling message in the student trainer kit's output device.

PROGRAMMING EXERCISES / EXPERIMENTS WITH µC8051:

6. Simple arithmetic operations with 8051: Multi precision addition / subtraction / multiplication/ division.
7. Programming with control instructions: Increment / Decrement, Ascending / Descending. order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
8. Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
9. Stepper motor controller interface.
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.

EE3501 POWER SYSTEM ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Impact knowledge on need for operational studies, andTo 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 9

Need for system planning and operational studies - Power scenario in India - Power system components, Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram, Network graph Theory - Bus incidence matrices, Primitive parameters, Formation of bus admittance matrix – Direct inspection method – Singular Transformation method.

UNIT II POWER FLOW ANALYSIS 9

Bus classification - Formulation of Power Flow problem in polar coordinates - Power flow solution using Gauss Seidel method - Handling of Voltage controlled buses - Power Flow Solution by Newton Raphson method **–** Flow charts – Comparison of methods.

UNIT III SYMMETRICAL FAULT ANALYSIS 9

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 9

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 9

Classification of power system stability – Rotor angle stability - Power-Angle equation – Steady state stability - Swing equation – Solution of swing equation by step by step method - Swing curve, Equal area criterion - Critical clearing angle and time, Multi-machine stability analysis – modified Euler method.

TOTAL : 45 PERIODS

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TEXT BOOKS:

1. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.
2. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, 3rd edition 2019.
3. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

REFERENCES

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.

2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.
3. P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, "Electrical Power Systems: Analysis, Security and Deregulation" Prentice Hall India (PHI), second edition - 2017
4. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, Reissue edition 2005.
5. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013

EE3591 **POWER ELECTRONICS** **L T P C**
3 0 0 3

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**

Power Diode – half wave rectifier – mid-point secondary transformer based full wave rectifier – bridge rectifier – voltage doubler circuit – distortion factor – capacitor filter for low power rectifiers – LC filters – Concern for power quality – three phase diode bridge.

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

TEXT BOOKS:

1. Ned Mohan, T.M.Undeland, W.P.Robbins, "Power Electronics: Converters, applications and design", John Wiley and Sons, 3rd Edition (reprint), 2009
2. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India, 3rd Edition, New Delhi, 2004.

REFERENCES:

1. Cyril. W.Lander, Power Electronics, McGraw Hill International, Third Edition, 1993.
2. P.S.Bimbhra, Power Electronics, Khanna Publishers, Third Edition 2003
3. Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013.
4. P.C.Sen, Power Electronics, Tata McGraw-Hill, 30th reprint, 2008.

EE3503	CONTROL SYSTEMS	LT P C 3 0 0 3

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 INVARIANT 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

Standard test inputs - Time response - Time domain specifications - Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation. Effect of adding poles and zeros.

UNIT III FREQUENCY DOMAIN ANALYSIS 9

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

UNIT IV STATE VARIABLE ANALYSIS 9

State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values - Eigen vectors - Free and forced responses for Time Invariant and Time Varying Systems - Controllability – Observability

UNIT V DESIGN OF FEED BACK CONTROL SYSTEM 9

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –PID controller - Design using reaction curve and Ziegler-Nichols technique- PID control in State Feedback form.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Benjamin C. Kuo, “Automatic Control Systems”, 7th edition PHI Learning Private Ltd, 2010.
2. Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers 2010.

REFERENCES:

1. Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Education Pearson, 3 Impression 2009.
2. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
3. Katsuhiko Ogata, “Modern Control Engineering”, PHI Learning Private Ltd, 5thEdition, 2010
4. NPTEL Video Lecture Notes on “Control Engineering” by Prof.S.D.Agashe, IIT Bombay.

EE3023 **MEMS AND NEMS** **L T P C**
2 0 2 3

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 **6**

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 6

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

UNIT III MICRO SENSORS AND MICRO ACTUATORS 6

Micromachining : Capactive Sensors- Piezoresistive Sensors- Piezoelectric actuators.

UNIT IV NEMS TECHNOLOGY 6

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

UNIT V MEMS and NEMS APPLICATION **6**

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

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

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
2. Assignment: Role of MEMS AND NEMS devices for Industry Standard 5.0.
3. Mini project : Design and analysis of any MEMS/NEMS device using multi physics tool.

