## CSE-INTERNET OF THINGS

(For the batches admitted from the academic year 2021-22)

**Vision**

* To be a recognized Centre in the field of Computer Science and Engineering by imparting quality education and also equipping the students with latest technologies, soft skills and ethical values to face the challenges in industry & society.

**Mission**

* To provide quality education by imparting state of the art facility in Computer Science and Engineering.
* Enrich the students with innovative and problem-solving skills by establishing continuous Industry Institute interaction.
* To prepare the learners possessing social commitment and ethical values to face the dynamic challenges of industry and society.

**Institutional Objectives**

* To create a conducive and competitive environment for students through curricular and extra-curricular activitiPBRVITeS s.
* Promote the culture of research among the faculty.
* To promote synergetic alliances with premier Institutions, Industry, CSIR laboratories and various Government organizations for Collaborative Research Projects.
* To promote economic and social enrichment of the society through Skill Development programmes, Entrepreneurship and extension activities.
* To introducedemand driven new UG&PG academic programmes.
* To ensure a high degree of quality in terms of providing infrastructure, research ambience, faculty and staff development.

**Core Values**

* *Thirst for Quality Education:* The stake holders of the institute particularly management, employees and students of the institution have a consistent thirst for quality improvement of the processes and services in the institution.
* *Lifelong Learning:* In the fast-changing technological world, acquiring a special skill at one point of time will not be enough for ever long survival. Hence to

flourish in the work place and to bring in innovations in the ways of doing, employee, student as well as alumni must be continuous learners and tech savvy.

* *Diversity and Participation:* PBRVITS promotes the involvement of faculty, staff and students from all social, economic, ethnics, cultural and religious backgrounds to get the synergy of combining the diversified agents. The focus is on involving students to exhibit their talent in various curricular and co- curricular activities and strengthening alumni link to share their experiences to the students.
* *Academic Integrity and Accountability:* Management induces accountability in the employees for the career of the students and the academic leadership establishes a mentoring mechanism for realization of responsibilities of students towards their parents and in turn to the society.

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**Semester I (First year)**

## CSE - INTERNET OF THINGS

(For the batches admitted from the academic year 2021-22)

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| **INDUCTION PROGRAM (3 weeks duration)** |
| * Physical activity * Creative Arts * Universal Human Values * Literary * Proficiency Modules * Lectures by Eminent People * Visits to local Areas * Familiarization to Dept./Branch & Innovations |

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| **S.No** | **Category** | **Course Code** | **Course Title**  PBRVITS | **Hours per**  **week** | | | **Credits** | **CIE** | **SEE** | **Total** |
| **L** | **T** | **P** | **C** |
| 1 | BS | 21A110101 | Calculus and Special Functions | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 2 | BS | 21A110105 | Applied Chemistry | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 3 | ES | 21A050302 | C-Programming & Data Structures | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 4 | BS | 21A110106 | Engineering Physics | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 5 | HSMC | 21A110202 | English for Professionals | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 6 | ES | 21A050301 | Engineering & IT  Workshop | 0 | 0 | 3 | 1.5 | 30 | 70 | 100 |
| 7 | BS | 21A110109a | Engineering Physics Lab | 0 | 0 | 2 | 1 | 30 | 70 | 100 |
| 8 | BS | 21A110108b | Applied Chemistry Lab | 0 | 0 | 2 | 1 | 30 | 70 | 100 |
| 9 | ES | 21A050303 | C-Programming & Data Structures Lab | 0 | 0 | 3 | 1.5 | 30 | 70 | 100 |
| **Total** | | | | | | | **20** |  |  | **900** |

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| **Course Code** | **CALCULUS AND SPECIAL FUNCTIONS**  (Common to all branches) | | **L** | **T** | **P** | **C** |
| **21A110101** | **3** | **1** | **0** | **3** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES**:

* This course will illuminate the students in the concepts of calculus and Mean value thorems.
* To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real- world problems and their applications.

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Utilize mean value theorems to real life problems.

**CO2:** Familiarize with functions of several variables which is useful in optimization.

**CO3:** Students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional coordinate systems.

**CO4:** Students will also learn important tools of calculus in higher dimensions. Students will become familiar with 3- dimensional coordinate systems.

**CO5**: Utilize special functions in evaluating definite integrals.

**CO-PO MAPPING:**

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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO3 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO4 | 3 | 2 | 2 | 3 | - | - | - | - | - | - | - | 2 | 1 | - | - |
| CO5 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | 1 | - | - |

## UNIT – I (10 Hrs)

**Mean Value Theorems:** Rolle’s Theorem, Lagrange’s mean value theorem, Cauchy’s mean value theorem, Taylor’s and Maclaurin theorems with remainders (without proof) related problems.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Translate the given function as series of Taylor’s and Maclaurin’s with remainders (L3)
* Analyze the behaviour of functions by using mean value theorems (L3)

## UNIT – II (12 Hrs)

**Multi variable calculus:** Partial derivatives, total derivatives, chain rule, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Find partial derivatives numerically and symbolically and use them to analyze and interpret the way a function varies. (L3)
* Acquire the Knowledge maxima and minima of functions of several variable (L1)
* Utilize Jacobian of a coordinate transformation to deal with the problems in change of variables (L3)

## UNIT – III (10 Hrs)

**Double Integrals:** Evaluation of Double integrals, change of order of integration, change of variables. Areas using Double Integrals.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Evaluate double integrals of functions of several variables in two dimensions using Cartesian and polar coordinates (L5)
* Apply double integration techniques in evaluating areas bounded by region (L4)

## UNIT – IV (10 Hrs)

**Triple Integrals:** Evaluation of triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates, volumes using triple integrals.

