CENTRAL UNIVERSITY OF PUNJAB BATHINDA

SYLLABUS

B. Tech Computer Science & Engineering

Batch 2024 & Onwards

Session – (2025-2029)

Department of Computer Science & Technology
Central University of Punjab, VPO-Ghudda, Bathinda, Punjab, India- 151401

Programme Educational Learning Outcomes

PELO–I: Students will establish themselves as effective professionals by solving real problems through the use of computer science knowledge and with attention to team work, effective communication, critical thinking and problem solving skills.
PELO–II: Students will develop professional skills that prepare them for immediate employment and for life-long learning in advanced areas of computer science and related fields.
PELO–III: Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies.
PELO–IV: Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career.
At graduation time, a student should have:

General Graduate Attributes	Discipline Graduate Attributes
G1 Ability to identify a problem, analyse using design thinking techniques, and evolve innovative approaches for solving it.	CS1 Proficiency in writing in at least two dissimilar programming languages programs of modest complexity which are: readable, tested for correctness, efficient, and secure
G2 Ability to apply mathematical concepts and techniques in problem solving.	CS2 Ability to design and apply appropriate algorithms and data structures for evolving efficient computing-based solutions for new problems.
G3 Ability to function effectively in multicultural teams to accomplish a common goal.	CS3 Understanding of computing systems at computer architecture, operating systems, and distributed- computing levels, and how they affect the performance of software applications.
G4 Ability to communicate effectively with a wide range of audience.	CS4 Understanding of theoretical foundations, fundamental principles, and limits of computing.
G5 Ability to self-learn and engage in lifelong learning and upgrade technical skills	CS5 Ability to analyse large volumes of data employing a variety of techniques for learning, better prediction, decision making, etc.
G6 An understanding of professional and ethical responsibility	ADVANCED/OPTIONAL GAs CS6 Ability to design, implement, and evaluate computer based system or application to meet the desired needs using modern tools and methodologies
G7 Ability to undertake small research tasks and projects.	CS7 Ability to develop full stack applications using one commonly used tech-stack and modern tool.
G8 An entrepreneurial mind set for opportunities using technology and innovations.	CS8 Understanding of and ability to use advanced techniques and tools in a few different domain areas (e.g. parallel processing, image processing, IR, …)
G9 An understanding of impact of solutions on economic, societal, and environment context.	CS9 Exposure to emerging technologies such as Cloud Computing, IoT, etc. G10 Strong emotional intelligence, human and cultural value

CENTRAL UNIVERSITY OF PUNJAB
(B. Tech. 2024 & Onwards)

Bachelors of Technology: It is an Under Graduate (UG) Programme of 4-year duration (8 semesters)
Eligibility for Admission: As per AICTE norms

Semester-I						
2-Week Orientation Programme and Bride Course						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	BSC-101	Physics-I	2	0	0	2
2.	BSCLC-101	Physics-I Lab	0	0	4	2
3.	BSC-102	Mathematics-I	3	1	0	4
4.	ESC-101	Basic Electrical Engineering	3	1	0	4
5.	ESCLC-101	Basic Electrical Engineering Lab	0	0	2	1
6.	ESC-102	Engineering Graphics & Design	1	0	4	3
7.	ESC-103	Programming for Problem Solving	3	0	0	3
8.	ESCLC-103	Programming for Problem Solving Lab	0	0	2	1
9.	MC-102	Design Thinking & IDEA Lab Workshop	3	0	0	3
10.	MCLC-102	Design Thinking & IDEA Lab Workshop - Lab	0	0	2	1
11.	MC-101	Mentoring and Professional Development	0	0	2	0
Total						**24**

Semester-II						
S. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	BSC-202	Fundamentals of Modern Computing	4	0	0	4
2.	BSC-201	Mathematics-II	3	1	0	4
3.	HSMC-201	Communication Skills	2	0	0	2
4.	HSLC-201	Communication Skills Lab	0	0	2	1
5.	ESC- 201	Object Oriented Programming Using C++	3	0	0	3
6.	ESCLC- 201	Object Oriented Programming Using C++	0	0	2	1

