Scheme of Instruction, Evaluation and

Syllabi

of

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

With effect from Academic Year 2024-25

DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous)
Osmania University
Hyderabad – 500 007, TG, INDIA

Estd. 1917

Estd. 1929

UNIVERSITY COLLEGE OF ENGINEERING

The University College of Engineering (UCE) has the distinction of being the oldest and the biggest among the Engineering Colleges of the State of Andhra Pradesh. Established in the year 1929, eleven years after the formation of Osmania University, it was the 6th Engineering College to be established in the whole of British India. The College moved to its present permanent building in the year 1947. Today it is the biggest among the campus colleges of Osmania University. The Golden Jubilee of the College was celebrated in 1979, the Diamond Jubilee in 1989 and the Platinum Jubilee in 2004. The College was made autonomous in 1994.

The College offers four-year engineering degree courses leading to the award of Bachelor of Engineering (B.E.) in Biomedical Engineering, Civil Engineering, Computer Science and Engineering, Electrical and Electronics Engineering, Electronics and Communications Engineering and Mechanical Engineering. The College also offers courses leading to Master of Computer

Applications, Master of Science by Research and also Ph.D., in the various branches of Engineering. Part-time courses are offered both at undergraduate and postgraduate levels.

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate, disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT OF ELECTRICAL ENGINEERING

The Department of Electrical Engineering started in 1949 to offer B.E in Electrical Engineering. Presently, the Department is offering B.E. in Electrical & Electronics Engineering. Continuing Education for employed diploma holders was started in 1963 through the four-year Part-Time Degree course in Electrical Engineering; The Post-graduate course in Electrical Machines was started in 1966. Later, in the year 1987, B.E in Instrumentation was offered.

With a view to provide diversity and industrial orientation to the Post Graduate program, currently the Department is offering M.E. courses in Industrial Drives & Control and Power Systems, which were introduced in 1971. Department also offers part time PG courses in Industrial Drives & Control and Power Systems for the working academicians and engineers. A new PG program in Power Electronic Systems is introduced in the year 2008. The Part-Time Ph.D. program in Electrical Engineering is being offered since 1972.

The Department has eighteen regular faculty members who are highly experienced and actively involved in research activities. The Department is also equipped with state-of-art equipment and well qualified technical staff. The department is accredited by NBA for 5 years from the year 2013 and reaccredited for 3 years from the year 2019 and further in 2022 for BE(EEE) program. PG Programs in Industrial Drives & Control and Power Systems are accredited by NBA for 3 years from the year 2021.

Vision

To strive for excellence in education and research; meet the requirement of industry in the field of electrical engineering to serve the nation.

Mission

- To provide knowledge-based technology and serve to meet the needs of society in electrical and allied industries.
- To help in building national capabilities for excellent energy management and to explore non-conventional energy sources.
- To create research-oriented culture and to provide competent consultancy.
- To create and sustain environment of learning in which students acquire knowledge and learn to apply it professionally with due consideration of ethical and economic issues.
- To be accountable through self-evaluation and continuous improvement.

Programme Educational Objectives (PEO):

PEO1: To provide students with a solid foundation in Mathematics, Sciences and Electrical Engineering which prepares students for further studies and hence research in Electrical Engineering and for a wide range of career opportunities in Industries and academics.

PEO2: To train the students with good engineering breadth so as to comprehend, analyze, innovate and design new products in electrical domain, to provide technical solutions to real life problems and to render technical services to the needs of the society.

PEO3: To inculcate professional and ethical attitude, creative, effective communication and presentation skills and enhanced ability to work in teams to pursue complex, open-ended investigations and research in electrical engineering for effective knowledge transfer.

PEO4: To provide students with an academic environment aware of excellence, proactiveness, leadership positions in multidisciplinary teams, entrepreneurial talent and lifelong learning for successful professional career.

PROGRAM OUTCOMES (POs)

POs	Engineering Graduates will be able to:
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
	PROGRAM SPECIFIC OUTCOMES (PSOs)
PSO1	Find solutions for effective operations and control of power systems to achieve quality and reliable power supply
PSO2	Provide solutions for effective and intelligent control of electric drives and renewable energy systems with electronic circuits for domestic and industrial applications

SCHEME OF INSTRUCTION AND EVALUATION

B.E. (Electrical and Electronics Engineering)

V – Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC 501 EE	Electrical Machines-III	3	-	-	3	3	40	60	3
2	PC 502 EE	Power Systems – II	3	-	-	3	3	40	60	3
3	PC 503 EE	Power Electronics	3	-	-	3	3	40	60	3
4	PC 504 EE	Digital Signal Processing and Applications	3	-	-	3	3	40	60	3
5	PC 505 EE	Basic Python Programming	3	-	-	3	3	40	60	3
6	**Professional Elective – II**		3	-	-	3	3	40	60	3
	PE 521 EE	Electrical Energy Conservation and Auditing								
	PE 522 EE	IoT Applications in Electrical Engineering								
	PE 523 EE	Programmable Logic Controllers								
	PE524 EE	Electrical Machine Design								
Practicals										
7	PC 551 EE	Electrical Machines Lab-II	-	-	2	2	3	25	50	1
8	PC 552 EE	Electrical Measurements Lab	-	-	2	2	3	25	50	1
9	PC 553 EE	Control Systems Lab	-	-	2	2	3	25	50	1
		Total	**18**	**-**	**6**	**24**	**27**	**315**	**510**	**21**

Course Code	Course Title					Course Type
PC 501 EE	ELECTRICAL MACHINES – III					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To acquire the knowledge of construction, winding factors and synchronous impedance of Synchronous machines.
- Delivering working knowledge of the synchronous Generator performance and additionally discussing the parallel operation of the synchronous generator.
- Delivering working knowledge of the synchronous motor, synchronizing power and applications.
- To acquire the idea of transient behavior of Alternators.
- To acquire knowledge of working principles and scope of applications for different contemporary machines e.g. BLDC, SRM and PMSM motors.

Course Outcomes:

1. Understand the principle of operation, constructional details, winding factors, armature reaction and suppression of harmonics in Synchronous machine.
2. Evaluate the characteristics, voltage regulation and analyze the two-reaction theory for the salient pole synchronous machine.
3. Carry out the performance calculations; investigate methods of starting and synchronization of Synchronous motors.
4. Analyze the transient behavior of an Alternator and understand the symmetrical and asymmetrical short circuit currents.
5. Understand the working principles and scope of applications of BLDC, SRM and PMSM motors.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1
CO1	3	2	1	3	1	1	-	-	-	2	2	2	3	2
CO2	3	3	3	2	3	2	2	-	1	2	2	3	3	3
CO3	3	3	3	2	2	1	-	-	2	2	2	2	3	3
CO4	3	3	3	2	2	1	-	-	2	2	-	2	3	3
CO5	3	3	3	2	2	-	-	-	2	2	-	2	2	2

UNIT – I

Introduction: Types and Constructional Details - Types of Winding, Winding factors- E.M.F. equation - Fractional pitch and fractional slot windings - Suppression of harmonics and tooth ripple - Armature reaction and reactance - Synchronous impedance.

UNIT – II

Synchronous Generator: Voltage Regulation - Phasor diagram of alternator with non- salient poles - O.C. and S.C. Characteristics- Synchronous impedance, Ampere turn, ZPF methods for finding regulation - Principle of two reaction theory and its application for the salient pole-synchronous machine analysis - Synchronizing and parallel operation.

UNIT-III

Synchronous Motor: Theory of operation - Vector diagram - Variation of current and p.f. with excitation - Hunting and its prevention - Current and power circle diagram - Predetermination of performance - Methods of starting and synchronizing - Synchronizing power, Synchronous condenser. Applications.

UNIT- IV

Transient Analysis: Elementary ideas of transient behaviour of an Alternator – Three phase short circuit of an Alternator- Analysis of symmetrical and asymmetrical short circuit current.

UNIT-V

Special Machines: Brushless D.C. Motors: Construction & Principle of Operation, Torque equation, Torque -angle Characteristics, Applications.

Switched Reluctance Motor: Constructional features, Principle of operation, Torque production, Torque - angle characteristics, various operating modes of SRM, applications.

Suggested Reading:

1. Kothari D.P. &Nagrath I.J. - Electrical Machines - Tata McGraw Hill, 2004.
2. Bhimbra P.S. - Generalized Theory of Electrical Machines, Khanna Publications, 2000.
3. Say MG. - The Performance and Design of AC. Machines - Pitman Publication, 2002.
4. Irving L. Kosow - Electric Machinery and Transforn1ers, PPH, Pearson Education, 2nd Edition. 2009.

Course Code	Course Title						Course Type
PC 502 EE	**POWER SYSTEMS – II**						Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To learn and understand the performance analysis of short, medium and long transmission lines.
- To comprehend analysis of symmetrical and unsymmetrical faults in the power system.
- To learn the use of per unit quantities and calculation of symmetrical faults on OH transmission lines.
- To give awareness about importance for maintaining constant voltage and different voltage control methods.
- To learn about the natural impedance of transmission line and significance in the operation of power system network.

Course Outcomes:

1. Acquire modeling of different short, medium and long transmission lines.
2. Learn the use of per unit quantities and calculation of symmetrical faults on OH transmission lines Deal with applications like timer/counter, registers etc.
3. Understand the impact of different types of faults on overhead transmission lines and calculation of fault currents and their significance.
4. Explain the reasons for voltage variation, importance of maintaining constant voltage in power system and different voltage control methods.
5. Acquire the knowledge of natural impedance of transmission line and significance in the operation of power system network.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	-	-	-	-	1	-	-	1	2	-
CO2	3	3	1	-	-	-	-	-	1	-	-	1	2	-
CO3	3	3	1	-	-	-	-	-	1	-	-	1	2	-
CO4	3	3	1	-	-	-	-	-	1	-	-	1	2	-
CO5	3	3	1	-	-	-	-	-	1	-	-	1	2	-

UNIT - I

Transmission Line Theory: Modelling and Performance of short, medium, long lines – Surge Impedance Loading-Tuned lines, Power circle diagram and their applications.
Corona - Causes - Disruptive and Visual critical voltages - Power loss - Minimization of corona effects.

UNIT - II

Symmetrical Faults: Use of per unit quantities in power systems, advantages of per unit system. Symmetrical Three-phase Faults, Transients in RL series circuits - Short circuit currents - Reactances of synchronous machines – Reactance diagram-Symmetrical fault calculations, Short circuit capacity of bus.

UNIT-III

Unsymmetrical Faults: Symmetrical components of unsymmetrical phasors - Power in terms of symmetrical components - Sequence impedance and sequence networks, Sequence networks of unloaded generators - Sequence impedances of circuit elements - Single line to ground, line to line and double line to ground faults on unloaded generator - Unsymmetrical faults of power systems, Open circuit faults.

UNIT- IV

Voltage Control: Phase modifiers, Induction Regulators -Tap changing Transformers, Series and Shunt Capacitors, Reactive Power requirement calculations, Static VAR compensators - Thyristor Controlled reactor, Thyristor switched capacitor.