TOTAL: 30+30 = 60 PERIODS

TEXTBOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2011, 2nd Edition.
2. Tai-.Ran Hsu, “MEMS and Microsystems: design , manufacture, and Nanoscale”- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3. Lyshevski, S.E. “ Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and

Microengineering " (2nd ed.). CRC Press,2005.
4. Julian W Gardner and Vijay K Varadan, " Microsensors, MEMS and Smart Devices", John Wiley and Sons Ltd, 2001, 1st Edition.

REFERENCES:

1. Marc F madou" Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.
2. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers .

EE3009 SPECIAL ELECTRICAL MACHINES L T P C

2 0 2 3

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 6

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 6

Constructional features –Principle of operation- Torque prediction-Characteristics-Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods- sensor less rotor position estimation-inductance based estimation –applications.

UNIT III PERMANENT MAGNET BRUSHLESS DC MOTORS 6

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller.

UNIT IV PERMANENT MAGNET SYNCHROUNOUS MOTORS 6

Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics –evaluation of control characteristics- design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES 6

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

30 PERIODS

LAB COMPONENT: 30 PERIODS

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

EE3014	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 6 (WECS)

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 6

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

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
3. Simulation of self- excited Induction Generator.

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:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009, 7th impression.
2. Rashid .M. H “Power electronics Hand book”, Academic press,2nd Edition, 2006 4th Edition, 2017
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.

EE3511 POWER ELECTRONICS LABORATORY L T P C

0 0 3 1.5

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

EE3512 CONTROL AND INSTRUMENTATION LABORATORY

L T P C

0 0 4 2

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.
2. Numerical Simulation of given nonlinear 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.
6. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform.
7. Root Locus based analysis in simulation platform.
8. Determination of transfer function of a physical system using frequency response and Bode's asymptotes.
9. Design of Lag, lead compensators and evaluation of closed loop performance.
10. Design of PID controllers and evaluation of closed loop performance.
11. Discretization of continuous system and effect of sampling.
12. Test of controllability and observability in continuous and discrete domain in simulation platform.
13. State feedback and state observer design and evaluation of closed loop performance.
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.

COURSE OUTCOMES:

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

CO1: To model and analyl

yze 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.

EE3601 SWITCHGEAR

PROTECTION AND

L T P C

3 0 0 3

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 **9**

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 **9**

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 **9**

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 **9**

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, and distantce protection of transmission lines.

UNIT V CIRCUIT BREAKERS **9**

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the successful completion of the course, students will have theability 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.

TEXT BOOKS:

1. Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, Four Edition, 2010.
2. Badri Ram ,B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
3. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., Second Edition, 2018.
4. Arun Ingole, 'Switch Gear and Protection' Pearson Education, 2018.

EE3602

POWER SYSTEM OPERATION AND CONTROL

L T P C
3 0 0 3

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 **9**

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 **9**

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 **9**

Generation and absorption of reactive power - Basics of reactive power control - Automatic Voltage Regulator (AVR) – Brushless AC excitation system – Block diagram representation of AVR loop static and dynamic analysis - Stability compensation - Voltage drop in transmission line - Methods of reactive power injection - Tap changing transformer, SVC and STATCOM for voltage control.

UNIT IV ECONOMIC OPERATION OF POWER SYSTEM **9**

Statement of economic dispatch problem – Input and output characteristics of thermal plant incremental cost curve - Optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) – Lambda-iteration method – Base point and participation factors method. Statement of Unit Commitment (UC) problem - Constraints on UC problem - Solution of UC problem using priority list - Special aspects of short term and long-term hydrothermal scheduling problems.

UNIT V COMPUTER AIDED CONTROL OF POWER SYSTEM **9**

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

TEXTBOOKS:

1. Olle. I. Elgerd, 'Electric Energy Systems theory - An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 2nd edition, 2017.
2. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 3rd editio

n, 2013.
3. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Fourth Edition, 2018.

EE3007

REFERENCE BOOKS:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw- Hill Education, Second Edition, Reprint 2018.
2. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 23rd reprint, 2015.
3. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 12th reprint, 2015.
4. B.M. Weedy, B.J. Cory et al, 'Electric Power systems', Wiley, Fifth Edition, 2012.

COURSE OBJECTIVES:

- To understand the evolution of Smart and Interconnected energysystems.
- To understand the various

allenges 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.

TEXT BOOKS:

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase,CRC, 2018.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley,2012
3. James Momoh ,Smart Grid Fundamentals of Design and Analysis, IEEE press 2012.