7.	ESC-202	Workshop/Manufacturing Practices	1	0	4	3
8.	AU-201	Sports and Yoga or NSS/NCC	0	0	2	1
9.	HSMC H-201	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	2	1	0	3
8.	MC- 201	Mentoring and Professional Development	0	0	2	0
Total						**22**

Semester-III						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	PCC CS-301	Introduction to Data Science	3	0	0	3
2.	PCC LC-301	Introduction to Data Science Lab	0	0	4	2
3.	PCC CS-302	Data structure and Algorithms	3	0	0	3
4.	PCC LC-302	Data structure and Algorithms Lab	0	0	4	2
5.	ESC-301	Digital Electronics	3	0	0	3
6.	ESCLC-301	Digital Electronics Lab	0	0	4	2
7.	ECS-302	IT Workshop	1	0	4	3
8.	BSC-301	Mathematics-III (Differential Calculus)	3	1	0	4
9.	HSMC-301	Humanities-I	3	0	0	3
Total						**25**

Semester-IV						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	PCC CS-401	Discrete Mathematics	3	1	0	4
2.	PCC CS-402	Computer Organization & Architecture	3	0	4	3
3.	PCC LC-402	Computer Organization & Architecture Lab	0	0	4	2
4.	PCC CS-403	Design & Analysis of Algorithms	3	0	0	3
5.	PCC LC-403	Design & Analysis of Algorithms Lab	0	0	4	2
6.	PCC CS-404	Advanced Programming Using Python	3	1	0	4
7.	HSMC-401	Management 1 (Organizational Behaviour/ Finance & Accounting)	3	0	0	3
8.	MC-401	Environmental Sciences	-	-	-	0
Total						**21**

Semester-V						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	PCC CS-501	Computer Networks	3	0	0	3
	PCC LC-501	Computer Networks Lab	0	0	4	2
2.	PCC CS-502	Introduction to Database Systems	3	0	0	3
3.	PCC LC-502	Introduction to Database Systems Lab	0	0	4	2
4.	PCC CS-503	Machine Learning	3	1	0	4
5.	PCC CS-504	Operating Systems	3	0	0	3
6.	PCC LC-504	Operating Systems Lab	0	0	4	2
7.	HSMC-501	Humanities II	3	0	0	3
8.	MC-502	Constitution of India/ Essence of Indian Knowledge Tradition	-	-	-	0
Total						**22**

Semester-VI						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	PCC CS-601	Software Engineering	3	0	0	3
2.	PCC CS-602	Introductory Cyber Security	3	0	0	3
3.	PCC LC-602	Introductory Cyber Security Lab	0	0	4	2
4.	PEC-XXX	**Core Elective-I**	3	0	0	3
	PEC-601	Information Security				
	PEC-602	Blockchain Technology				
	PEC-603	Principle of Distributed Systems				
	PEC-604	Microcontroller based Design				
5.	PEC-XXX	**Core Elective-II**	3	0	0	3
	PEC-621	Internet of Things				
	PEC-622	Digital Image Processing				
	PEC-623	Building Cloud and Big Data Applications				
	PEC-624	Deep Learning				
7.	PCC CS-603	Theory of Computation	3	1	0	4
8.	PROJ CS-601	Internship	0	0	6	3
Total						**21**

Semester-VII						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	PCC CS-702	Compiler Design	3	0	0	3
2.	PCC LC-702	Compiler Design Lab	0	0	4	2
3.	PEC- XXX	**Core Elective-III**	3	0	0	3
	PEC-701	Advanced Computer Networks				
	PEC-702	Generative AI Technologies				
	PEC-703	Cloud system Engineering				
	PEC-704	Embedded System Design				
	PEC-705	Natural Language Processing				
	PEC-706	IoT Communication protocols				
4.	OEC-XXX	**Open Elective-I**	3	0	0	3
	OEC-701	Augmented and Virtual Reality				
	OEC-702	Human Computer Interaction				
	OEC-703	Cyber Law and Ethics				
	OEC-704	Financial Technology				
5.	BSC-701	Bioinformatics	2	1	0	3
6.	PROJ CS-701	Project-1	0	0	12	6
Total						**20**