UNIT-V

Travelling Wave Theory: Causes of over voltages - Travelling wave theory - Wave equation - Open circuited line - The short circuited line - Junction of lines of different natural impedances - Reflection and Refraction Coefficients - Junction of cable and overhead lines - Junction of three lines of different natural impedances- Bewley Lattice diagram.

Suggested Reading:

1. CL Wadhwa - Electrical Power Systems, New Age International, 4th edition, 2006.
2. Grainger and Stevenson - Power System Analysis, Tata McGraw Hill, 4th edition, 2003.
3. Nagarath and Kothari - Modern Power System Analysis, Tata McGraw Hill, 4th edition- 2012.

Course Code	Course Title					Course Type
PC 503 EE	POWER ELECTRONICS					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To be able to understand various power switching devices, characteristics and applications.
- To learn and understand the various single phase, three phase Half controlled & fully controlled rectifiers, principle of operation, characteristics and applications.
- To learn and understand the Choppers & AC voltage controllers, principle of operation, characteristics and application
- To learn and understand the various single-phase inverters, principle of operation, characteristics and applications.
- To learn and understand the various three phase inverters, principle of operation, characteristics and applications.

Course Outcomes:

1. Understand the differences between signal level and power level devices.
2. Analyze single phase and three phase controlled rectifier circuits.
3. Analyze the operation of DC-DC choppers and AC-AC converters.
4. Analyze the operation of single-phase inverters.
5. Analyze the three phase inverters.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	-	-	-	2	1	-	2	2	3
CO2	3	3	3	2	1	-	-	-	2	1	-	2	2	3
CO3	3	3	3	2	1	-	-	-	2	1	-	2	2	3
CO4	3	3	3	2	1	-	-	-	2	1	-	2	2	3
CO5	3	3	3	2	1	-	-	-	2	1	-	2	2	3

UNIT - I

Power switching devices: Diode, Thyristor, MOSFET, IGBT: static and dynamic Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

UNIT - II

Thyristor rectifiers: Single-phase half-wave, full-wave and semi controlled rectifiers with R-load, RL-load, highly inductive load and RLE load. Three-phase half wave, full wave and semi controlled bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

UNIT-III

DC-DC Converters: Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit and operation of buck, boost and buck-boost, bidirectional buck-boost converters in continuous conduction mode, duty ratio control of output voltage.

AC-AC Converter: Power circuit and operation of single-phase AC Voltage Controller with R & RL Load. Basic concepts of Cyclo converter.

UNIT- IV

Single-phase inverter: Power circuit and operation of single-phase voltage source inverter in square wave mode, sinusoidal pulse width modulation (Unipolar and bi-polar), relation between modulation index and output voltage. Calculation of performance parameters of inverter.

UNIT-V

Three-phase inverter: Power circuit and operation of three-phase voltage source inverter in 180^0 and 120^0 modes, Bi-polar sinusoidal pulse width modulation, relation between modulation index and output voltage. Elementary operation of CSI, Comparison of Voltage Source Inverter and Current source Inverter.

Suggested Reading:

1. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2020.
2. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2010.
3. P.S. Bimbhra, “Power Electronics”, Khanna Publishers, 2022
4. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
5. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.

Course Code	Course Title						Course Type
PC 504 EE	DIGITAL SIGNAL PROCESSING AND APPLICATIONS						Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand processing in frequency domain with DFT and FFT
- To understand the characteristics of IIR digital filters.
- To understand the Characteristics of FIR digital filters.
- To study the digital signal processor TMS 320LF2407 architecture and instruction set.
- To understand functioning of the on-chip peripherals of TMS320LF2407 such as GPIO, interrupts, ADC and Event Managers.

Course Outcomes:

1. Obtain the frequency spectrum of discrete time signals using FFT.
2. Analyze and Design IIR digital filters
3. Analyze and Design FIR digital filters
4. Understand the functioning of Digital Signal Processor TMS320LF2407 and familiarize with the instruction set of TMS320C2xx processor.
5. Understand functioning of the on-chip peripherals of TMS320LF2407 such as GPIO, interrupts, ADC and Event Managers and producing PWM waveforms.

Articulation matrix of Course Outcomes with POs:

.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	2	-	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2	-	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2	-	2
CO4	2	3	2	-	-	-	-	-	-	-	-	2	-	3
CO5	2	3	3	-	-	-	-	-	-	-	-	2	-	3

UNIT - I

Review of discrete time signals and systems, Review of Discrete time Fourier transform (DTFT) DFS, Properties- Frequency domain sampling DFT, Properties - circular convolution - Fast Fourier transforms (FFT) - Radix-2 decimation in time (DIT) and decimation in frequency (DIF) FFT Algorithms, IDFT using FFT.

UNIT - II

IIR digital filters: Analog filter approximations - Butterworth and Chebyshev filters - Design of IIR Digital filters from analog filters using Bilinear transformation, Impulse invariant and step invariant methods. Realization of IIR filters - Direct form - I, Direct form - II, Cascade and parallel form realizations.

UNIT-III

FIR digital filters: Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital filters using window techniques, Linear phase realization.
Multirate signal processing: Decimation, Interpolation, Sampling rate conversion, Implementation of sampling rate conversion.

UNIT- IV

TMS320LF2407 DSP Controller: Introduction, brief introduction to peripherals, types of physical memory, software tools.
TMS320C2XX DSP CPU and instruction set: TMS320C2xx DSP architecture, Memory, Addressing modes, Instruction set.

UNIT-V

GPIO functionality: Pin multiplexing (MUX) and GPIO Overview, multiplexing and GPIO control registers.
Interrupts on the TMS320LF2407: Introduction, Interrupt Hierarchy and its Control Registers.
ADC: Overview, Operation and programming modes.
Event managers: Overview, Interrupts, Timers, Compare Units, and PWM Signal Generation with Event Managers.

Suggested Reading:

1. Proakis & Manolakis - Digital Signal Processing, Principles, Algorithms and Applications, Prentice Hall of India - 3rd Edition-1994.
2. Opeinheim & Schaffter - Digital Signal Processing, PHI Publications, 2002.
3. Salivahanan Valluaraj & Gnanapriya - Digital Signal Processing- Tata McGraw Hill, 2001.
4. Anand Kumar.A - Digital Signal Processing - PHI learning Private Ltd. 2013.
5. Hamid A Toliyat, DSP based Electromechanical Motion Control, Steven Campbell 2004, CRC Press.

Course Code	Course Title					Course Type
PC 505 EE	BASIC PYTHON PROGRAMMING					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:

1. Develop algorithmic solutions to simple computational problems.
2. Develop simple Python programs for solving problems.
3. Structure a Python program into functions.
4. Represent compound data using Python lists, tuples, dictionaries.
5. Read and write data from/to files in Python Programs

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	3	-	-	-	-	-	-	2	2	2
CO2	3	3	2	-	3	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	3	-	-	-	-	-	-	2	2	2
CO4	3	3	2	-	3	-	-	-	-	-	-	2	2	2
CO5	3	3	2	-	3	-	-	-	-	-	-	2	2	2

UNIT - I

Introduction to Computing and Problem-Solving: Fundamentals of Computing — Computing Devices — Identification of Computational Problems — Pseudo Code and Flowcharts — Instructions — Algorithms — Building Blocks of Algorithms.
Introduction to Python Programming: Python Interpreter and Interactive Mode- Variables and Identifiers — Arithmetic Operators — Values and Types — Statements, Reading Input, Print Output, Type Conversions, The type () Function and Is Operator, Dynamic and Strongly Typed Language.
Control Flow Statements: The if, The if...else, The if...else if...else Decision Control Statements, Nested if Statement, The while Loop, The for Loop. The continue and break Statements.

UNIT - II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, and Command Line Arguments.
Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as a return value; Dictionaries: operations and methods; advanced list processing - list comprehension

UNIT-III

Files and **Exception:** Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.
Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings
Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.
Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT- IV

Algorithm Analysis: Time and Space complexity analysis, Linear Search and Binary Search; sorting algorithms: Bubblesort, Selection sort, Insertion sort, Merge sort and Quick sort.

Data Structures: Linked Lists, Stack and Queue.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the Tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Reading:

1. Richard L. Halterman,"Learning To Program With Python", Copyright fi 2011.
2. Dr Charles R,"Pythonfor Everybody, Exploring Data UsingPython 3",Severance. 2016.
3. Gowrishankar S., Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)

Course Code	Course Title					Course Type
PE 521 EE	ELECTRICAL ENERGY CONSERVATION AND AUDITING					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand the current energy scenario and importance of energy conservation.
- To understand the concepts of energy management.
- To understand the methods of improving energy efficiency in different electrical systems.
- To understand the concepts of different energy efficient devices.

Course Outcomes:

1. Identify the demand supply gap of energy in Indian scenario.
2. Analyze the concepts of energy management.
3. Draw the process flow and energy balance diagrams of energy facilities.
4. Select appropriate energy conservation method to reduce the wastage of energy.

UNIT - I

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy security, energy conservation and its importance. Sankey diagram. Energy Conservation Act- 2001 and its features.

UNIT - II

Basics of Energy and its various forms: Potential energy, Chemical energy, Nuclear energy, Storage energy, Mechanical energy, Gravitational energy, Kinetic energy, Radiant energy, Thermal energy, Sound energy and Electrical energy. Work Energy and Power. Direct current, Alternating current, Power factor, Electrical energy, Energy units and conservation.

UNIT-III

Energy Management & Audit: Definition, energy audit, need, types of energy audit – Preliminary energy audit, Targeted energy audit, Detailed energy audit, Post audit phase, format for energy conservation recommendations. Methodology for conducting detailed energy audit. Energy audit process flow diagram. Economic feasibility. Energy audit report.

UNIT- IV

Energy Efficiency in Electrical Systems: Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT-V

Energy Efficiency in Electrical Utilities: Electrical system, Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.

Suggested Reading:

1. Guide books for National Certification Examination for Energy Manager / Energy AuditorsBook-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy AuditorsBook-3, Electrical Utilities (available online)
3. S. C. Tripathy, ―Utilization of Electrical Energy and Conservation‖, McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Course Code	Course Title					Course Type
PE 522 EE	IoT APPLICATIONS IN ELECTRICAL ENGINEERING					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To learn about a few applications of Internet of Things.
- To distinguish between motion less and motion detectors as LOT applications.
- To know about Micro Electro Mechanical Systems (MEMS) fundamentals in design.
- To understand about applications of IOT in smart grid.
- To introduce the new concept of Internet of Energy for various applications

Course Outcomes:

1. To get exposed to recent trends in few applications of IoT in Electrical Engineering.
2. To understand about usage of various types of motionless sensors.
3. To understand about usage of various types of motion detectors.
4. To get exposed to various applications of IoT in smart grid.
5. To get exposed to future working environment with Energy Internet.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	1	3	2	2	-	-	3	-	2	2	1
CO2	2	2	2	1	2	-	-	-	1	2	-	2	1	2
CO3	1	-	-	-	3	1	2	-	1	1	-	2	2	1
CO4	3	2	2	1	3	1	2	-	-	-	-	1	2	1
CO5	3	2	2	1	3	1	2	-	-	-	-	-	2	-

UNIT - I

Definitions, Terminology, Classification, Temperature sensors, Thermoresistive, Resistance, temperature detectors, Silicon resistive thermistors, Semiconductor, Piezoelectric, Humidity and moisture sensors. Capacitive, Electrical conductivity, Thermal conductivity, time domain reflectometer, Pressure and Force sensors: Piezoresistive, Capacitive, force, strain and tactile sensors, Strain gauge, Piezoelectric

UNIT - II

Capacitive occupancy, Inductive and magnetic, potentiometric - Position, displacement and level sensors, Potentiometric, Capacitive, Inductive, magnetic velocity and acceleration sensors, capacitive, Piezoresistive, piezoelectric cables, Flow sensors, Electromagnetic, Acoustic sensors Resistive microphones, Piezoelectric, Photo resistors.