***Learning Outcomes:*** At the end of this unit, studPBRVITS ents should be able to

* Evaluate triple integrals in Cartesian, cylindrical and spherical polar coordinates. (L5)
* Apply triple integration techniques in evaluating volumes.(L4)

## UNIT – V (12 Hrs)

**Beta and Gamma functions:** Beta and Gamma functions and their properties, relation between beta and gamma functions,evaluation of definite integrals using beta and gamma functions.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Understand beta and gamma functions and its relations (L2)
* Conclude the use of special function in evaluating definite integrals (L4)

## TEXTBOOKS:

1. Higher Engineering Mathematics,B. S. Grewal, 44/e, Khanna Publishers, 2017.
2. Advanced Engineering Mathematics, Erwin Kreyszig,10/e, John Wiley & Sons, 2011.

## REFERENCE BOOKS:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar,3/e, Alpha Science International Ltd., 2002.
2. Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Thomas,13/e, Pearson Publishers, 2013.
3. Advanced Modern Engineering Mathematics, Glyn James,4/e, Pearson publishers, 2011.
4. Advanced Engineering Mathematics,Micheael Greenberg, 9th edition, Pearson Education
5. Advanced Engineering Mathematics with MATLAB, Dean G. Duffy,CRC Press
6. Advanced Engineering Mathematics, Peter O’neil, Cengage Learning.
7. Engineering Mathematics Volumes-I &II, R.L. Garg NishuGupta ,Pearson Education
8. Higher Engineering Mathematics, B. V. Ramana, McGraw Hill Education
9. Higher Engineering Mathematics, H. k Das, Er. RajnishVerma, S. Chand.
10. Advanced Engineering Mathematics,N. Bali, M. Goyal, C. Watkins, Infinity Science Press.
11. Engineering Mathematics, T.K.V Iyengar, B. Krishna Gandhi, S.Ranganatham,

M.V.S.S.N Prasad ,S. Chand.

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| **Course Code** | **APPLIED CHEMISTRY**  (Common to EEE, ECE, CSE, CSE-AI & CSE-IOT) | | **L** | **T** | **P** | **C** |
| **21A110105** | **3** | **1** | **0** | **3** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* To familiarize Applied chemistry and applications.
* To train the students on the principles and applications of electrochemistry and polymers.
* To introduce instrumental methods and applications.

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Explain the salient features of different theories along with their applications.

**CO2:** Discuss about the model engineering materials.

**CO3:** Apply the knowledge of various electrodes for the development of new batteries.

**CO4:** Identify the different polymers and their uses in various fields of engineering.

**CO5:** Analyze the knowledge of different analytical techniques used in engineering and also development of new techniques.

**CO-PO MAPPING:**

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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | - | - | PBRVITS - | - | - | - | - | - | - | - |
| CO2 | 3 | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | - | - | - | - |

## UNIT-I (14 Hrs)

**Structure and Bonding Models:** Planck's quantum theory, dual nature of matter, Schrodinger equation, significance of Ψ and Ψ2, Molecular orbital theory –bonding in homo and hetero nuclear diatomic molecules – energy level diagrams of O2 and CO, π-molecular orbital’s of butadiene and benzene, calculation of bond order. Crystal field theory–salient features– splitting in octahedral and tetrahedral geometry.

***Learning Outcomes:*** At the end of this unit, students should be able to

* + Illustrate the molecular orbital energy level diagram of different molecular species (L2)
  + Discuss the basic concept of molecular orbital theory (L3)
  + Explain the calculation of bond order of O2 and CO molecules (L2)
  + Discuss the salient features of Crystal field theory (L3)

## UNIT-II (10 Hrs)

**Modern Engineering Materials**: Band theory of solids- band diagrams for conductors, Insulators, Semiconductors, Effect of doping on band structures. Super conductors and Super capacitors: Introduction, Definition, Classification, Applications.

Nano chemistry: Introduction, classification of nano materials, properties and applications of Fullerenes, carbon nanotubes and Graphene nanoparticles.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Explain the band theory of solids for conductors, semiconductors and insulators (L2)
* Demonstrate the application of Fullerenes, carbon nanotubes and Graphenes nanoparticles (L2).

## UNIT-III (13 Hrs)

**Electro Chemistry and Applications:** Electrodes and their concepts, Types of Reference electrodes-their applications. Electrochemical cell, Nernst equation, Numerical problems on emf.

Primary cells – Zinc-air battery, Secondary cells – Lead-acid and Lithium-ion batteries-working of the batteries including cell reactions; Fuel cells- hydrogen-oxygen, methanol- oxygen fuel cells – working of the cells.

Potentiometry- principle, potentiometric titrations (redox titrations), Conductometry-conducto

metrictitrations (acid-base titrations).

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Electrochemical sensors– potentiometric sensors principle with examples, ampere metric sensors principle with examples and their applications.