Semester-VIII						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**
1.	PEC-XXX	**Core Elective-IV**	3	0	0	3
	PEC-801	Network Routing and Switching				
	PEC-802	Software Testing and Maintenance				
	PEC-803	IoT Security				
	PEC-804	VLSI Design				
	PEC-805	Open Source Software				
2.	OEC-XXX	**Open Elective-II**	3	0	0	3
	OEC-801	Business Analytics				
	OEC-802	Fundamentals of Quantum Computing				
	OEC-803	Introduction to Web Technologies				
	OEC-804	Technologies for Sustainable Development				
	OEC-805	Introduction to Cognitive Science				

3.	OEC-XXX	**Open Elective-III**	3	0	0	3
	OEC-821	Social Media Analytics				
	OEC-822	Mobile Application Development				
	OEC-823	Innovations in Computing				
	OEC-824	Computer Vision				
4.	PROJ CS-801	Project-II	0	0	12	6
Total						**15**

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SEMESTER-I

Course Code: BSC- 101
Course Title: **Physics – 1**
Total Hours: 30-35

L	T	P	Cr
2	0	0	2

Course Objectives

The objective of the course is to develop a scientific temper and analytical capability in the engineering graduates through the learning of physical concepts and their application in engineering & technology. Comprehension of some basic physical concepts will enable graduates to think logically about the engineering problems that would come across due to rapidly developing new technologies.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Apply the concepts of Quantum mechanics to one dimensional motion of electrons.
CLO2: Classify solids on the basis of Band theory and to calculate carrier concentrations.
CLO3: Evaluate the electrical conductivity and identify the type of semiconductor.
CLO4: Implement the fundamentals of LASER for different applications.

Units/ Hours	Contents	Mapping with Course Learning Outcome
Unit I 08 Hours	**Quantum Mechanics** Matter waves, Properties of matter waves, Physical significance of wave function. Schrödinger's time dependent and time independent equations, Operators, Eigen values and Eigen functions, Expectation values, Applications of Schrödinger's equation; Motion of a free particle, Electron in an infinite deep potential well (rigid box). **Learning Activities**: Lecture and Discussion, Interactive Demonstration	CLO1
II Units 10 Hours	**Solid State Physics** Band theory of solids, Energy level splitting in a solid as a function of interatomic distance. Band formation in Silicon. Fermi-Dirac probability function, Nearly free electron theory (E-k curve), classification of solids on the basis of band theory Introduction to Semiconductor Physics **Learning Activities**: Lecture and Discussion, Lecture and Discussion, Problem solving and Lab experiments	CLO2

III Units 8 Hours	**Mechanical Vibrations** Introduction to Mechanical Vibrations, Equation of motion and its solution, Equivalent stiffness of spring combinations, Natural frequency and time period, concepts of damping and critical damping, Free Vibrations of Un-damped and damped SDOF system.	CLO3
	Learning Activities: Lecture and Discussion, Lecture and Discussion, Problem solving, Group Activity and Lab experiments	
IV Units 7 Hours	**Laser Physics** Introduction to laser, Spontaneous and stimulated emission of radiations, Thermal equilibrium, Condition for Light amplification, Population inversion, Pumping (Three level and four level pumping), Optical resonator, Laser beam characteristics, Ruby laser, Nd-YAG Laser, He-Ne Laser, Semiconductor Laser, Engineering applications of Laser (Fiber optics, Laser material interaction).	CLO4
	Learning Activities: Lecture and Discussion, Lecture and Discussion, Problem solving, Group Activity and Lab experiments	

Text Books

1. Concepts of Modern Physics, Arthur Beiser; Tata McGraw – Hill Edition.
2. Introduction to Solid State Physics, Charles Kittel, Wiley.

Suggested Readings

1. Introduction to quantum mechanics / David J. Griffiths
2. A text book of Engineering physics, Avadhanulu and Kshirsagar, S. Chand Pub.
3. Concepts of Modern Physics, Arthur Beiser; Tata McGraw – Hill Edition.
4. Introduction to Solid State Physics, Charles Kittel, Wiley.
5. Solid State Physics, S. O. Pillai, New Age International Publishers.
6. Solid state electronic devices, Ben G. Streetman, Sanjay Banerjee Pearson PrenticeHall.
7. LASERS Theory and Applications, K. Thyagarajan, A. K. Ghatak; Macmillan India Ltd.