UNIT-III

Basic concepts of MEMS design, Beam/diaphragm mechanics, electrostatic actuation and fabrication, Process design of MEMS based sensors and actuators, Touch sensor, Pressure sensor, RF MEMS switches, Electric and Magnetic field sensors

UNIT- IV

IoT for smart grid: Driving factors, Generation level, Transmission level, Distribution level, Applications, Metering and monitoring applications, Standardization and interoperability, Smart home

UNIT-V

IOE-Internet of energy: Concept of Internet of Energy, Evaluation of IoE concept, Vision and motivation of IOE, Architecture, Energy routines, information sensing and processing issues, Energy internet as smart grid.

Suggested Reading:

1. Jon S. Wilson, Sensor Technology Hand book, Newnes Publisher, 2004
2. Tai Ran Hsu, MEMS and Microsystems: Design and manufacture, 1st Edition, Mc Grawhill
3. ErsanKabalci and YasinKabalci, From Smart grid to Internet of Energy, 1st Edition
4. Raj Kumar Buyya and Amir VahidDastjerdi, Internet of Things: Principles and Paradigms, Kindle Edition, Morgan Kaufmann Publisher, 2016
5. Yen Kheng Tan and Mark Wong, Energy Harvesting Systems for IoT applications: Generation, Storage and Power Management, 1st Edition, cRC Press, 2019.
6. RMD SundaramShriram, K. Vasudevan and Abhishek S. Nagarajan, Internet of Things, Wiley, 2019

Course Code	Course Title					Course Type
PE 523 EE	PROGRAMMABLE LOGIC CONTROLLERS					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To provide the knowledge of different components used in PLCs such as processor, input/output devices and programmer monitors.
- To make the students thorough with ladder programming of PLC.
- To train them how to use timer, counter, register, arithmetic and different conversion systems.
- To give awareness about application of different PLC features in Process control industry.
- To explain the students about different data handling functions of PLC.

Course Outcomes:

1. Understand different components of PLC.
2. Will be able to construct ladder diagrams for different industry applications.
3. Deal with applications like timer/counter, registers etc.
4. Understand the utility of different features of PLC in process industry.
5. Use data handling function in PLC programming.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	2	2	-	-	-	-	-	2	-	1
CO2	2	3	3	3	3	2	-	-	-	-	-	2	-	2
CO3	2	3	3	3	3	2	-	-	-	-	-	2	-	2
CO4	2	3	3	3	3	2	-	-	-	-	-	2	-	2
CO5	2	3	3	3	3	2	-	-	-	-	-	2	-	2

UNIT - I

PLC Basics: Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUs and Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures - Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLC input and output modules are connected - Input on/off switching devices - Input analog devices - Output analog on/off devices and output analog devices.

UNIT - II

Basic PLC Programming: Programming on/off inputs to produce on/off outputs - PLC input instructions - Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gate logic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from process control descriptions - Sequence listings - Large process ladder diagram constructions.

UNIT-III

Basic PLC Functions: General Characteristics of Registers - Module addressing - Holding registers - Input registers - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLC counter functions.

UNIT- IV

Intermediate Functions: PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock - PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmetic functions - PLC number comparison functions. PLC basic comparison functions and applications - Numbering systems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numbering systems.

UNIT-V

Data Handling Functions: The PLC skip and master control relay functions - Jump functions - Jump with non return - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions working with bits - PLC digital bit functions and applications - PLC sequence functions - PLC matrix functions.

.

Suggested Reading:

1. John W. Weff, Ronald A. Reis, Programmable Logic Controllers, Prentice Hall of India Private Limited, Fifth edition, 2003.

Course Code	Course Title					Course Type
PE 524 EE	ELECTRICAL MACHINE DESIGN					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand various materials used in electrical systems and the construction and basic design of the electrical machines.
- To understand basic concepts of design of magnetic and thermal circuits, draw the winding diagrams of rotating machines.
- To understand the Design principles of different rotating machines.
- To acquire knowledge of electrical machine parameters such as main dimensions and the design of major parts.
- To study the design optimization of the electrical machine for industrial, agriculture and residential applications.

Course Outcomes:

1. Acquire the knowledge of various electrical materials used in design of electrical system.
2. Analyze magnetic, thermal circuits in electrical machines and their design aspects.
3. Understand the importance of cooling and design of cooling system for various electrical machines and also able to know design AC armature windings in rotating machines.
4. Design of rotating machines and transformers.
5. Understand the computer aided design of electrical machines with various methods of approaches and flowcharts.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	2	-	-	-	-	-	2	2	2
CO2	3	3	2	-	-	2	-	-	-	-	-	2	2	2
CO3	3	3	3	-	-	3	-	-	-	-	-	2	2	2
CO4	3	3	3	-	-	3	-	-	-	-	-	2	2	2
CO5	3	3	3	-	-	3	-	-	-	-	-	2	2	2

UNIT - I

Electrical Engineering Materials: Insulating materials: Properties of ideal insulating materials. Classification and types of insulating materials, Gaseous, liquid, Solid, fibrous and mineral insulating materials, Plastic, glass and ceramic materials. Conducting Materials: General properties materials, Super conductors.

Magnetic Materials: Classification of magnetic materials, Soft and hard magnetic materials, sheet, cold rolled steel, solid core and powder core materials.

UNIT - II

Magnetic Circuit: Basic principles, magnetic circuit calculation flux density in air-gap and tooth. Carter‟s coefficient, ampere turns for gap and teeth, real and apparent flux density, magnetic leakage, leakage flux from salient poles, field distribution curves, field turns, armature reaction ampere turns. Reluctance of rectangular slots.

UNIT-III

Electrical Circuit: AC Single phase, three phase windings. Mesh and concentric winding, Double layer winding.

Thermal Circuit: Types of enclosures, ventilating and cooling methods in Electrical Machines-Losses, Temperature rise time curve and cooling curve. Rating of electrical machines, calculation for quantity of cooling medium.

.

UNIT- IV

Transformer Design – Main dimensions-output Equations-Core Design-cooling system design. Design principles of rotating machines: output equations and main dimensions, defining of magnetic loading, design of slot field coils, estimation of air gap lengths.

UNIT-V

Computer Aided Design: Introduction, Advantages of digital computers: computer aided design-different approaches: Analysis method, synthesis method, hybrid method, optimization. General procedure for optimization, variable constraints. Computer aided designof 3 phase induction motor. List of symbols used, general design procedure.

.

Suggested Reading:

1. A.K. Sawhney, A course in Electrical Machines Design, Dhanpat Rai and Sons,1996
2. R.K. Agarwal,Principles of Electrical Machine Design, ESS Kay Publications, Naisarak, New Delhi,1994
3. V.N.Mittal, Design of Electrical Machines, Standard Publishers and Distributors, New Delhi,1992

Course Code	Course Title					Course Type
PC 551 EE	ELECTRICAL MACHINES LAB – II					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	-	-	2	3	25	50	1

Course Objectives:

- To learn operation and performance characteristics of induction machines by conducting various experiments and tests practically.
- To develop the circle diagram of the given induction machine by conducting various experiments and tests practically.
- To learn the speed control concepts of Induction Machine
- To understand the operation and performance characteristics of synchronous machines by conducting various experiments and tests.
- To analyze the BLDC Motor speed Torque characteristics

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Course Outcomes:

1. Understand Performance characteristics of single-phase induction motor
2. Understand Performance characteristics of three-phase induction motor
3. Understand the operation of BLDC Motor
4. Understand the importance of Voltage regulation of an alternator
5. Explain different methods used to measure the voltage regulation of an alternator

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1
CO1	3	3	2						2	2		2		
CO2	3	3	2						2	2		2		
CO3	3	3	2						2	2		2		
CO4	3	3	2						2	2		2		
CO5	3	3	2						2	2		2		

LIST OF EXPERIMENTS:

1. No-load test, and blocked rotor test on 3-phase induction motor.
2. Load test on 3-phase induction motor.
3. Speed control of 3-phase induction motor by (a) Cascade connection (b) Rotor resistance control (C) Pole changing
4. No-load test, and blocked rotor test on single-phase induction motor.
5. load test on single-phase induction motor.
6. Voltage regulation of an alternator by Synchronous impedance method
7. Voltage regulation of an alternator by (a) Ampere - turn method (b) Z.P.F. method.
8. Regulation of alternator by slip test.
9. Determination of V curves and inverted V curves of synchronous motor.
10. Power angle characteristics of a synchronous machine.
11. Power factor improvement of three phase Induction motor using capacitors.
12. Dynamic braking of 3-phase induction motor.
13. Speed control of BLDC motor.
14. Load characteristics of induction generator.
15. Speed control of SRM motor.

Note: At least ten experiments should be conducted in the Semester.

Suggested Reading:

1. Kothari D.P. &Nagrath I.J. - Electrical Machines - Tata McGraw Hill, 2004.
2. Bhimbra P.S. - Generalized Theory of Electrical Machines, Khanna Publications, 2000.
3. Say MG. - The Performance and Design of AC. Machines - Pitman Publication, 2002.
4. Irving L. Kosow - Electric Machinery and Transforn1ers, PPH, Pearson Education, 2nd Edition. 2009.
5. Satish Kumar Peddapelli and Sridhar Gaddam, Electrical Machines - A Practical Approach, De Gruyter Publisher, Germany, 2020

Course Code	Course Title					Course Type
PC 552 EE	ELECTRICAL MEASUREMENTS LAB					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	-	-	2	3	25	50	1

Course Objectives:

- To acquire practical knowledge for measuring resistance, inductance and capacitance using various bridges.
- To understand the usage of A.C. and D.C. potentiometers.
- To acquire knowledge about the operation of CRO and its usefulness in finding the amplitude, phase and frequency of waveforms.
- To acquire knowledge about the functionality of single phase energy meter.
- To acquire knowledge about the measurement of iron losses using Lloyd Fishers magnetic square.