***Learning Outcomes:*** At the end of this unit, students should be able to

* + Apply the Nernst equation for calculating electrode and cell potentials (L3)
  + Differentiate between potentiometric and conductometric titrations (L2)
  + Explain the theory of construction of battery and fuel cells (L2)

## UNIT-IV (13 Hrs)

**Polymer Chemistry:** Introduction to polymers, functionality of monomers and their significance, Tacticity of polymers, Types of polymerization- chain growth, step growth and copolymerization with specific examples and mechanisms of polymer formation.

Plastomers-Thermoplastics and Thermo setting plastics, Preparation, properties and applications of– PVC, Teflon, Bakelite, Nylons.

Elastomers – Buna-S, Buna-N– preparation, properties and applications of Buna-S, Buna-N. Conducting polymers, examples, classification, polyacetylene, polyaniline - mechanism of conduction and applications.

***Learning Outcomes****:* At the end of this unit, students should be able to

* + Explain the different types of polymers and their applications (L2)
  + Explain the preparation, properties and applications of Bakelite, Nylons (L2)
  + Describe the mechanism of conduction in conducting polymers (L2)
  + Discuss Buna-S and Buna-N and their applications (L2)

## UNIT-V (10 Hrs)

**Instrumental Methods and Applications:** Introduction, Electromagnetic spectrum. Absorption of radiation: Beer-Lambert’s law- Principle, instrumentation and applications of UV-Visible**,** IR- Spectroscopy’s and pH-metry, Solid-Liquid Chromatography–TLC, retention factor.

***Learning Outcomes****:* At the end of this unit, students should be able to

* + Explain the different types of spectral series in electromagnetic spectrum (L2)
  + Understand the principles and applications of different analytical instruments (L2)

## TEXTBOOKS:

1. Engineering Chemistry, Jain and Jain, Dhanpat Rai publications, 2018, 17/e,
2. Engineering Chemistry, Shashai Chawla, Dhanpat Rai publications, 2014, 2/e
3. Principles of Instrumental Analysis, Skoog, FJ Holler and SR Crouch, 2018, 7/e
4. Applied Chemistry, Guesser, Springer’s Publications, 2001
5. Physical Chemistry, Peter Atkins, Juliode Paula and James Keeler, Atkins, Oxford University Press, 2010, 10/e,

## REFERENCE BOOKS:

PBRVITS

1. Concise Inorganic Chemistry, J.D.Lee, Oxford University Press, 2008, 5/e
2. Engineering Chemistry, G.V.SubbaReddy, K.N.Jayaveera and Ramachandraiah McGrawHill, 2020.

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| **Course Code** | **C-PROGRAMMING & DATA STRUCTURES**  (Common to all branches) | | **L** | **T** | **P** | **C** |
| **21A050302** | **3** | **1** | **0** | **3** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* Introduce the Concept of Algorithm and use it to solve computational problems
* To illustrate the basic concepts of C Programming language
* Demonstrate the use of Control structures of C Programming language
* To discuss the concepts of Arrays, Functions, Pointers and Structures
* To familiarize with Stack, Queue and Linked lists data structures

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Solve computational problems, choose appropriate control structure depending on the problem to be solved.

**CO2:** Design applications in C using Arrays and Strings.

**CO3:** Modularize the problem and also solution.

**CO4:** Design applications in C using Functions, Pointers, and Structures.

**CO5**: Explore various operations on Stacks, Queues and Linked lists.

**CO-PO MAPPING:**

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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | - | - |
| CO2 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 1 | - | 3 |
| CO3 | 3 | 3 | 1 | 3 | - | - | - | - | - | - | - | - | 1 | - | - |
| CO4 | 3 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | 3 |
| CO5 | 1 | 2 | 3 | 1 | - | - | - | - | - | - | - | - | - | 2 | 3 |

## UNIT-I (15 Hrs)

**Computer Fundamentals,** Algorithm, Flowchart.

**Introduction to C Language:** Characteristics, Identifiers, Constants, Data types, Keywords, Basic input/output statements, Structure of a C program.

**Operators and Expressions:** Operators classification, Assignment Operator, Arithmetic Operators, Relational and Logical Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators with examples – Operator precedence and Associativity, Type casting.

**Statements:** Simple and Compound statements, Control Statements - Conditional/Decision statements, Loop Control Statements, Branch Control statements.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Solve complex problems using language independent notations (L3)
* Use C basic concepts to write simple C programs (L3)
* Test and execute the programs and correct syntax and logical errors (L4)
* Select the control structure for solving the problem (L4)
* Implement conditional branching, iterations (L2)

## UNIT-II (12 Hrs)

**Arrays:** Declarations, Initialization and accessing elements, Single, Two and Multi-dimensional arrays.

**Array Techniques:** Array order reversal, finding the maximum and minimum number in a set, sorting the given array elements.

**Strings:** String I/O functions, String handling functions, Data conversion functions.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Use arrays to process multiple homogeneous data (L3)
* Solve mathematical problems using C Programming languages (L3)
* Apply string handling functions (L3)

## UNIT-III (12 Hrs)

**Functions:** Types of functions, Library functions, User-defined functions, Function Categories, Nested functions, Recursion, Symbolic constants, Pre-processor Commands, Storage classes – auto, register, static, extern, Type qualifiers.