Alternative NPTEL/SWAYAM Course

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTIONTO ELECTROMAGNETIC THEORY	PROF. MANOJ HARBOLA	IIT KANPUR

Course Code: BSCLC- 101
Course Title: **Physics – 1 Laboratory**
Total Hours: 30

L	T	P	Cr
0	0	4	2

Course Objectives

The aim and objective of the Engineering Physics lab is to provide students the first-hand experience of verifying various theoretical concepts learnt in theory courses so that they can use these in Engineering as per their requirement.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: calculate energy gap, carrier concentration and mobility of the given material
CLO2: verify quantum mechanical phenomena
CLO3: Estimate the size of the object using Laser diffraction
CLO4: Determine the magnetic susceptibility and dielectric constant of the material.

Laboratory/ Practical

1) Frank-Hertz Experiment
2) Planck's Constant
3) To determine the wavelengths of light of a given source using diffraction grating
4) Band gap of a semiconductor by four probe method
5) Hall effect in Semiconductor
6) Magnetoresistance measurement of semiconductor
7) To determine the reverse saturation current and material constant of PN Junction
8) To determine the dielectric constant of material
9) Study of Biot-Savart's law
10) Measurement of magnetic susceptibility by Quinke's method
11) To find the natural frequency of the spring mass system.
12) Equivalent stiffness of springs in series and parallel
13) Determine the spring constant of a spring by two different methods.

Course Code BSC-102
Course Title: Mathematics-I
Total Hours: 60

L	T	P	Cr
3	1	0	4

Course Objectives

The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
CLO2: The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
CLO3:The tool of power series and Fourier series for learning advanced Engineering Mathematics.
CLO4: To deal with functions of several variables that are essential in most branches of engineering.
CLO5: To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 hours	**Basic Calculus:** (6 hours) Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. **Single-variable Calculus (Differentiation): (6 hours)** Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L' Hospital's rule.	CLO1, CLO2
	Learning Activities: Assignment based and numerical exercise based learning	

Unit II 10 Hours	**Sequences and series:** (10 hours) Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.	CLO3, CLO4
	Learning Activities Assignment based and numerical exercise based learning	
Unit III Hours 10	**Multivariable Calculus (Differentiation): (8 hours)** Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.	CLO5
	Learning Activities: Assignment based and numerical exercise based learning	
Unit IV 10 Hours	**Multivariable Calculus (Integration):** (10 hours) Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.	CLO4
	Learning Activities: Assignment based and numerical exercise based learning	

Textbooks/references:

1. G.b. Thomas and R.L. Finney, calculus and analytic geometry, 9th edition, Pearson, reprint, 2002.
2. Erwin Kreyszig, advanced engineering mathematics, 9th edition, john wiley & sons, 2006.
3. Ramana b.v., higher engineering mathematics, tata mcgraw hill new delhi, 11th reprint, 2010.
4. Veerarajan t., engineering mathematics for first year, tata mcgraw-hill, new delhi, 2008.
5. N.p. bali and manish goyal, a text book of engineering mathematics, laxmi publications, reprint, 2008.
6. B.S. grewal, higher engineering mathematics, khanna publishers, 36th edition, 2010.

Course Code: ESC-101
Course Title: Basic Electrical Engineering
Total Hours: 60

L	T	P	Cr
3	1	0	4

Course Objectives

The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Have the knowledge of DC circuits, AC Circuits, basic magnetic circuits, working principles of electrical machines, and components of low voltage electrical installations
CLO2: Be able to analyse of DC circuits, AC Circuits
CLO3: Understand the basic magnetic circuits and apply it to the working of electrical machines
CLO4: Be introduced to types of wiring, batteries, and LT switchgear.