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Course Outcomes:

1. Measure the inductance, capacitance and resistance using various bridges.
2. Measure resistance and calibrate ammeter, voltmeters and wattmeter using A.C. and D.C. potentiometers.
3. Have hands on experience on the operation of CRO.
4. Calibrate single phase energy meter using direct loading.
5. Measure iron losses using Lloyd Fishers magnetic square.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	2	2	-	1	2	-
CO2	3	-	-	-	-	-	-	-	2	2	-	1	2	-
CO3	3	-	-	-	-	-	-	-	2	2	-	1	2	-
CO4	3	-	-	-	-	-	-	-	2	2	-	1	2	-
CO5	3	-	-	-	-	-	-	-	2	2	-	1	2	-

LIST OF EXPERIMENTS:

1. Measurement of low resistance by Kelvin's Double Bridge.
2. Calibration of single phase energy meter.
3. Measurement of inductance by Maxwell's and Anderson's bridges.
4. Measurement of capacitance by Desauty's and Schering's bridges.
5. Measurement of Iron losses by Lloyd Fishers magnetic square.
6. Measurement of Resistance and calibration of Ammeter using D.C. potentiometer.
7. Calibration of voltmeter and wattmeter using D.C. potentiometer.
8. Measurement of unknown voltage and impedance using A.C. potentiometer.
9. Calculation of iron losses using B-H curve with oscilloscope.
10. Localizing Ground and short circuit faults using Murray loop test and Varley loop test.
11. Measurement of relative permittivity (Ɛr) of a dielectric medium using Schering Bridge.
12. Measurement of frequency of unknown sinusoidal signal with CRO.
13. Measurement of phase and amplitude using CRO.
14. Calibration of given power factor meter using calibrated voltmeter, ammeter and wattmeter.

Note: At least ten experiments should be conducted in the Semester.

Suggested Reading:

1. Shawney A.K., Electrical and Electronics Measurements and Instruments, Dhanpatrai& Sons, Delhi, 2000.
2. Umesh Sinha, Electrical, Electronics Measurement & Instrumentations, Satya Prakashan, New Delhi.
3. Golding E.W., Electrical Measurements & Measuring Instruments, Sir Issac& Pitman & Sons Ltd., London.

Course Code	Course Title					Course Type
PC 553 EE	CONTROL SYSTEMS LAB					Course
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE
	-	-	2	3	25	50	1

Course Objectives:

- To develop transfer function of various control system plants practically by conducting the experiments.
- To analyze systems in time-domain and frequency domain.
- To study the different types of controllers
- To simulate control system concepts using MATLAB.
- To design controllers using MATLAB

Course Outcomes:

1. Determine the transfer function of D.C servomotor and A.C servo motor.
2. Find the step response and frequency response of system.
3. Study the effects of PID controller, On-Off controller and Lead-Lag controllers
4. Study the control system concepts using MATLAB.
5. Design Lead, Lag and Lead-Lag compensators using MATLAB.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	2	-	2	-	-	3	3	2	2	-	3
CO2	2	2	2	2	-	2	-	-	3	3	2	2	2	2
CO3	2	2	3	3	-	2	-	-	3	3	2	2	2	3
CO4	2	2	2	3	3	2	-	-	3	3	2	2	2	2
CO5	2	2	3	3	3	2	-	-	3	3	2	2	2	2

LIST OF EXPERIMENTS:

1. Characteristics of synchros.
2. Characteristics of D.C. Servomotor and their transfer function.
3. Characteristics of AC. Servomotor and their transfer function.
4. Operating characteristics of Stepper motor.
5. Step response of second order system.
6. D.C. Position control system.
7. A.C. Position control system.
8. Performance of P, PI and PID Controller on system response.
9. Frequency response of lag and lead compensators.
10. ON - OFF temperature control systems.
11. Simulation of control system concepts using MATLAB.
12. Design of Lead, Lag and Lead-lag compensators using MATLAB.

Note: At least ten experiments should be conducted in the Semester.

Suggested Reading:

1. Nagrath I.J. &Gopal.M - Control System Engineering, Wiley Eastern, 2003.

2. B.C.Kuo - Automatic Control Systems, Wiley India edition, 7th Edition, 2002.

3. K.Ogata - Modern Control System, Prentice Hall of India, 4th edition, 2002. 4. N.C.Jagan - Control Systems, B.S Publications, 2nd edition.

SCHEME OF INSTRUCTION AND EVALUATION

B.E. (Electrical and Electronics Engineering)

VI– Semester

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
1	PC 601 EE	Utilization of Electrical Energy	3	-	-	3	3	40	60	3
2	PC 602 EE	Switchgear and Protection	3	-	-	3	3	40	60	3
3	PC 603 EE	Electric and Hybrid Vehicles	3	-	-	3	3	40	60	3
4	PC 604 EE	AI Techniques in Electrical Engineering	3	-	-	3	3	40	60	3
5	PC 605 EE	FACTS Controllers and HVDC Transmission	3	-	-	3	3	40	60	3
6	**Professional Elective – III**		3	-	-	3	3	40	60	3
	PE 631 EE	Special Electrical Machines								
	PE 632 EE	Power Quality Engineering								
	PE 633 EE	Advanced Python Programming								
	PE 604 CS	Deep Learning								
7	**Open Elective – I**		3	-	-	3	3	40	60	3
	OE 601 BM	Engineering Applications in Medicine								
	OE 602 BM	Human Assistive Technologies								
	OE 601 CE	Disaster Management								
	OE 602 CE	Road safety Engineering								
	OE 601 CS	Python Programming								
	OE 602 CS	Cyber Security								
	OE 601 EC	Principles of Electronic Communication								
	OE 602 EC	Verilog HDL								
	OE 601 EE	Applications of Electrical Energy								

	OE 602 EE	Electrical Safety Management								
	OE 601 ME	3D Printing Technology								
	OE 602 ME	Finite Element Method								
Practicals										
8	PC 651 EE	Power Electronics Lab	-	-	2	2	3	25	50	1
9	PC 652 EE	Digital Signal Processing Lab	-	-	2	2	3	25	50	1
10	PW 651 EE	Mini-Project	-	-	6	6	-	50	-	3
		Total	**21**	-	**8**	**31**	**27**	**380**	**520**	**26**

Note: At the end of VI semester students should undergo Summer Internship during Summer Vacation. Marks will be awarded in VII semester

Course Code	Course Title						Course Type
PC 601 EE	UTILIZATION OF ELECTRICAL ENERGY						Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc
- To understand various types of control circuits for three phase induction motors.
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the basic principle of electric traction including speed-time curves of different traction services.
- To understand systems of train lighting and also various types of batteries.

Course Outcomes:

1. Identify a suitable heating/welding scheme for a given application.
2. Design control circuits for the reliable operation of three phase induction motors.
3. Classify types of electric light sources based on nature of operation and their objectives, performance and reliability.
4. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.
5. Select proper train lighting scheme according to the requirement and analyze various batteries.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1
CO1	3	1	1	-	-	-	-	-	-	-	-	1	1	2
CO2	3	2	2	1	2	-	-	-	1	2	-	2	1	2
CO3	1	1	1	2	3	2	3	-	1	1	-	2	2	2
CO4	3	2	1	1	1	-	2	-	-	-	-	1	-	2
CO5	3	1	2	1	1	1	2	-	-	-	-	-	-	1

UNIT - I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

Electric Welding: Classification of Electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

UNIT - II

Schematic Utilization and Connection Diagrams for Motor Control: Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

UNIT-III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau‟s construction, Discharge lamps, Sodium vapour and Mercury vapour lamps, LED lamps, Fluorescent lamps, Starting and power factor corrections, Stroboscopic effects, Neon signs, Application to factory lighting, Street lighting and Flood lighting.

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UNIT- IV

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion.

Traction Motors: Desirable characteristics, DC series motors, AC series motors 3-phase induction motors, DC motor series & parallel control, Energy saving.

UNIT-V

Train Lighting: Systems of train lighting, Special requirements of train lighting, Methods of obtaining unidirectional polarity, Methods of obtaining constant output, Single battery system, Double battery parallel block system, Principal equipment of double battery system, Coach wiring, Dynamo.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimatingand Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L.Theraja, A Text Book of Electrical Technology, S.Chand& Company Ltd, Vol-I.

Course Code	Course Title					Course Type
PC 602 EE	SWITCHGEAR AND PROTECTION					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To be able to understand the need of protection in power system and protection with conventional relays.
- To understand the operation of static and distance relays.
- To understand the protection of transformers and generators.
- To understand the construction and operation of various types of circuit breakers.
- To understand the operation of the components of Gas Insulated Substation and the protection against over voltages.

Course Outcomes:

1. Acquire the knowledge on construction, working principles of different electromagnetic, induction and static relays and their applications in Feeder protection.
2. Draw block diagrams of various static over current relays and also obtain the characteristics of various distance relays with their applications in transmission line protection.
3. Choose a proper relay for protection of generator and transformer.
4. Explain the working principle, construction, rating and applications of different types of circuit breakers used in power system networks.
5. Understand the constructional details, advantages and disadvantages of Gas Insulated Substations and also choose a suitable protection for Transmission lines and the power system equipment against direct lightning strokes.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	1	-	-	1	2	-
CO2	3	1	1	2	-	-	-	-	1	-	-	1	2	-
CO3	3	2	1	2	-	-	-	-	1	-	-	1	2	-
CO4	3	2	1	2	-	-	-	-	1	-	-	1	2	-
CO5	3	2	1	2	-	-	-	-	1	-	-	1	2	-

UNIT- I

Introduction to Protective Relays: Need for protection - primary protection - backup protection- Zones of protection - Definitions of relay pick up and reset values - Classification of relays - Operating principles and construction of Electromagnetic and Induction type relays. Over current relay - Over voltage - Directional relay - Universal relay torque equation. Over current protection for radial feeder and ring mains - Protection of parallel lines - Relay settings for over current relays Earth fault and phase fault protection.

UNIT-II

Static phase and Amplitude comparators: Characteristics of dual input comparators. Static Relays - Instantaneous over current relay - Definite time over current relay - Inverse time over current relay - Directional over current relay (Block diagram approach only) Distance protection - Characteristics of 2- input distance relays on the RX diagram - Input characteristics for various types of distance relays - 3-step distance relays, Microprocessor based over current relay (block diagram).

UNIT- III

Transformer and Generator Protection: Differential relays -Percentage differential relays protection of generator and transformer using percentage differential relays, Split phase protection, Overheating, Loss of excitation - Protection of transformers against magnetizing inrush - Buchholz relay - Protection of earthing transformers.

UNIT-IV

Circuit Breakers : Need for circuit breakers, Parts of circuit breaker trip coil circuit- Arc properties - Principles of arc quenching - Theories, Recovery and restriking voltages - Rating of circuit breakers - Rated symmetrical and asymmetrical breaking current - Rated making current - Rated capacity, Voltage and frequency of circuit breakers, Auto re-closure-duty cycle, Current chopping - Resistance switching - Derivations of RRRV - Maximum RRRV, Recovery voltage, Problems - Types of circuit breakers - Oil, Minimum oil, Air, Air blast, SF6, Vacuum and miniature circuit breakers, Testing of circuit breakers.

UNIT-V

Gas Insulated Substations & Over Voltage Protection: Constructional details (components), Merits and Demerits of Gas Insulated Substations over conventional Air insulated Substations. Protection of transmission lines against direct lightning strokes – ground wires - Protection angle - Protection zone - Tower footing resistance and its effects - Equipment protection assuming rod gaps, arcing horns - Different types of lightning arresters - their construction Surge absorbers - Peterson coil - Insulation coordination.

Suggested Reading:

1. Wadhwa C.L. - Electrical Power System, Wiley Eastern Ltd., 3rd Edition-2002.
2. Badriram & Viswakarma-Power System Protection & Switchgear, Tata McGraw Hill, 2003.
3. Sunil S. Rao - Switchgear & Protection, Khanna Publications, 2000.
4. M.S. Naidu - Gas Insulated Substations, I.K. int. Publishing House Pvt. Ltd. -2008.