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**Input and output:** Standard input and output, Non-formatted Input and Output statements, Formatted Input and Output statements.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Understand basic terminology of modular programming (L2)
* Apply modular approach for solving the problem (L3)
* Writing C programs using various storage classes to control variable access (L5)
* Apply input and output statements to process the data in various formats (L3)

## UNIT-IV (12 Hrs)

**Pointers:** Pointers and addresses, Passing parameters to functions, Address Arithmetic operations, Void and Null pointers, Pointer and Arrays, Pointer and Strings, Array of Pointers, Pointer and Functions, Pointer-to-Pointer, Dynamic Memory Allocation. Uses of Pointers, Command line Arguments.

**Structure and Union:** Declaration and Initialization of a structure, Copy and comparisons, Array of structures, Structure with pointer, Nested structures, Type Definition, Enumeration, Union.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Structure the individual data elements to simplify the solutions (L6)
* Facilitate efficient memory utilization (L6)
* Use pointers and structures to formulate algorithm and write programs (L3)

## UNIT-V (14 Hrs)

**Data Structures:** Overview of data structures, **Stack:** Representation of a stack, Operations and Applications of a Stack – Evaluation of Arithmetic Expressions, Implementation of Recursion – **Queue:** Representation of a queue, Operations and Applications of a Queue – CPU Scheduling in Multi-programming Environment.

**Linked List:** Representations of linked lists, singly linked list, doubly linked list, Circular linked list and its operations.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Describe the operations of a stack (L2)
* Develop various operations on Queues (L6)
* Analyze various operations on singly linked list (L4)
* Interpret operations of doubly linked lists (L2)
* Apply various operations on Circular linked lists (L6)

## TEXTBOOKS:

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1. “The Complete Reference C” Herbert Schildt – McGraw Hill Education, Fourth Edition
2. “Programming in C and Data Structures” – J.R. Hanly, Ashok N Kamthane and A. Ananda Rao – Pearson Education.
3. “Fundamentals of Data Structures in C” – Ellis Horowitz, Sartaj Sahni, Susan Anderson- Freed - Computer Science Press, Second Edition

## REFERENCE BOOKS:

1. The C Programming Language, Brain W Kernighan and Dennis M Ritchie, Prentice Hall Publication, Second Edition,
2. “C and Data Structures”, E Balaguru swamy, Tata McGraw Hill, Fourth Edition,
3. “Programming in C”, Pradip Dey and Manas Ghosh, Oxford University Press, 2018.
4. “Data Structures”, Schaum’ Outlines – Seymour Lipschutz – McGraw Hill – Revised First Edition.

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| **Course Code** | **ENGINEERING PHYSICS**  (Common to EEE, ECE & CSE) | | **L** | **T** | **P** | **C** |
| **21A110106** | **3** | **1** | **0** | **3** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* To present the basic concepts needed to understand the crystal structure of materials, X- ray diffraction and the importance of nano materials.
* To understand the mechanisms of lasers and propagation of light through optical fibres along with engineering applications.
* To explain the significant concepts of dielectric and magnetic materials that leads to potential applications in the emerging micro devices.
* To explain the significance of acoustics and ultrasound in different engineering fields.
* Evolution of band theory to distinguish materials and explain the properties of semiconductors.

**COURSE OUTCOMES:**

After the completion of the course, the student will be able to

**CO1:** Explain the important properties of crystals & structure determination using X-ray Diffraction along with the nano materials.

**CO2:** Identify the importance of of lasers and fiber optics in different engineering fields

**CO3:** Understands the response of dielectric & magnetic materials to the applied electric & magnetic

fields

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**CO4:** Explain the basic concepts of acoustics and ultrasonics.

**CO5:** Elaborate the physical properties of semiconductors.

**CO-PO MAPPING:**

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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| CO3 | 3 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |

## UNIT-I (12 Hrs)

**Crystallography & Nano materials**

**Crystallography:** Introduction – Space lattice – Unit cell – Lattice parameters – Bravias lattice – Crystal systems – Packing fractions of SC, BCC and FCC - Directions and planes in crystals – Miller indices – Interplanar spacing in cubic crystals – X-ray diffraction - Bragg’s law – Laue Method - Powder method.

**Nano materials** – Introduction – Surface area and quantum confinement – Physical properties: electrical and magnetic properties – Synthesis of nanomaterials: Top-down: Ball

Milling – Bottom-up: Chemical Vapour Deposition – Applications of nanomaterials.

***Learning Outcomes****:* At the end of this unit, students should be able to

* Classify various crystal systems (L2)
* Identify different planes in the crystal structure (L3)
* Analyze the crystalline structure by Bragg’s law to measure the crystallinity of a solid by powder method (L4)
* Identify the nano size dependent properties of nano materials (L2)
* Illustrate the methods for the synthesis and characterization of nano materials (L2)

## UNIT - II (12 Hrs)

**Lasers and Fiber optics**

**Lasers**- Introduction – Characteristics of laser – Spontaneous and Stimulated emission of radiation – Einstein’s coefficients – Population inversion – Lasing action – Pumping mechanisms – Nd-YAG laser – He-Ne laser – Applications of lasers.

**Fiber optics**- Introduction – Principle of optical fiber – Acceptance Angle – Numerical Aperture – Classification of optical fibers based on refractive index profile and modes – Transmission of signals in step index and graded index fibers – Propagation Losses (qualitative) – Applications of fiber in medical field .