Units/ Hours	Contents	Mapping with Course Learning Outcome
Unit 1 15 Hours	D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields. **Learning Activities:** Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	CLO1
Unit-II 15 Hours	**Single Phase A.C. Circuits** covering, Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; **Three Phase A.C. Circuits** covering, Necessity and Advantages	CLO2

	of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method	
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	
Unit-III 15 Hours	**Transformers** covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation; **DC Machines** covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor.	CLO3, CLO4
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	
Unit –IV 15 Hours	Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter. Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geo- thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation.	CLO4
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	

Text books

1. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.

Reference books

1. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
2. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
3. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India
Hughes, E. 2005.

Course Code: ESCLC- 101
Course Title: Basic Electrical Engineering - Laboratory
Total Hours: 30

L	T	P	Cr
0	0	2	1

Course Objectives

CO1: The aim and objective of the Basic Electrical Engineering lab is to familiarize students with basic electrical components, instruments, and safety procedures.
CO2: To provide hands-on experience in analyzing electrical circuits.
CO3: To build foundational electrical engineering knowledge applicable to real-world systems and interdisciplinary applications that they can use these in Engineering as per their requirement.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Demonstrate the use of electrical components and instruments safely.
CLO2: Verify circuit theorems and laws through practical implementation.
CLO3: Analyze power and circuit behavior in AC and DC electrical systems.
CLO4: Conduct performance tests on transformers, generators, and motors.

Laboratory/ Practical

1) Study of Electrical Components and Equipments.
2) Verification of Kirchhoff's Law
3) Verification of Thevenin's Theorem and Norton's Theorem
4) Verification of Superposition's Theorem
5) Single Phase AC Power Calculations
6) R-L-C Circuit Analysis
7) Three Phase Power Measurement
8) Tests on Single Phase Transformer
9) Load characteristics of DC Shunt Generator
10) Speed Control of Three Phase Slipring Induction Motor

Course Code: ESC- 102
Course Title: Engineering Graphics & Design
Total Hours: 60

L	T	P	Cr
1	0	4	3

Course Objectives

The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To describe engineering design and its place in society and discuss the visual aspects of engineering design
CLO 2: To employ engineering graphics standards.
CLO 3: To illustrate solid modelling.
CLO 4: To use computer-aided geometric design.
CLO 5: To create working drawings.

Course contents:

Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 15 Hours	**Introduction to Engineering Drawing:** Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales; **Orthographic Projections:** Principles of Orthographic Projections-Conventions -	CLO1

	Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes; **Projections of Regular Solids:** Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.	
	Learning Activities: Technical drawing exercises, and assignments, CAD Software Training, design challenges for real world problems, Project-Based Learning	
Unit II 15 Hours	**Sections and Sectional Views of Right Angular Solids:** Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only). **Isometric Projections:** Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;	CLO2 & 3
	Learning Activities: Technical drawing exercises, and assignments, CAD Software Training, design challenges for real world problems, Project-Based Learning	
Unit III 15 Hours	**Overview of Computer Graphics**: Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids. **Customisation & CAD Drawing:** Consisting of set up of the drawing page and the printer, including scale settings, setting up of Modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines,	CLO 4

	Applying various ways of drawing circles.	
	Learning Activities: Technical drawing exercises, and assignments, CAD Software Training, design challenges for real world problems, Project-Based Learning	
Unit IV 15 Hours	**Annotations, layering & other functions**: Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer- aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling; **Demonstration of a simple team design project that illustrates**: Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modelling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).	CLO5
	Learning Activities: Technical drawing exercises, and assignments, CAD Software Training, design challenges for real world problems, Project-Based Learning	

Text Books

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.

Reference Books

1. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
4. (Corresponding set of) CAD Software Theory and User Manuals.

Course Code: ESC-103
Course Title: Programming for Problem Solving
Total Hours: 60

L	T	P	Cr
3	0	0	3

Course Objectives:

This course covers computer fundamentals, program development steps, C programming syntax and semantics, structured programming approach, algorithm formulation, and output analysis based on input variables.

Course Learning Outcomes:

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: To formulate simple algorithms for arithmetic and logical problems.
CLO2: To translate the algorithms to programs (in C language).
CLO3: To test and execute the programs and correct syntax and logical errors.
CLO4: To implement conditional branching, iteration and recursion.