Course Code	Course Title					Course Type
PC 603 EE	ELECTRIC AND HYBRID VEHICLES					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand the basics of electric and hybrid electric vehicles and their working
- To understand the basics of batteries and their role for electric/hybrid vehicle applications
- To obtain the knowledge of various types of electric/hybrid vehicles
- To understand the real time challenges in the implementation of this technology
- To understand the concepts and methods of power transmission in hybrid and electrical vehicle.

Course Outcomes:

1. Understand basics of electric and hybrid electric vehicles both conceptually and mathematically so that clear understanding from basics physics is achieved.
2. Have the knowledge of battery behavior for electric vehicle application.
3. Understand different types of Electric/Hybrid vehicles technologies available and their applications.
4. Analyze challenges in implementing electric/hybrid vehicle technology by looking into various charging topologies and their impact on distribution systems.
5. Analyze various electric drives suitable for hybrid electric vehicles.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	2	-	2	-	-	-	-	-	-	1	2
CO2	3	-	3	2	-	2	-	-	-	-	-	-	1	2
CO3	3	-	3	2	-	2	-	-	-	-	-	-	1	3
CO4	3	-	3	2	-	2	-	-	-	-	-	-	1	3
CO5	3	-	3	2	-	2	-	-	-	-	-	-	1	3

UNIT- I

Introduction to Electric Vehicles: Sustainable Transportation - EV System – EV - Advantages - Vehicle Mechanics - Performance of EVs - Electric Vehicle drive train - EV Transmission Configurations and components-Tractive Effort in Normal Driving - Energy Consumption - EV Market - Types of Electric Vehicle in Use Today – Electric Vehicles for the Future.

UNIT-II

Electric Vehicle Modelling - Consideration of Rolling Resistance – Transmission Efficiency - Consideration of Vehicle Mass - Tractive Effort - Modelling Vehicle Acceleration - Modelling Electric Vehicle Range -Aerodynamic Considerations - Ideal Gearbox Steady State Model - EV Motor Sizing - General Issues in Design.

UNIT- III

Introduction to electric vehicle batteries - electric vehicle battery efficiency – electric vehicle battery capacity - electric vehicle battery charging - electric vehicle battery fast charging - electric vehicle battery discharging - electric vehicle battery performance – testing.

UNIT-IV

Hybrid Electric Vehicles - HEV Fundamentals -Architectures of HEVs- Interdisciplinary Nature of HEVs - State of the Art of HEVs - Advantages and Disadvantages - Challenges and Key Technology of HEVs - Concept of Hybridization of the Automobile-Plug-in Hybrid Electric Vehicles - Design and Control Principles of Plug-In Hybrid Electric Vehicles - Fuel Cell Hybrid Electric Drive Train Design - HEV Applications for Military Vehicles.

UNIT-V

EV Charging - Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles

Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks – Sizing Ultra capacitors for Hybrid Electric Vehicles.

Suggested Reading:

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles –Fundamentals, Theory and Design – Mehrdad Ehsani, UiminGao and Ali Emadi - Second Edition - CRC Press, 2010.
2. Electric Vehicle Technology Explained - James Larminie, John Lowry – John Wiley & Sons Ltd, - 2003.
3. Electric Vehicle Battery Systems – Sandeep Dhameja – Newnes - 2002.
4. Hybrid electric Vehicles Principles and applications with practical perspectives Chris Mi, Dearborn - M. AbulMasrur, David WenzhongGao - A John Wiley & Sons, Ltd., - 2011.
5. Electric & Hybrid Vehicles – Design Fundamentals-Iqbal Hussain, Second Edition, CRC Press, 2011.

Research Papers:

1. The Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks: a Review and Outlook - Robert C. Green II, Lingfeng Wang andMansoorAlam - 2010 IEEE.
2. Sizing Ultracapacitors For Hybrid Electric Vehicles - H. Douglas P Pillay 2005 IEEE.

Course Code	Course Title					Course Type
PC 604 EE	AI TECHNIQUES IN ELECTRICAL ENGINEERING					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Introduction of Artificial Intelligent techniques such as Artificial Neural Networks
- Fuzzy Logic and Genetic Algorithms. Neural Network architecture, learning mechanisms.
- Introducing different components of Fuzzy Logic Controllers such as Fuzzification Rule base, Inference and defuzzification.
- Different Genetic operators are introduced and how to they help to solve optimization problems is demonstrated.
- Application of AI techniques in solving different Electrical problems

Course Outcomes:

1. Understand the how nature inspired algorithms such as Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms solve Engineering problems.
2. Develop Neural Network and algorithms to train them.
3. Understand the concept of fuzzy logic, membership, fuzzification and defuzzification.
4. Design Fuzzy controllers for practical applications
5. Develop Genetic algorithm to solve optimization problems.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	2	3	-	-	-	-	-	-	-	3	3	3
CO3	3	2	2	3	-	-	-	-	-	-	-	3	3	3
CO4	3	2	2	3	-	-	-	-	-	-	-	3	3	3
CO5	3	2	2	3	-	-	-	-	-	-	-	3	3	3

UNIT- I

Artificial Neural Networks: Introduction, Models of Neuron Network-Architectures, Knowledge representation, Artificial Intelligence and Neural networks, Learning process, Error correction learning, Hebbian learning, Competitive learning, Boltzmann learning, Supervised learning, Unsupervised learning, Reinforcement learning, Learning tasks.

UNIT-II

ANN Paradigms: Multi-layer perceptron using Back propagation Algorithm (BPA), SelfOrganizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Applications of ANN.

UNIT- III

Fuzzy Logic: Introduction –Fuzzy versus crisp, Fuzzy sets - Membership function, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy cartesian Product, Operations on Fuzzy relations, Fuzzification methods and Defuzzification methods.

UNIT-IV

Fuzzy Logic Controller: Fuzzy inference - Rule based system - Fuzzy control systems - Applications of Fuzzy control systems.

UNIT-V

Genetic Algorithms: Introduction, different types of encoding, Fitness Function, Genetic Operators: selection - types of selection, Cross over- types of crossover, Mutation operator, Elitism, Algorithmic steps- Applications of GA. Economic Load Dispatch.

Suggested Reading:

1. S.Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi,2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition,2011
3. P.D.Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York,1989.
4. Neural Netwroks – Simon Hykins, Pearson Education.
5. D.E. Goldberg, Genetic Algorithms, Addison-Wesley1999.

Course Code	Course Title					Course Type
PC 605 EE	FACTS CONTROLLERS AND HVDC TRANSMISSION					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand the issues involved in existing Power Transmission system.
- To be familiar with the Techniques to overcome the problems associated with AC Power Transmission system.
- To Understand the control of active and reactive power control using Power electronic converters (FACTS Controllers)
- To understand the HVDC transmission systems.
- To understand the control schemes of HVDC system.

Course Outcomes:

1. Analyze the conventional power flow limitations and Definitions of FACTS controllers.
2. Analyze and select a suitable shunt compensation for a given power flow condition.
3. Analyze and select a suitable series compensation for a given power flow condition.
4. Analyze the advantages of HVDC transmission system over AC transmission system.
5. Analyze converter configurations used in HVDC and their control characteristics.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	1	-	-	-	-	-	2	2	2
CO2	3	3	2	2	3	1	-	-	-	-	-	2	2	2
CO3	3	3	2	2	3	1	-	-	-	-	-	2	2	2
CO4	3	3	2	2	3	1	-	-	-	-	-	2	2	2
CO5	3	3	2	2	3	1	-	-	-	-	-	2	2	2

UNIT- I

FACTS concepts: Introduction to FACTS, Flow of power in AC parallel paths and meshed systems, Limitations in Loading capability, Power flow control in simple two machine system, basic types of FACTS controllers, brief description of FACTS controllers.

UNIT-II

Static shunt compensators: Shunt compensation - objectives of shunt compensation, Methods of controllable VAR generation: Variable impedance type Static Var generators (TCR, TSR, TSC, FC-TCR and TSC-TCR). Switching converter type Var generators: Basic operating principles, basic control approaches. Static Var compensators – SVC and STATCOM, Comparison between SVC and STATCOM.

UNIT- III

Static series compensators: Series compensation - objectives of series compensation, Variable impedance type series compensators: GTO-Thyristor-controlled series capacitor (GCSC), Thyristor switched series capacitors (TSSC) and basic operating control schemes. Switching converter type series compensators: static series synchronous compensator (SSSC), power angle characteristics.

UNIT-IV

HVDC transmission system: Introduction, Comparison of AC and DC systems, Applications of DC transmission. Description of DC Transmission system: types of DC links, Layout of HVDC Converter station and various equipments. Modern trends in HVDC Technology.

UNIT-V

Analysis of HVDC converters: Analysis of bridge converters with and without overlap, inverter operation, equivalent circuit representation of rectifier and inverter configurations, Principle of DC link control, Converter control characteristics.

Introduction to multiterminal DC (MTDC) systems and applications, comparison of series and parallel MTDC systems.

Suggested Reading:

1. Narain G Hingorani, L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.
2. Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
3. K.R.Padiyar, 'HVDC power transmission systems', New age International publishers 2012.Neural Netwroks – Simon Hykins, Pearson Education.
4. Mohan Mathur R. and Rajiv K.Varma , 'Thyristor - based FACTS controllers for Electrical transmission systems', IEEE press, Wiley Inter science , 2002.
5. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.
6. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles Camacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.

Course Code	Course Title					Course Type
PE 631 EE	SPECIAL ELECTRICAL MACHINES					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand and develop stepper motors for high-precision applications, optimize stepper motor performance for specific applications integrate stepper motors with advanced controllers.
- Optimize SRM motor performance for specific applications, design and develop SRM motor control systems, analyze and mitigate SRM motor control circuits.
- To understand and develop high-performance PMSM motor drives, optimize PMSM motor efficiency and reliability, integrate PMSM motors with advanced control systems.
- Understand the construction and operating principles of BLDC motors analyze the advantages and applications of BLDC motors, design and develop BLDC motor systems.
- To introduce various types of linear motors, including linear induction motors (LIM) and linear synchronous motors (LSM), their applications in different industries, to provide practical experience and case studies on the implementation of linear motors in real-world applications such as transportation systems, automation, and robotics.

Course Outcomes:

1. Students will be able to explain the working principles and operations of various special electrical machines such as stepper motors, SRM, BLDC, PMSM and linear motors.
2. Students will demonstrate the ability to analyze the performance characteristics of special electrical machines under different operating conditions.
3. Students will be able to apply mathematical models and simulation techniques to design and optimize the performance of special electrical machines.
4. Students will acquire the skills to implement and evaluate different control strategies for special electrical machines.
5. Students will be capable of identifying and solving practical problems involving special electrical machines in industrial and technological applications.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	-	-	-	-	-	-	3	3	3
CO2	3	3	2	3	2	-	-	-	-	-	-	3	3	3
CO3	3	3	2	3	2	-	-	-	-	-	-	3	3	3
CO4	3	3	2	3	2	-	-	-	-	-	-	3	3	3
CO5	3	3	2	3	2	-	-	-	-	-	-	3	3	3

UNIT- I

Stepper Motors: Constructional features, Principle of operation, Variable Reluctance (VR) stepping motor-Single Stack, Multi-Stack, Permanent Magnet Step motor, Hybrid Step Motor, Torque Equation Open Loop Drive, Open loop and closed loop control of Step Motor, Applications.