***Learning Outcomes****:* At the end of this unit, students should be able to

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Understand the basic concepts of LASER light Sources (L2)

* Apply the concepts to learn the types of lasers (L3)
* Identifies the Engineering applications of lasers (L2)
* Explain the working principle of optical fibers (L2)
* Classify optical fibers based on refractive index profile and mode of propagation (L2)
* Identify the applications of optical fibers in various fields (L2)

## UNIT – III (12 Hrs)

**Dielectric Materials**- Introduction – Dielectric polarization – Dielectric polarizability, Susceptibility and Dielectric constant – Types of polarizations: Electronic, Ionic and Orientation polarizations (Qualitative) – Lorentz internal field – Clausius-Mossotti equation. **Magnetic Materials**- Introduction – Magnetic dipole moment – Magnetization – Magnetic susceptibility and Permeability – Origin of permanent magnetic moment – Classification of magnetic materials: Dia, para & Ferro-Domain concept of Ferromagnetism (Qualitative) – Hysteresis – Soft and Hard magnetic materials.

***Learning Outcomes****:* At the end of this unit, students should be able to

* Explain the concept of dielectric constant and polarization in dielectric materials (L2)
* Summarize various types of polarization of dielectrics (L2)
* Interpret Lorentz field and Clausius - Mosotti relation indielectrics (L2)
* Classify the magnetic materials based on susceptibility and their temperature dependence (L2)
* Explain the applications of dielectric and magnetic materials (L2)

## UNIT - IV (13 Hrs)

**Acoustics and Ultrasonics**

**Acoustics**- Introduction – Requirements of acoustically good hall – Reverberation – Reverberation time – Sabine’s formula (Derivation using growth and decay method ) – Absorption coefficient and its determination – Factors affecting acoustics of buildings and their remedies.

**Ultrasonics-** Introduction – Properties – Production by magneto striction and piezoelectric methods – Detection – Acoustic grating – Non Destructive Testing – Applications.

***Learning Outcomes****:* At the end of this unit, students should be able to

* Explain how sound is propagated in buildings (L2)
* Analyze acoustic properties of typically used materials in buildings (L4)
* Recognize sound level disruptors and their use in architectural acoustics (L2)
* Identify the use of ultrasonics in different fields (L3)

## UNIT - V (13 Hrs)

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**Semiconductors**- Origin of energy bands - Classification of solids into conductors, semiconductors and insulators -Intrinsic and extrinsic semiconductors (Qualitative treatment)– Density of carriers and Fermi levels in intrinsic & extrinsic semiconductors Drift & diffusion currents and Einstein’s equation – Hall effect - Direct and indirect band gap semiconductors.

***Learning Outcomes****:* At the end of this unit, students should be able to

* Classify the energy bands of semiconductors (L2)
* Interpret the direct and indirect band gap semiconductors (L2)
* Identify the type of semiconductor using Hall effect (L2)
* Identify applications of semiconductors in electronic devices (L2)

## TEXTBOOKS:

1. Engineering Physics, Dr.M.N.Avadhanulu & Dr.P.G.Kshirsagar, S.Chandand Company.
2. Engineering Physics, B.K. Pandey and S. Chaturvedi, Cengage Learning.
3. Engineering Physics, K. Thyagarajan, McGraw Hill publishers.

## REFERENCE BOOKS:

1. Engineering Physics, Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018.
2. Engineering Physics, Sanjay D. Jain, D. Sahasrambudhe and Girish, University Press.
3. Semiconductor physics and devices-Basic principle, Donald A, Neamen, McGraw Hill.
4. Engineering physics, P.K. Palanisamy, Scitech Publications.
5. Applied Physics, S. Mani naidu, Pearson Publications.
6. Lasers and Non-Linear Optics by B.B.Laud new age International Publishers

PBRVITS

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| **Course Code** | **ENGLISH FOR PROFESSIONALS**  (Common to all branches) | | **L** | **T** | **P** | **C** |
| **21A110202** | **3** | **1** | **0** | **3** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* To improve Reading and Writing proficiency of students in English with an emphasis on Vocabulary development.
* To provide knowledge of grammatical structures and encourage their appropriate use in writing.
* To improve students’ comprehension skills required for academic and professional needs.
* To equip students with writing skills required for professional correspondence in different contexts.

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Demonstrate word knowledge and its usage in appropriate contexts.

**CO2:** Recognize and incorporate basic grammar mechanics and sentence variety in writing.

**CO3:** Improve comprehension skills through intensive and extensive reading practice.

**CO4:** Learn and apply various writing formats for effective communication.

**CO5:** Improve writing skills needed for professional correspondence in various contexts.

**CO-PO MAPPING:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PBRVPITS O8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | - | 2 |  | - | - | - | - | - | - | 3 | - | 2 | - | - | - |
| CO2 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO3 | - | 3 | - | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO4 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO5 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |

## UNIT-I (10 Hrs)

**Vocabulary Building:** Introduction to affixes and base words, Prefixes and suffixes, Basic comparing and contrasting, Idioms and Phrases, One word substitutes, Words often confused, Synonyms and Antonyms used in the everyday contexts, Using prior knowledge to determine the correct word for the context, Discovering the correct word in the sentence by looking at the surrounding words, Vocabulary in social interactions.