Units/ Hours	**Contents**	**Mapping With Course Learning Outcome**
Units I Hours 15	**Introduction to Programming;** Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.	CLO1, CLO2
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	
	Arrays, Arrays (1-D, 2-D), Character arrays and Strings. Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)	

Units II Hours 15	Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference	**CLO2** **CLO3**
	Learning Activities: I Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	
Units III Hours 15	Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort. Structures, Defining structures and Array of Structures	**CLO3**
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	
Units IV Hours 15	Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation) File handling (only if time is available, otherwise should be done as part of the lab).	**CLO4**
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	

Text books

1. Object Oriented Programming with C++ by Balaguruswamy, 8th edition, 2020.
2. Let Us C++" by Yashavant Kanetkar (17th Edition, 2020)

Suggested readings

1. Object-Oriented Programming in C++ By Robert Lafore, 2001.
2. Mastering C++ By K.R Venugopal , Rajkumar, TMH, 2017.
3. Problem Solving and Program Design in C" by Jeri R. Hanly and Elliot B. Koffman (8th Edition, 2015)
4. C++ and Object-Oriented Programming By - Kip R. Irvine, Prentice Hall, 1997

Course Code: ESCLC-103
Course Title: Problem Solving Skill with Programming Laboratory
Total Hours: 30

L	T	P	Cr
0	0	2	1

Course Objects:

Course Learning Outcomes:

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To formulate the algorithms for simple problems.
CLO2: To translate given algorithms to a working and correct program.
CLO3: To be able to correct syntax errors as reported by the compilers.
CLO4: To be able to identify and correct logical errors encountered at run time.
CLO5: To be able to write iterative as well as recursive programs.
CLO6: To be able to represent data in arrays, strings and structures and manipulate them through a program

Laboratory/ Practical

1.Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

Course Code: MC-102
Course Title: Design Thinking & IDEA Lab Workshop
Total Hours: 60

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: To develop new ways of creative thinking and learn the innovation cycle of Design Thinking process

CLO2: To create real-time innovative engineering product designs

CLO3: Perceive individual differences and its impact on everyday decisions and further Create a better customer experience.

CLO4: Design and assemble basic electronic circuits, understanding the function and placement of components such as resistors, capacitors, transistors, and ICs.

CLO5: Utilize PCB design software to create and fabricate printed circuit boards for custom electronic projects.

Units/ Hours	**Contents**	**Mapping With Course Learning Outcome**
Units I Hours 15	Basics of Design Thinking: Definition of Design Thinking, need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test Being Ingenious & Fixing Problem: Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem-Solving Process of Product Design: Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design	CLO1, CLO2
	Learning Activities: Learning Activities: Empathy Interviews	

Units II Hours 15	Design Thinking & Customer Centricity: Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design Feedback, Re-Design & Re-Create: Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution". **Learning Activities:** Students will be encouraged to iterate on their designs based on insights gained from user testing, feedback, and reflection.	CLO3
Units III Hours 15	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Overview of Software Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT Introduction to basic hand tools - Tape measure, combination square, Vernier caliper, hammers, fasteners, Introduction wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives **Learning Activities:** Brainstorming sessions, Prototyping Sessions	CLO3
Units IV Hours 15	Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts	CLO4

	programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and chargingBasics of IPR and patents; Accessing and utilizing patent information in IDEA Lab	
	Learning Activities: Brainstorming sessions, Prototyping Sessions	

Suggested Readings

1.Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Bloomsbury Publishing India Private Limited

2.Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business

3.The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.

4.The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269

5.Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633

6.Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773

7.Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

Course Code: MCLC-102
Course Title: Design Thinking & IDEA Lab Workshop
Total Hours: 60

L	T	P	Cr
0	0	2	1

Course Objectives

The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

Course Learning Outcomes

List of Experiments

1.Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.Machining of 3D geometry on soft material such as soft wood or modelling wax.
3.3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
6.Familiarity and use of welding equipment.
7.Familiarity and use of normal and wood lathe.
8.Embedded programming using Arduino and/or Raspberry Pi.
9.Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure**.**

Course Code: MC-101
Course Title: Mentoring and Professional Development
Total Hours: 30

L	T	P	Cr
0	0	2	0

The objective of mentoring will be development of

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills.