UNIT-II

Switched Reluctance Motors: Constructional features, Principle of Operation, Torque equation, Torque-speed characteristics, Power Converter for SR Motor-Asymmetrical converter, DC Split converter, Control of SRM, Rotor Position sensors, Current Controllers, Applications.

UNIT- III

Permanent Magnet Synchronous Motor: Permanent magnets and their characteristics, Machine Configurations-SPM, SIPM, IPM and Interior PM with circumferential, Sensorless control, Applications.

UNIT-IV

Brushless DC Motor: Construction, Principle of Drive operation with inverter, Torque speed Characteristics, Closed loop control, Sensorless control, Applications.

UNIT-V

Linear Induction Motors and Linear Synchronous Motors: Linear induction motor, Construction details, LIM Equivalent Circuit, Steps in design of LIM, Linear Synchronous Motor: Principle and Types of LSM, LSM Control, Applications.

Suggested Reading:

1. R.Krishnan, *Electric Motor Drives*, Pearson , 2007
2. B.K.Bose, *Modern Power Electronics and AC Drives*, PHI, 2005
3. Venkataratnam, *Special electrical Machines*, University Press, 2008
4. E.G.Janardanan, *Special Electrical Machines*, PHI, 2014
5. T.J.E.Miller, *Brushless Permanent Magnet and Reluctance Motor Drive*, Clarendon Press, Oxford, 1989

Course Code	Course Title					Course Type
PE 632 EE	POWER QUALITY ENGINEERING					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand the importance of power quality, different power quality issues and their effects in power system network.
- To understand methods of calculating the voltage sag magnitude and duration.
- To understand the types of sags and characterize the voltage sags experienced by machines.
- To acquire knowledge of harmonics, locate sources of harmonics and mitigate harmonics.
- To acquire knowledge of various measuring equipment and understand assessment of PQ measuring data.

Course Outcomes:

1. Understand the significance of power quality study and identify various power quality disturbances.
2. Write algorithms to calculate voltage sags magnitude and duration in power system.
3. Demonstrate the effect and also analyze the characteristics of voltage sags experienced by ASDs.
4. Evaluate THD and mitigate harmonics in distribution system.
5. Understand the Operation and use PQ measuring equipment for assessment of data.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	-	1	-	1	-	-	1	2	-
CO2	3	2	1	1	1	-	1	-	1	-	-	1	2	-
CO3	3	1	1	1	1	-	1	-	1	-	-	1	2	-
CO4	3	2	1	1	1	-	1	-	1	-	-	1	2	-
CO5	3	1	1	1	1	-	1	-	1	-	-	1	2	-

UNIT- I

Introduction: Power Quality (PQ),PQ problems, Sags, Swells, Transients, Harmonics, Interruptions, Flicker, Voltage fluctuations, Notch. Transient Over voltages, Sources of Transient Over voltages.

Wiring and Grounding: Resources, Definitions, Reasons for Grounding, Typical wiring and grounding problems, Solutions to wiring and grounding problems.

UNIT-II

Voltage Sag Characteristics and Analysis: Voltage sag characteristics, Methodology for computation of voltage sag magnitude and occurrence, Accuracy of sag analysis, Duration & frequency of sags, Faults behind transformers, Effect of pre-fault voltage, Simple examples, Voltage dip problems, fast assessment methods for voltage sags in distribution systems.

UNIT- III

PQ in Industry: Voltage tolerance curves of computers, PLCs and process control equipment CBEMA and ITIC curves, Adjustable speed drive (ASD) systems AC and DC, Characterization of voltage sags experienced by three-phase ASD systems, Types of sags and phase angle jumps, Effects of momentary voltage dips on the operation of induction and synchronous motors.

UNIT-IV

Harmonics: Harmonic distortion, Voltage versus current distortion, Harmonics versus Transients, Harmonic Indices, Harmonic sources from commercial loads, Harmonic sources from industrial loads, Locating Harmonic sources, System response characteristics, Effects of Harmonic distortion, Inter harmonics, Devices for controlling harmonic distortion.

UNIT-V

Power Quality Monitoring: Monitoring considerations, Historical Perspective of PQ Measuring Instruments, PQ measurement equipment, Assessment of PQ measurement data, Application of intelligent systems, PQ monitoring standards

Suggested Reading:

1. Math H.J. Bollen, Understanding Power Quality Problems, IEEE Press, 1999.
2. Roger C. Dugan, MarkF. McGranaghan, Surya Santoso, H.Wayne Beaty, Electrical Power Systems Quality, Second Edition, Tata McGraw-Hill Edition.
3. C. Sankaran, Power Quality, CRC Press, 2002.

Course Code	Course Title					Course Type
PE 633 EE	ADVANCED PYTHON PROGRAMMING					PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Teach Object-Oriented Programming (OOP) concepts such as classes, objects, inheritance, and polymorphism in Python.
- Cover threading and concurrency, including thread creation, synchronization, and inter-thread communication.
- Introduce network programming with a focus on sockets, server-client communication, and file transfer over networks.
- Provide an overview of relational database management systems (RDBMS), including SQL queries and database manipulation.
- Introduce web programming basics like HTML5, CSS, RESTful APIs, JSON, and MVC architecture.

Course Outcomes:

1. Develop proficiency in designing and implementing object-oriented Python programs, utilizing classes, objects, inheritance, and polymorphism to solve complex problems.
2. Demonstrate the ability to create and manage threads in Python, understand thread life cycles, and effectively use threading for concurrent programming tasks.
3. Gain skills in developing network applications in Python, including creating server and client programs using sockets, transferring files over networks, and processing URLs.
4. Acquire proficiency in using SQL for relational database management, including creating, querying, and manipulating databases and tables.
5. Learn to create basic web applications, understanding the principles of web development, RESTful APIs, and JSON, and applying these concepts in projects.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	-	-	-	2	2	2
CO2	3	3	3	-	3	-	-	-	-	-	-	2	2	2
CO3	3	3	3	-	3	-	-	-	-	-	-	2	2	2
CO4	3	3	3	-	3	-	-	-	-	-	-	2	2	2
CO5	3	3	3	-	3	-	-	-	-	-	-	2	2	2

UNIT- I

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance the Polymorphism.

UNIT-II

Threading and Concurrency: Multithreading, Thread Life Cycle, creating a Thread, starting a thread, joining Threads, Naming Threads, Thread Scheduling, Thread pools, Main Thread, Thread Priority, Daemon Threads, Synchronizing Threads, Thread Deadlock, Inter-thread Communication, Interrupting a Thread.

UNIT- III

Network Programming: Sockets, Socket Programming, The socket module, Server Socket Methods, Client Socket methods, Socket server, Socket Client, File transfer through socket, URL processing, Generics.

UNIT-IV

Relational Database Management Systems [RDBMS]: Introduction to Databases, Types of Databases, Primary key and Foreign keys, Autoincrement, Create and Drop Database, Create, Delete and Alter tables, Views, SQL QUERY Statements (SELECT, WHERE , AND, NOT, OR, INSERT, UPDATE, DELETE, MIN, MAX, COUNT, SUM, AVG, JOIN, GROUP BY, JOINs)

UNIT-V

Introduction to Web programming: HTML5, CSS basics, RESTful APIs, REST client , REST server, Basics of JSON, JSON parsing and JSON building, MVC architecture.

Suggested Reading:

1. Aditya Kanetkar ,Yashavant Kanetkar *"Let Us Python", 6th Edition*.
2. Charles R. Severance, Publisher: Shroff Publishers. "Python for Everybody. Author: "
3. (The PDF of this book is currently available freely at http://do1.dr-chuck.com/pythonlearn/EN_us/pythonlearn.pdfGowrishankar S., Veena A,*"Introduction to Python Programming",* CRC Press, Taylor & Francis Group, 2019.
4. Ben Frain,*"Responsive Web Design with HTML5 and CSS",* 4th edition.
5. Abraham Silberschatz , Henry F. Korth, S. Sudarshan, "*Database Management Systems*"

Course Code	Course Title						Course Type
PE 604 CS	DEEP LEARNING						PE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives :

- To understand complexity of Deep Learning algorithms and their limitations
- To understand modern notions in data analysis oriented computing;
- To apply Deep Learning algorithms in practical applications
- To perform experiments in Deep Learning using real-world data.

Course Outcomes:

1. Understand the concepts of Neural Networks, its main functions, operations and the execution pipeline
2. Implement deep learning algorithms, understand neural networks and traverse the layers of data abstraction.
3. Learn topics such as Convolutional neural networks, recurrent neural networks, training deep networks and modifications
4. Build deep learning models in PyTorch and interpret the results

UNIT-I

Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.

Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT-II

Multilayer Perceptrons:

Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT-III

Introduction to Convolutional Neural Networks:
Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters

Modern Convolutional Neural Networks:
Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet).

UNIT-IV

Recurrent Neural Networks: Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through Time**.**

Modern Recurrent Neural Networks: Gated Recurrent Units (GRU), Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence, Beam Search.

UNIT-V

Auto Encoders: Types of Auto Encoders and its applications

Generative Adversarial Networks: Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks

Suggested Readings:

1. Goodfellow, I., Bengio,Y., and Courville, A., "*Deep Learning"*, MIT Press, 2016.

2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "*Dive into Deep Learning",* 2020.

Course Code	Course Title					Course Type
OE 601 BM	ENGINEERING APPLICATIONS IN MEDICINE					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To make the students gain basic knowledge of Human Physiology.
- To make the students learn the applications of various branches of engineering in Medicine.

Course Outcomes:

1. Describe the major organ systems of the human body
2. Understand the concepts of bioelectricity and medical instruments
3. Apply solid and fluid mechanics principles to joints and blood flow respectively
4. Learn the need and applications of BCI
5. Analyze and choose proper biomaterial for various applications

UNIT- I

Evolution of Modern healthcare, Major organ systems- Cardiovascular, Respiratory, Nervous, Skeletal, Muscular. Homeostasis. Physiological signals and their diagnostic importance.

UNIT-II

Bioelectricity-Excitable cells, Resting potential, Action potential, Accommodation, Strength-Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves.

Medical Instrumentation System-Functions, Characteristics, Design Challenges.

Signal Processing-QRS detection.

UNIT- III

Solid mechanics-Analysis of muscle force and joint reaction force for the limb joints.

Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of Hagen-Poiseuille flow to blood flow.

UNIT-IV

Brain-Computer Interface: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical applications-Word forming, Device control.

UNIT-V

Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements. Implants- Manufacturing process, Design, fixation.

Suggested Reading:

1. John Enderle, Susan M. Blanchard and Joseph Bronzino, *Introduction to Biomedical Engineering*, Second Edition, Elsevier, 2005.
2. Ozkaya, Nordin. M, *Fundamentals of Biomechanics*, Springer International Publishing, 4th Edition, 2017.
3. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
4. John G.Webster, *Medical Instrumentation: Application and Design*, John Wiley and Sons Inc., 3rd Ed., 2003.