***Learning Outcomes:*** At the end of this unit, students should be able to

* Recognize word parts: affixes, prefixes, suffixes and base words. (L2)
* Use words appropriately in a context. (L3)
* Guess the meanings of the words by using the contextual clues. (L2)
* Use synonyms, antonyms, phrases and idioms in writing. (L2)

## UNIT-II (10 Hrs)

**Essentials of Sentence Formation:** Basic Sentence Structure, word order, Subject-Verb Concord, Using Tenses, Punctuation Marks, Correction of Common Errors

***Learning Outcomes:*** At the end of this unit, students should be able to

* Frame a sentence without any grammatical errors. (L3)
* Use appropriate punctuation marks. (L3)
* Identify common errors in a sentence. (L2)

## UNIT-III (10 Hrs)

**Reading Comprehension:** Understanding short real world notices, messages, factual material - Scanning, skimming - Inferring meaning - Critical reading - Reading and information transfer ***Learning Outcomes:*** At the end of this unit, students should be able to

* Use skimming and scanning strategies while reading. (L3)
* Infer meaning from the given text. (L3)
* Distinguish between the main idea and supporting ideas. (L3)
* Critically analyse the given text. (L4)

## UNIT-IV (10 Hrs)

**Writing Skills:** Rules for good writing and composition; Paragraph Writing: Structure of a paragraph, Types of paragraphs, Usage of CohPBRVITSesive Devices; Essay writing : Structure of an Essay, Types of Essays; Letter Writing (Formal and informal): Format and Structure; and Email writing

***Learning Outcomes:*** At the end of this unit, students should be able to

* Learn to organize thoughts into meaningful paragraphs. (L2)
* Use cohesive devices in making the piece of writing more coherent. (L3)
* Compose essays on different topics in a more organised structure. (L3)
* Draft letter and emails in a definite format. (L3)

## UNIT-V (10 Hrs)

**Professional Correspondence:** Internal Correspondences – Memorandum, Note Taking, Minutes of Meetings; External Correspondences - Business Letters - Cover Letters - Sale Letters

* Inquiry Letters - Complaint Letters - Emails & Netiquette

***Learning Outcomes:*** At the end of this unit, students should be able to

* + Draft official e-mails and letters for different professional purposes. (L3)
  + Write proficiently memos and minutes of meeting. (L3)

## TEXTBOOKS:

1. Technical Communication – Principles and Practice, by MEENAKSHI RAMAN, SANGEETA SHARMA, Oxford University Press

## REFERENCE BOOKS:

1. A Textbook of English Phonetics for Indian Students – by T. BALASUBRAMANIAN, Mc Millan India Pvt
2. English Vocabulary in Use – by MIECHEL Mc CARTHY, Cambridge University Press
3. Strengthen your English – by BHASKARAN, HORSBURGH, Oxford University Press
4. Practical English Usage – by MIECHEL SWAN, Oxford University Press

## ONLINE SOURCES FOR PRESCRIBED READING TEXTS:

1. <https://digital.library.upenn.edu/women/sultana/dream/dream.html>
2. <https://owl.purdue.edu/>
3. <https://www.thesaurus.com/>
4. <https://www.readwritethink.org/classroom-resources/student-interactives>
5. <https://www.fluentu.com/blog/english/english-writing-websites/>

PBRVITS

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| **Course Code** | **ENGINEERING & IT WORKSHOP LAB**  (Common to all branches) | | **L** | **T** | **P** | **C** |
| **21A050301** | **0** | **0** | **3** | **1.5** |
| Pre-requisite | NIL | Semester | I | | | |

## PART-A (ENGINEERING WORKSHOP)

**COURSE OBJECTIVES:**

* To familiarize the students with wood working, sheet metal operations, fitting and electrical house, Wiring and foundry skills.
* To provide technical training to the students on Word, Excel and Presentation.
* To make the students know about the internal parts of a computer.
* To learn how to use Internet facility for Browsing and Searching.

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Apply wood working skills and Build different parts with metal sheets in real world applications.

**CO2:** Apply fitting operations in various applications and Preparation of moulds and castings.

**CO3:** Apply different types of basic electric circuit connections.

**CO4:** Prepare documentation, spread sheets for calculations and slides for Presentation.

**CO5:** Identify Computer peripherals and its functions , Internet browsing to obtain therequired

information

**CO-PO MAPPING:**

PBRVITS

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 2 | - | - | - | - | - | 2 | 1 | - | - |
| CO2 | 3 | 2 | 2 | - | - | 2 | - | - | - | - | - | 2 | 1 | - | - |
| CO3 | 3 | 2 | - | - | - | 2 | - | - | - | - | - | 2 | 1 | 2 | - |
| CO4 | 3 | - | - | - | - | 2 | - | - | - | - | - | 2 | - | 2 | 3 |
| CO5 | 3 | 2 | - | - | - | 2 | 2 | - | - | - | - | 2 | - | 2 | 3 |

## LIST OF TOPICS:

**Wood Working:** Familiarity with different types of woods and tools used in wood working and make following joints

a) Half – Lap joint b) Dovetail joint or Bridle joint

**Sheet Metal Working:** Familiarity with different types of tools used in sheet metal working,

Developments of following sheet metal job from GI sheets

a) Tapered tray b) Conical funnel

**Fitting:** Familiarity with different types of tools used in fitting and do the following fitting exercises

a) V-fit b) Square fit.