REFERENCES:

1. Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018.
2. C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011.doi: 10.1109/TII.2011.2166794.

EE3012 ELECTRICAL DRIVES L T P C 2 0 2 3

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

c 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

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

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 6

Steady state analysis of the single and three phase converter fed separately excited DC motor drive – continuous and discontinuous conduction – Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive.

UNIT III INDUCTION MOTOR DRIVES 6

Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening mode – voltage / current fed inverter – closed loop control,

UNIT IV SYNCHRONOUS MOTOR DRIVES 6

V/f control and self-control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 6

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.

30 PERIODS

LAB COMPONENT:

30 PERIODS

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

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1: Understand the basic re

quirements 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.

L T P C
3 0 0 3

TEXTBOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2nd Edition January 2010.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1st Edition.

REFERENCES:

1. S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3rd Edition 2012.
2. Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1st Edition.
3. Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey,1989, 1st Edition.

EE3036 SUSTAINABLE AND ENVIRONMENTAL FRIENDLY HV INSULATION SYSTEM

COURSE OBJECTIVES:

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

UNIT I SUSTAINABLE AND ENVIRONMENTAL ENERGY AND PRODUCTS 9

Carbon print, global warming potential, environment requirement for any product and system.

UNIT II ALTERNATE GREEN GASEOUS INSULATORS 9

SF6 gas and its hazardous environmental effects, alternate gases, gaseous mixtures and other sources and it's properties.

UNIT III ALTERNATE GREEN LIQUID INSULATORS 9

hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environmental friendly liquid such as ester oil, vegetable oils dielectric and it's properties.

UNIT IV ALTERNATE GREEN SOLID INSULATORS 9

hazardous effects of existing solid dielectric materials, alternate sources of environmental friendly solid dielectric and its properties.

UNIT V EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS 9

Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications and standards

TOTAL : 45 PERIODS

REFERENCES:

1. https://www.iso.org/standard/79064.html
2. https://www.ictfootprint.eu/en/iec-tr-627252013-factsheet
3. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1275,25
4. https://www.iec.ch/ords/f?p=103:41:628762356646470::::FSP_ORG_ID,FSP_LANG_ID:3237, 25
5. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1299,25
6. https://www.iec.ch/sdgs/sdg13
7. http://highperformanceinsulation.eu/wp- content/uploads/ 2016/08/ sustainability_a_guide.pdf

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

EE3611	POWER SYSTEM LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1 To provide a better understanding of modelling of transmission lines in impedance and admittance forms.
2 To apply iterative techniques for power flow analysis and to carry out short circuit and stability studies on power system.
3 To analyze the load – frequency and voltage controls.
4 To analyze optimal dispatch of generators and perform state estimation.
5 To understand the operation of relays, characteristics, and applications.

LIST OF EXPERIMENTS:

1 Computation and modelling of transmission Lines.
2 Formation of Bus Admittance and Impedance Matrices.
3 Power Flow Analysis Using Gauss-Seidel Method.
4 Power Flow Analysis Using Newton Raphson Method.
5 Symmetric and Unsymmetrical Fault Analysis.
6 Transient Stability Analysis of SMIB System.
7 Load – Frequency Dynamics of Single- Area and Two-Area Power Systems.
8 Economic Dispatch in Power Systems.
9 State estimation: Weighted least square estimation.
10 Performance analysis of over current relay.
11 Performance analysis of impedance relay.
12 Testing of CT, PT, and Insulator string.
13 Relay Coordination in Radial Feeder Protection Scheme.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the successful completion of the laboratory, students will be able to:
CO1: Model and analyze the performance of the transmission lines.
CO2: Perform power flow, short circuit, and stability analysis for any power system network.
CO3: Understand, design, and analyze the load frequency control mechanism.
CO4: Perform optimal scheduling of generators and compute the state of the power system.
CO5: Understand, analyze, and apply the relays for power system protection.

EE3701 **HIGH VOLTAGE ENGINEERING** **L T P C**
3 0 0 3

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

Generation of High DC, AC, impulse voltages and currents - Analysis of DC/AC and Impulse generator circuits - Tripping and control of impulse generators**,** Measurement of High voltages and High currents – High Resistance with series ammeter – Dividers - Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters, Electrostatic Voltmeters – Sphere Gaps, High current shunts- Digital techniques in high voltage measurement.