Course Code	Course Title					Course Type
OE 602 BM	HUMAN ASSISTIVE TECHNOLOGIES					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
- To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
- To develop improved lower-extremity devices.

Course Outcomes:

1. Apply fundamental knowledge of engineering in rehabilitation
2. Apply analytical skills to assess and evaluate the need of the end-user
3. Develop self-learning initiatives and integrate learned knowledge for problem solving
4. Understand the basics of robotics and apply their principles in developing prosthetics
5. Apply the knowledge of computers in solving rehabilitation problems

UNIT- I

Introduction to Rehabilitation Engineering, Definition of Rehabilitation Engineering, Scope and importance of the field, Historical perspective. Interdisciplinary nature and collaboration with healthcare professionals. Physical disabilities: mobility impairments, spinal cord injuries. Cognitive disabilities: learning disabilities, traumatic brain injuries. Psychosocial aspects of disability.

UNIT-II

Assistive Technology, Human Factors and Ergonomics in Assistive Technology Design. Mobility Aids, Types of Wheelchairs and design aspects: Manual wheelchairs, Powered wheelchairs, Customizable features and design considerations, Auxiliary devices and systems. Human-Centered Designing.

UNIT- III

Sensory disabilities: visual and hearing impairments. Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Assessment and Outcome Measurement

UNIT-IV

Rehabilitation Robotics, Exoskeletons, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics Materials and fabrication techniques, Functional and cosmetic considerations. FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

UNIT-V

Case Studies and Real-World Applications. Augmentative and Alternative communications, Software tools for simulation and testing. Virtual reality applications in rehabilitation. Machine learning applications in assistive technology. Predictive analytics for personalized rehabilitation

Suggested Reading:

1. Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2. Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3. Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4. Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rd Ed., CRC Press, Taylor & Francis Group, London, 2006.

Course Code	Course Title						Course Type
OE 601 CE	DISASTER MANAGEMENT						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

UNIT- I

Introduction to Disaster: Understanding the Concepts, Definitions and Terminologies used in the field of Disaster Management (i.e. Hazard, Risk, Vulnerability, Resilience, and Capacity Building); Differential impacts of Disasters in terms of Gender, Age, Social Status, Location, Prosperity, Disabilities; Disaster- Development Nexus.

UNIT-II

Types of Hazards and Emerging Trends: Classification, Causes, Consequences and Controls of: Geophysical hazards-Earthquakes, Landslides, Tsunami; Weather related hazards- Meteorological (Cyclones, and Storm- surge), Hydrological (Floods, Droughts, Avalanches), Climatological (Wildfire, Cold & Heat Waves); Biological hazards-Epidemic & Pandemics; Technological hazards-Chemical, Industrial, Nuclear; Man-made hazards-Structural Failure, Fire, Transportation accidents, Terrorism and Wars; Emerging Disasters- Urban Areas, Climate Change; Regional and Global Trends-loss of life & Property in various hazards

UNIT- III

Disaster Management Cycle And International Framework: Disaster Management Cycle: Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Building; Awareness; During Disaster –Evacuation – Disaster Communication – Search and Rescue– Emergency Operation Centre – Incident Command System – Relief and Rehabilitation; Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery– Reconstruction and Redevelopment; Paradigm Shift in Disaster Management: International Decade for Natural Disaster Reduction; Yokohama Strategy; Hyogo Framework of Action

UNIT-IV

Disaster Risk Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt; Disaster Management Act 2005 – Institutional and Financial Mechanism; National Policy on Disaster Management; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-governmental Agencies

UNIT-V

Technological Approaches to Disaster Risk Reduction: Geo-informatics in Disaster Management (RS, GIS, GPS and RS); Technological in Disaster Communication System (Early Warning and Its Dissemination), rescue and restoration of services; Disaster Safe Designs and Constructions; Application of technology and innovations for Structural and non structural Mitigation; Science & Technology Institutions for Disaster Management in India

Suggested Reading:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5. Disasters in India Studies of grim reality, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur
6. National Disaster Management Policy, 2009, GoI.
7. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

Course Code	Course Title						Course Type
OE 602 CE	ROAD SAFETY ENGINEERING						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To introduce the fundamentals of road safety and road safety audit.
- To get familiarized with various road safety techniques, measures and their applications.
- To be able to understand and evaluate various traffic control devices.
- Familiarize with traffic management techniques.
- To examine and analyze the incident management process.

Course Outcomes:

1. Analyze Accident data.
2. Plan and design of road safety improvement programs
3. Apply the principles of road safety in urban transport
4. Apply traffic management techniques
5. Able to plan effective incident management program

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	2	2	2	-	-	2	-	-	-	2	2
CO2	2	2	2	2	2	2	-	2	-	1	1	-	1	1
CO3	2	2	1	1	1	1	-	-	-	-	-	1	2	-
CO4	3	2	2	2	2	2	-	1	2	-	-	2	3	2
CO5	1	3	3	3	2	3	2	1	2	1	2	1	1	2

UNIT- I

Road accidents: Causes, scientific investigations and data collection, analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of road accident statistics, safety performance function: The empirical Bayes method identification of hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & driver characteristics influencing road safety

UNIT- III

Road Signs and Traffic Signals: Classification, Location of signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols, Road marking: Role of road marking, classification, visibility. Traffic signals: Need, Signal face illumination and location of signals, factors affecting signal design, pedestrian's safety, fixed and vehicle actuated signals. Design of signals, area traffic control, Delineators, traffic impact attenuators, road side rest areas, safety barriers, traffic aid posts

UNIT-IV

Traffic Management Techniques: Integrated safety improvement and traffic calming schemes, speed and load limit, traffic lights, safety cameras, tests on driver and vehicles, pedestrian safety issues, parking, parking enforcement and its influence on accidents, travel demand management, methods of traffic management measures: restriction of turning movements, One way streets, tidal flow operation methods, exclusive bus lanes and closing side-streets; latest tools and techniques used for road safety; legislation, enforcement, education and propaganda.

UNIT-V

Incident Management: Introduction, characteristics of traffic incidents types of incidents, impacts, incident management process, incident traffic management; application of ITS: Motorist information, equipment used; planning effective incident management program, best practice in incident management programs. National importance of survival of transpiration systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017.
2. KadiyaliL.R,.Traffic Engineering and Transport planning, 9th Edition, Khanna Tech Publishers, 2013.
3. Donald Drew, Traffic Flow Theory Chapter 14 in Differential Equation Models, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017
5. Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009

Course Code	Course Title						Course Type
OE 601 CS	**PYTHON PROGRAMMING**						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods;

advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT-III

Files and Exception: Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, "*Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R, "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "*Think Python: How to Think Like a Computer Scientist*", 2nd Edition, Shroff O"Reilly Publishers, 2016

Course Code	Course Title					Course Type
OE 602 CS	CYBER SECURITY					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies.

Course Outcomes:

1. Understand the various network threats
2. Analyze the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, search and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrieval, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

Course Code	Course Title						Course Type
OE 601 EC	**PRINCIPLES OF ELECTRONIC COMMUNICATION**						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Provide an introduction to fundamental concepts in the understanding of Electronic communications systems
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer
- Provide an introduction to the evolution of wireless systems and current wireless technologies
- Provide an introduction to fundamental concepts in the understanding of Telecommunication and optical communications systems
- Provide an introduction to fundamental concepts in Analog and Digital Communications

Course Outcomes:

1. Understand the working of analog and digital communication systems.
2. Understand the Data Communication and Networking
3. Understand the concepts of modulation and demodulations
4. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems
5. Understand the principles of optical communications systems

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	1	1	1	1
CO2	2	1	2	1	-	-	-	-	1	1	1	1
CO3	2	1	1	1	-	-	-	-	1	1	1	1
CO4	3	2	2	2	-	1	1	1	1	1	1	1
CO5	1	1	2	2	1	-	1	-	1	1	1	1

UNIT- I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels, Signal Transmission Concepts-Baseband transmission and Broadband transmission, Communication parameters-Transmitted power, Channel bandwidth and Noise, Need for modulation Signal Radiation and Propagation-Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation

UNIT-II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation

UNIT- III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP

UNIT-IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony. Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing

UNIT-V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, And OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks

Suggested Reading:

1. Louis E. Frenzel, "Principles of Electronic Communication Systems", 3e, McGraw Hill publications, 2008.
2. Behrouz A. Forouzan,"Data Communications and Networking", 5e TMH, 2012.
3. Kennady, Davis, "Electronic Communications systems", 4e, TMH, 1999.
4. Keiser Gerd "Optical Fiber Communication (SIE)",5th Edition, McGraw Hill Education India,2017.
5. Simon Haykin, "Communication Systems", 5th Edition, Wiley publications, 2006.

Course Code	Course Title					Course Type
OE 602 EC	VERILOG HDL					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL
- To design and develop Verilog HDL models of combinational and sequential circuits
- To learn Synthesis and FPGA design flow
- To design and develop real time applications: Booth‘s multiplier, Divider, hardwired control for basic CPU, FIR filter

Course Outcomes:

1. Implement and distinguish different Verilog HDL modeling styles.
2. Construct and analyze Verilog HDL models of combinational and sequential circuits.
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications.
4. Outline FPGA design flow and timing analysis.
5. Understand implementation of real time applications.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	-	-	-	-	2	-	-	-	2	-
CO2	2	2	2	2	2	-	-	-	2	2	-	-	2	-
CO3	2	3	3	2	2	-	-	-	2	2	-	-	2	-
CO4	2	3	3	2	2	1	-	-	2	2	-	2	2	-
CO5	2	2	2	-	-	1	-	-	2	1	-	2	2	-

UNIT- I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT-II

Structural and Dataflow Modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples.

UNIT- III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT-IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT-V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Reading:

1. Samir Palnitkar, ―*Verilog HDL A Guide to Digital Design and Synthesis,*‖ 2nd Edition, Pearson Education, 2006..
2. Ming-Bo Lin, ―*Digital System Designs and Practices: Using Verilog HDL and FPGA,*‖ Wiley India Edition, 2008
3. J. Bhasker, ―*A Verilog HDL Primer*,‖ 2nd Edition, BS Publications, 2001

Course Code	Course Title					Course Type
OE 601 EE	APPLICATIONS OF ELECTRICAL ENERGY					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
- To understand various techniques of electric welding and types of batteries.
- To understand the concept of illumination and study about the laws of illumination.
- To know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electric traction including speed – time curves of different traction services.

Course Outcomes:

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Study the nature and production of light and laws related to illumination.
4. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
5. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO2	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO3	3	2	2	-	-	2	-	-	1	-	-	1	2	1
CO4	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO5	3	1	2	-	-	2	-	-	1	-	-	1	2	1

UNIT- I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT-II

Electric welding: Classification of electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT- III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau‟s construction.

UNIT-IV

Types of lamps - Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp and LED lamps. Starting and power factor corrections, stroboscopic effects, Application to factory lighting, Street lighting and Flood lighting.

UNIT-V

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion..

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol-I.