**Electrical Wiring:** Familiarities with different types of basic electrical circuits and make the following connections

1. Parallel and series b) Two way switch c) Godown lighting

## Foundry:

* 1. Preparation of mould cavity using single piece pattern.
  2. Preparation of mould cavity using split piece pattern

## PART-B (IT WORKSHOP)

**LIST OF TOPICS:**

## Task 1:

MS-Word : Students should be able to create documents using the word processor tool. Alignment of the lines, Inserting header and Footer, changing the font, changing the color, including images and tables in the word file, making page setup, copy and paste block of text, images, tables, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Students should be able to prepare project cover pages, content sheet and chapter pages at the end of the task using the features studied. Students should submit report.

## Task 2:

PBRVITS

Spreadsheet: Students should be able to create, open, save the application documents

and format them as per the requirement. Creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells. Students should submit a user manual of the Spreadsheet.

## Task 3:

Presentations: creating, opening, saving the presentations, selecting the style for slides, formatting the slides with different fonts, colors, creating charts and tables, inserting and deleting text, graphics and animations, bulleting and numbering, running the slide show.

**Task 4:** Learn about Computer: Identify the internal parts of a computer, and its peripherals. Write specifications for each part of a computer including peripherals and specification of Desktop computer. Submit it in the form of a report.

## Task 5:

Browsing Internet: Student should access the Internet for Browsing. Students should

search the Internet for required information. Students should be able to create e-mail account and send email.

**REFERENCE BOOKS:**

1. WORKSHOP PRACTICE MANUAL/K.VENKATA REDDY, BS PUBLICATIONS.
2. Engineering work shop practice for JNTU, V. Ramesh babu, VRB PUBLISHERS PVT. LTD., 2009.
3. Work shop manual / P.KANNAIAH/ K.L.NARAYANA/ SCITECH PUBLISHERS.
4. Engineering practices lab manual, JEYAPOOVAN, SARAVANAPANDIAN, VIKAS 4/E
5. Dictionary of mechanical engineering, GHF NAYLER, JAICO PUBLISHING HOUSE.
6. Introduction to Computers, Peter Norton, McGraw Hill
7. MOS study guide for word, Excel, Power point& Outlook Exams, Joan Lambert, Joyce Cox.
8. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
9. Networking your computers and devices, Rusen, PHI
10. Trouble shooting, Maintaining & Repairing PCs, Bigelows, TMH

PBRVITS

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| **Course Code** | **ENGINEERING PHYSICS LAB**  (Common to ME, CSE-IOT & CSE-AI) | | **L** | **T** | **P** | **C** |
| **21A110109a** | **0** | **0** | **2** | **1** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* Understand the role of Optical fiber parameters in engineering applications.
* Recognize the significance of laser by studying its characteristics and its application in finding the wavelength.
* Understands the concepts of interference, diffraction and their applications.
* Verify the Laws of Stretched Strings by sonometer.

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Operate various optical instruments

**CO2:** Estimate wavelength of laser using laser

**CO3:** Evaluate the acceptance angle of an optical fiber and numerical aperture

**CO4:** Plot the intensity of the magnetic field of circular coil carrying current with distance

**CO-PO MAPPING:**

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|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | PBRVITS - | - | - | - | - | - | - | - |
| CO4 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | - | - |

## LIST OF EXPERIMENTS

1. Determine the thickness of the wire using wedge shape method
2. Determination of the radius of curvature of the lens by Newton’s ring method
3. Determination of wavelength by plane diffraction grating method
4. Determination of wavelength of LASER light using diffraction grating.
5. Determination of numerical aperture and acceptance angle of a given optical fiber
6. Magnetic field along the axis of a circular coil carrying current –Stewart Gee’s method.
7. Sonometer: Verification of the three laws of stretched strings
8. Determination of particle size using LASER.
9. Study the variation of B versus H by magnetizing the magnetic material.(B-H curve)
10. Determination of rigidity modulus of material of a wire -dynamic method. (Torsional Pendulum)

## REFERENCE BOOKS:

1. S. Balasubramanian, M.N. Srinivasan “A Textbook of Practical Physics”- S Chand Publishers, 2017.
2. <http://vlab.amrita.edu/index.php>-Virtual Labs, Amrita University

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| --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **APPLIED CHEMISTRY LAB**  (Common to EEE, ECE & CSE) | | **L** | **T** | **P** | **C** |
| **21A110108b** | **0** | **0** | **2** | **1** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* To get familiar with the basic concepts of Chemistry
* To verify the fundamental concepts withexperiments.

**COURSE OUTCOMES:**

After completion of the course, student will be able to

**CO1:** Distinguish different types of titrations in the volumetric analysis

**CO2:** Determine the cell constant and conductance of solutions

**CO3:** Measure the strength of an acid present in secondary batteries

**CO4:** Analyze the effect of absorbance of given sample solution on concentration by using colorimetry.

**CO5:** Prepare advanced polymer Bakelitematerials.

**CO-PO MAPPING:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | - | - | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | - | - | - | - |
| CO5 | 3 | 2 | - | - |  | - | - | - | - | - | - | - | - | - | - |

PBRVITS

## LIST OF EXPERIMENTS

1. Preparation of Standard Oxalic acid solution
2. Determination of Strength of an acid in Lead- Acid battery
3. Estimation of Ferrous Iron by Dichrometry
4. Potentiometry - Determination of redox potentials and emfs
5. Conductometry - Determination of cell constant and conductance of solutions.
6. Conductometric titration of a) strong acid vs strong base b) weak acid vs strong base.
7. PH-metric titration of a) strong acid vs strong base b) weak acid vs strong base.
8. Verification of the Beer-Lambert’sLaw and determination of strength of the given unknown solution.
9. Determination of the Retention factor of the sample by Thin Layer Chromatography (TLC).
10. Measurement of 10Dq by spectrophotometric method.
11. Preparation of Bakelite and measurement of its mechanical properties (strength)
12. Preparation of nanomaterial’s.