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

Introduction - electrostatic applications- electrostatic precipitation, separation, painting / coating, spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

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 methodsof 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

1. M.S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals', Newnes Second Edition, Elsevier , New Delhi, 2005.
3. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Fourth Edition, 2020.

REFERENCES

1. L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition 2006.
2. C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Fourth Edition, 2020
3. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, RoshdayRadwan, High Voltage Engineering – Theory &Practice,Second Edition, Taylor & Francis Gourp, 2019
4. Subir Ray." An Introduction to High Voltage Engineering "PHI Learning Private Limited, New Delhi, Second Edition-2011

GE3791	HUMAN VALUES AND ETHICS	LT P C 2 0 0 2

COURSE DESCRIPTION

This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

COURSE OBJECTIVES:

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

UNIT I DEMOCRATIC VALUES 6

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.

Reading Text: Excerpts from John Stuart Mills' *On Liberty*

UNIT II SECULAR VALUES 6

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

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

UNIT III SCIENTIFIC VALUES 6

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.

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

UNIT IV SOCIAL ETHICS 6

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

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

UNIT V SCIENTIFIC ETHICS 6

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

Reading Text: Excerpt from *American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer* by Kai Bird and Martin J. Sherwin.

TOTAL: 30 PERIODS

REFERENCES:

1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

COURSE OUTCOMES

Students will be able to

CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life

CO2 : Practice democratic and scientific values in both their personal and professional life.

CO3 : Find rational solutions to social problems.

CO4 : Behave in an ethical manner in society

GE3751 PRINCIPLES OF MANAGEMENT L T P C 3 0 0 3

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 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers- managerial roles and skills - Evolution of Management -Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment - Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour- Motivation - Motivation theories - Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNIT V CONTROLLING 9

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:

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill,1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.

EE3033 HYBRID ENERGY TECHNOLOGY LT P C

3 0 03

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

Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind-Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems - Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy - Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics.

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**

Introduction to Power Converters **–** Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations.

UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS (7+2 Skill) 9

Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis - Case studies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.

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

AU3791 ELECTRIC AND HYBRID VEHICLES L T P C

3 0 0 3

COURSE OBJECTIVES:

The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT II ENERGY SOURCES 9

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III MOTORS AND DRIVES 9

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV POWER CONVERTERS AND CONTROLLERS 9

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors - four quadrant operations -operating modes

UNIT V HYBRID AND ELECTRIC VEHICLES 9

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles. Explain the role of power electronics in hybrid and electric vehicles
4. Analyze the energy and design requirement for hybrid and electric vehicles.

TEXT BOOKS:

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003

2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

OCS353 DATA SCIENCE FUNDAMENTALS L T P C
2 0 2 3

COURSE OBJECTIVES:

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

UNIT I INTRODUCTION 6

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data.

UNIT II DATA MANIPULATION 9

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

UNIT III MACHINE LEARNING 5

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

UNIT IV DATA VISUALIZATION 5

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

UNIT V HANDLING LARGE DATA 5

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

30 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

LAB EXERCISES

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
   a) Frequency distributions
   b) Mean, Mode, Standard Deviation
   c) Variability
   d) Normal curves
   e) Correlation and scatter plots
   f) Correlation coefficient

g) Regression

6. Use the standard benchmark data set for performing the following:
a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.

COURSE OUTCOMES:

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

CO1: Gain knowledge on data science process.
CO2: Perform data manipulation functions using Numpy and Pandas.
CO3 Understand different types of machine learning approaches.
CO4: Perform data visualization using tools.
CO5: Handle large volumes of data in practical scenarios.

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

REFERENCES

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press,2014.

AU3791 ELECTRIC AND HYBRID VEHICLES L T P C

3 0 0 3

COURSE OBJECTIVES:

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UNIT V HYBRID AND ELECTRIC VEHICLES 9

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control

Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

5. Understand the operation and architecture of electric and hybrid vehicles
6. Identify various energy source options like battery and fuel cell
7. Select suitable electric motor for applications in hybrid and electric vehicles.
8. Explain the role of power electronics in hybrid and electric vehicles
9. Analyze the energy and design requirement for hybrid and electric vehicles.

TEXT BOOKS:

3. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
4. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.

REFERENCES:

4. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
5. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
6. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

EE3811	PROJECT WORK / INTERNSHIP	L	T	P	C
		0	0	20	10

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 : 300 PERIODS

COURSE OUTCOMES:

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

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 projectsunderstanding 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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