Course Code	Course Title					Course Type
OE 602 EE	ELECTRICAL SAFETY MANAGEMENT					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Understand electrical safety measures, the hazards associated with electric current, and voltage identify different types of electrical shocks.
- Understand installation work of electrical plant and equipment. Safety during installation of outdoor switchyard equipment, safety during installation of electrical rotating machines.
- Understand procedure of domestic wirings to handle different domestic electrical appliances, Procedure of Agricultural pump installation.
- Identifies different hazardous zones, classification of equipment enclosure for various hazardous gases, importance of earthing system. Understand Management Safety Policy.
- Understand standards on electrical safety, different IE Rules and Acts.

Course Outcomes:

1. Explain the objectives and precautions of Electrical safety, effects of shocks and their prevention.
2. Summarize the safety aspects during installation of plant and equipment.
3. Describe the electrical safety in residential, commercial and agricultural installations.
4. Describe the various Electrical safety in hazardous areas, Equipment earthing and system neutral earthing.
5. State the electrical systems safety management and IE rules.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO2	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO3	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO4	3	3	3	2	2	2	2	-	2	2	-	2	2	2
CO5	3	3	3	1	2	2	2	-	2	2	-	2	2	2

UNIT- I

Introduction to electrical safety, shocks and their prevention: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety.

Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

UNIT-II

Safety during installation of plant and equipment: Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

UNIT- III

Electrical safety in residential, commercial and agricultural installations: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT-IV

Electrical safety in hazardous areas: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

Equipment earthing and system neutral earthing: Introduction, Distinction between system grounding and Equipment Grounding, Equipment Earthing, Functional Requirement of earthing system, description of a earthing system, neutral grounding (System Grounding), Types of Grounding, Methods of Earthing Generators Neutrals.

UNIT-V

Safety management of electrical systems: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

Review of ie rules and acts and their significance: Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility. The Electricity Act, 2003, (Part1, 2, 3, 4 & 5).

Suggested Reading:

1. S.Rao, Prof. H.L.Saluja, "Electrical safety, fire safety Engineering and safety management", 1st edition Khanna Publishers. New Delhi, 2016 Reprint.
2. Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept Publishing company, New Delhi, 1997.

Course Code	Course Title						Course Type
OE 601 ME	3D PRINTING TECHNOLOGY						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand the fundamental concepts of 3D Printing, its advantages and limitations.
- To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based 3D Printing Technologies.
- To know the various types of STL file errors and other data formats used in 3D Printing Technology.
- To know the features of various 3D Printing software's.
- To know diversified applications of 3D Printing Technologies.

Course Outcomes:

1. Interpret the features of 3D Printing and compare it with conventional methods.
2. Illustrate the working principle of liquid, solid and powder based 3D Printing Technologies.
3. Identify various types of errors in STL file and other data formats used in 3D Printing Technology.
4. Select suitable software used in 3D Printing Technology.
5. Apply the knowledge of various 3D Printing technologies for developing innovative applications.

UNIT- I

Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, 3D Printing wheel, Commonly used Terms, Classification of 3D printing processes, Fundamental Automated Processes: Distinction between 3D Printing and Conventional Machining Processes.

UNIT-II

Liquid-based 3D Printing Systems: Stereo Lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based 3D Printing System: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT- III

Powder Based 3D Printing Systems: Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following 3D Printing Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM),

UNIT-IV

3D Printing Data Formats & Software: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. 3D Printing Software's Features: Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing.

UNIT-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

Suggested Reading:

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
3. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
4. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265/

Course Code	Course Title						Course Type
OE 602 ME	**FINITE ELEMENT METHOD**						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To understand the theory and application of the finite element method for analyzing structural systems.
- To learn Approximation theory for structural problems as the basis for finite element methods.
- To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of element formulations will be examined using Matlab.
- To understand modeling and analysis of structures using planar, solid, and plate elements

Course Outcomes:

1. Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation.
2. Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models that adequately and efficiently represent physical systems.
3. Underlying the FEA as applied to solid mechanics.
4. Solve 2D vector variable problems and analyze higher order elements and its applications.
5. Create his/her own FEA computer programs using Matlab to solve simple engineering problems.

UNIT- I

Introduction: Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT-II

One-Dimensional Problems: One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.

UNIT- III

Two Dimensional Scalar Variable Problems: Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT-IV

Two Dimensional Vector Variable Problems: Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT-V

Isoparametric Formulation: Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Suggested Reading:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", Pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.

Course Code	Course Title					Course Type
PC 651 EE	**POWER ELECTRONICS LAB**					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	-	-	2	3	25	50	1

Course Objectives:

- To be able to understand R, RC and UJT firing circuits.
- To be able to understand choppers and Rectifiers.
- To be able to understand PWM methods for single phase inverters.
- To be able to understand AC voltage controllers and Cyclo converters.
  To be able to understand various converters through simulation.

Course Outcomes:

1. To analyze R, RC and UJT firing circuits through experiment.
2. To analyze Choppers and Rectifiers through experiment.
3. To analyze PWM methods for single phase inverters through experiment.
4. To analyze AC voltage controllers and Cyclo converters through experiment.
5. To analyze various converters through simulation.

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	-	-	3	3	-	2	2	3
CO2	3	3	3	2	2	-	-	-	3	3	-	2	2	3
CO3	3	3	3	2	2	-	-	-	3	3	-	2	2	3
CO4	3	3	3	2	2	-	-	-	3	3	-	2	2	3
CO5	3	3	3	2	3	-	-	-	3	3	-	2	2	3

LIST OF EXPERIMENTS:

1. Simulation of single phase and three phase AC voltage controller.
2. R, RC, UJT Trigger Circuits for SCR's.
3. Speed control of universal motors using choppers.
4. Study of single phase half and fully controlled rectifier.
5. Study of forced commutation techniques of SCRs.
6. Study of single phase and three phase AC voltage controller.
7. Study of single phase dual converter.
8. Study of single phase cyclo converter.
9. IGBT based PWM inverters.
10. Simulation of single phase half and fully controlled rectifier.
11. Simulation of single phase inverter & three phase inverter.
12. Study of SCR chopper.
13. Speed control of separately excited DC motor by controlled rectifier.
14. Design and fabrication of trigger circuits for single phase half-controlled and fully controlled bridge rectifiers.
15. Design and fabrication of trigger circuit for MOSFET chopper.

Note: At least ten experiments should be conducted in the Semester.

Suggested Reading:

1. Bimbra.P.S. - Power Electronics, Khanna Publications, 2022.

2. Rashid M.H. - Power Electronics Circuits, Devices and Applications - PHI, 2004.

3. Singh. M.D., Khanchandani K.B. - Power Electronics - TMH, 14th reprint, 1999.

4. Mohan, Undeland& Robbins - Power Electronic Converters. Applications and Design - John Wiley & Sons - 3rd Edition, 2007.

Course Code	Course Title					Course Type
PC 652 EE	DIGITAL SIGNAL PROCESSING LAB					Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	-	-	2	3	25	50	1

Course Objectives:

- To practically demonstrate Digital signal processing applications
- To familiarize with Code composer studio
- To configure interrupts for real time applications
- To demonstrate working of ADC
- To generate PWM waveforms

Course Outcomes:

1. Demonstrating Digital Signal processing concepts in MATLAB
2. Design of IIR and FIR filters
3. Develop software in assembly language for DSP processor for different applications
4. Interface the DSP processor with external circuitry for data acquisition
5. Generate PWM signals for motor drive applications using DSP processor

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	2	-	-	3	3	2	2	-	3
CO2	3	2	2	2	3	2	-	-	3	3	2	2	-	2
CO3	3	2	3	3	3	2	-	-	3	3	2	2	-	3
CO4	3	2	3	3	3	2	-	-	3	3	2	2	-	2
CO5	3	2	3	3	3	2	-	-	3	3	2	2	-	2

LIST OF EXPERIMENTS:

Experiments using MATLAB

1. Generation of discrete time signals.
2. Operations on discrete time signals
3. Implement and verify linear and circular convolution between two given signals.
4. Frequency response of a discrete time system (DTFT)
5. Compute and implement the N-point DFT of a given sequence.
6. Implement and verify N-point DIT-FFT of a given sequence and find the frequency response (magnitude and phase).
7. Implement and verify N-point IFFT of a given sequence.
8. Design IIR filters (Low PassFilter /High Pass Filter/Band pass/Band stop)
9. Design FIR filter (Low Pass Filter /High Pass Filter) using windowing technique.
10. Demonstration of Sampling Theorem and the aliasing phenomenon

Experiments using Digital Signal Processor

1. Familiarization of IDE and code-composer studio for arithmetic and logical operations.
2. Addressing modes and instruction set of the DSP processor
3. Study of fixed-point arithmetic for the DSP processor
4. Study of digital I/O lines of the DSP processor
5. Study of Interrupts of DSP processor to implement real-time applications
6. Study of ADC of DSP processor
7. Generation of PWM signals for power electronic applications using the DSP processor
8. Measurement of speed of a motor with shaft encoder using the capture units and QEP of the DSP processor
9. Implementation of Digital Filters using the DSP processor

Course Code	Course Title						Course Type
PW 651 EE	MINI – PROJECT						Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	-	-	6	-	50	-	3

Course Objectives:

- Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
- Design, implement and test the prototype/algorithm in order to solve the conceived problem.
- Write comprehensive report on mini project work.

Guidelines:

1. The mini-project is a team activity having 3-4 students in a team.
2. The mini project may be a complete hardware or a combination of hardware and software.
3. Mini Project should cater to a small system required in laboratory or real life.
4. It should encompass components, devices, with which functional familiarity is introduced.
5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
8. Work can be implemented using any software.
9. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Course Code	Course Title						Course Type
PW 752 EE	SUMMER INTERNSHIP						Core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	-	-	-	-	50	-	2

Internship Objectives:

- Will expose Technical students to the industrial environment, which cannot be simulated in theclassroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerialskills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Gain experience in writing Technical reports/projects.
- Expose students to the engineer's responsibilities and ethics.
- Familiarize with various materials, processes, products and their applications along with relevantaspects of quality control.
- Promote academic, professional and/or personal development.
- Expose the students to future employers.
- Understand the social, economic and administrative considerations that influence the workingenvironment of industrial organizations
- Understand the psychology of the workers and their habits, attitudes and approach to problem solving.

Internship Outcomes:

1 Understand the actual industrial environment and tuned to readily accept the works for execution.

2 Generate detail project reports and understand industry administration and finance. machines.

3 Troubleshoot problems with more confidence.

4 Design systems/products following standard procedures and norms.

5 Interact with fellow workers and manage the activities efficiently.

INTERNSHIP ACTIVITIES

During summer vacation after 6th sem.

Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise/ Online Internship.

INTERNSHIP REPORT

(a) Student's diary/ daily log

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students‟ thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions,information gathered and suggestions given, if any.

It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit.
Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

(b) Internship report

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor and Faculty

Mentor. The Internship report will be evaluated on the basis of following criteria:

i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.
v. Practical applications, relationships with basic theory and concepts taught in the course.

EVALUATION THROUGH SEMINAR PRESENTATION/VIVA-VOCE

The student will give a seminar based on his training report, before an expert committee constituted bythe Department as per norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with theinternship report.

Seminar presentation will enable sharing knowledge & experience amongst students & teachers andbuild Communication skills and confidence in students.

*Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and the credits will be awarded after evaluation in VII semester.