## TEXTBOOKS:

1. “A TEXT BOOK ON EXPERIMENTS AND CALCULATIONS IN ENGINEERING CHEMISTRY” 9/e, S. Chand Publications, 2003.
2. “ENGINEERING CHEMISTRY” Shashi Chawla, 2/e, DhanpatRai publications, 2014.
3. “EXPERIMENTS IN APPLIED CHEMISTRY” Dr.Sunita Rattan, 2/e, S.K.Kataria & Sons Publishers of Engineering, 2004.

## REFERENCE BOOKS:

1. “VOGEL’S TEXT BOOK OF QUANTITATIVE CHEMICAL ANALYSIS” Mendham J et.al, 6/e, Pearson Education,2012.

PBRVITS

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| **Course Code** | **C-PROGRAMMING & DATA** | | **L** | **T** | **P** | **C** |
| **21A050303** | **STRUCTURES LAB**  (Common to all branches) | | **0** | **0** | **3** | **1.5** |
| Pre-requisite | NIL | Semester | I | | | |

**COURSE OBJECTIVES:**

* To get familiar with the basic concepts of C Programming
* To make the student solve problems, implement algorithms using C language
* To design programs using arrays, strings, pointers and structures
* To design Stack and Queue operations
* To apply different operations o linked lists

**COURSE OUTCOMES:**

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

**CO1:** Demonstrate the basic concepts of C programming language.

**CO2:** Select the right control structure for solving the problem.

**CO3:** Develop C programs using functions, arrays, structures and pointers.

**CO4:** Illustrate the concepts Stacks and Queues.

**CO5**: Design operations on Linked lists.

**CO-PO MAPPING:**

PBRVITS

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 3 | - | - | - | - | - | - | - | 1 | - | - |
| CO2 | 2 | 2 | 2 | 1 | 3 | - | - | - | - | - | - | - | 1 | - | 3 |
| CO3 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - | - | - | 1 | - | - |
| CO4 | 2 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | 2 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | 2 | 3 |

## Week 1

1. Write a C program to swap the given two integer values without using temporary variable.
2. Write a C program to print the first ‘N’ Fibonacci sequence numbers.

## Week 2

1. Write a C program to print reverse of a given integer value.
2. Write a C program to find the roots of a quadratic equation.

## Week 3

Write a C program that use recursive functions.

* 1. GCD of given two values.
  2. Factorial of a given value.

## Week 4

1. Write a C program to find both the largest and smallest number in a list of integers.
2. Write a C program to perform the following:
   1. Addition of Two matrices ii) Multiplication of Two matrices

## Week 5

1. Write a C program that displays the position or index in the string S where the string T begins or -1 if S doesn’t contain T.
2. Write a C program to read a set of strings and sort them in alphabetical order.

## Week 6

1. Write a C program to count number of alphabets, digits and special symbols of a given line.
2. Write a C program to check whether a given string is palindrome or not.

## Week 7

Write a C program to demonstrate the difference between call-by-value and call-by-address mechanisms.

## Week 8

Write a program to perform the operations aPBdRVITS dition, subtraction, multiplication of complex numbers.

## Week 9

Write a C program that implement stack operations using arrays.

## Week 10

1. Write a C program that implement linear queue operations using arrays.
2. Write a C program that implement circular queue operations using arrays.

## Week 11

Write a C program that uses functions to perform the following operations on singly linked list.

i) Creation ii) Insertion iii) Deletion iv) Traversal

## Week 12

Write a C program that uses functions to perform the following operations on doubly linked list.

i) Creation ii) Insertion iii) Deletion iv) Traversal

## Week 13

Write a C program that uses functions to perform the following operations on circular linked list.

1. Creation ii) Insertion iii) Deletion iv) Traversal

## TEXTBOOKS:

* 1. “Programming in C and Data Structures” – J.R. Hanly, Ashok N Kamthane and A. Ananda Rao – Pearson Education.
  2. B.A. Forouzon and R.F. Gilberg, “COMPUTER SCIECE: A Structured Programming Approach Using C”, CENGAGE Learning, Third Edition, 2016.
  3. “C and Data Structures”, E Balaguruswamy, Tata McGraw Hill, Fourth Edition.
  4. “Data Structures”, Schaum’ Outlines – Seymour Lipschutz – McGraw Hill – Revised First Edition.

## REFERENCE BOOKS:

1. The C Programming Language, Brain W Kernighan and Dennis M Ritchie, Prentice Hall Publication, Second Edition,
2. “Fundamentals of Data Structures in C”– Ellis Horowitz, Sartaj Sahni, Susan Anderson- Freed - Computer Science Press– Second Edition.
3. “Programming in C”, Pradip Dey and Manas Ghosh, Oxford University Press, 2018.

PBRVITS

Differentiator, Integrator.

***Learning outcomes:*** At the end of this unit, students should be able to

* Describe operation of Op-Amp based linear application circuits, converters, amplifiers and non-linear circuits. (L2)
* Analyze Op-Amp based comparator, differentiator and integrator circuits. (L3)