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A (Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B (Outdoor Activities)

1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

SEMESTER-II

Course Code: BSC-202
Course Title: Fundamentals of Modern Computing
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives

This course introduces Artificial Intelligence concepts, cloud computing architecture, IoT systems, Machine learning, and Generative AI, covering concepts, theories, applications, architecture, services, deployment models, and algorithms for creating new content.

Course Learning Outcomes:

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: To understand the basic concept of Artificial Intelligence and mathematical models behind them

CLO2: To describe the core concepts and architecture of cloud computing and explore the fundamental principles and components of IoT systems

CLO3: To apply Supervised and Unsupervised Machine Learning techniques

CLO4: To examine Generative AI and its ethical consideration.

Units/ Hours	**Contents/Learning activities**	**Mapping with Course Learning Outcome**
Units I Hours 15	**Introduction to Artificial Intelligence:** Definition and history of AI, Applications of AI in various industries, Ethical considerations in AI, Overview of AI techniques: Search algorithms, logic, and reasoning, Introduction to AI tools and platform	**CLO1**
	Learning Activities: Interactive Lectures and Demonstrations,assignments involving implementation of propositional and predicate logics using Prolog and Logictools. Practical application of Fuzzy logic.	
Units II Hours 15	**Introduction to Cloud and IoT:** Overview of cloud computing, History and evolution of cloud computing, Key characteristics and benefits of cloud computing and Cloud service models (IaaS, PaaS, SaaS). Definition and characteristics of IoT, History and evolution of IoT, IoT architecture and protocols and IoT Components and Devices.	**CLO2**
	Learning Activities: Interactive Lectures and Demonstrations, assignments involving practical applications of cloud and IoT technologies	

Units III Hours 15	**Introduction to Machine Learning:** Overview of machine learning, Types of machine learning: supervised, unsupervised, **Data Pre-processing and Feature Engineering,** Applications of machine learning and Tools.	**CLO3**
	Learning Activities: Interactive Lectures and Demonstrations, Weekly assignments, Implementation of machine learning techniques on public datasets, Class participation and engagement: Ask students to formulate classification tasks on the basis of their daily life observations	
Units IV Hours 15	**Introduction to Generative AI:** Overview of generative AI, Applications of generative models in pics and text generation, Text generation models (e.g., GPT-3), Applications of generative AI in NLP, Ethical considerations in generative AI.	**CLO4**
	Learning Activities: Interactive Lectures and Demonstrations, Weekly assignments, Class participation and engagement	

Textbook:

1.Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig

Suggested readings:

1. Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, 2013.
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry, 2017.
3. Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido (2016).
4.Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" by David Foster (2019).

Course Code: BSC-201
Course Title: Mathematics- II
Total Hours: 60

L	T	P	Cr
3	1	0	4

Course Objectives
Mathematics fundamental necessary to formulate, solve and analyse engineering problems.

Course Learning Outcomes
Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To describe matrices and linear algebra in a comprehensive manner.
CLO2: To associate mathematical tools for the solutions of differential equations that model physical processes.
CLO3: To assess and adapt differentiation and integration of functions of a complex variable that are used in various techniques dealing with engineering problems.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
UNIT I 16 Hours	**Matrices** (10 hours): Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem. **First order ordinary differential equations: (6 hours)** Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. **Learning Activities:** Math Worksheets, games and puzzles, Interactive Whiteboard Activities	CLO1
UNIT II 14 Hours	**Ordinary differential equations of higher orders: (8 hours)** Second order linear differential equations with constant and variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.	CLO2

	Learning Activities: Interactive Whiteboard Activities, games and puzzles, group activities	
UNIT III 15 Hours	**Complex Variable – Differentiation: (8 hours):** Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties. .	CLO3
	Learning Activities: Group Problem Solving, questions that promote critical thinking, mathematical debates	
UNIT IV 15 Hours	**Complex Variable – Integration: (8 hours):** Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour	CLO4
	Learning Activities: Group Problem Solving, questions that promote critical thinking, mathematical debates	

Textbooks

1. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

Suggested Readings

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
2. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
3. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
4. S. L. Ross, Differential Equations, 3rd Edition, Wiley India, 1984.
5. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
7. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2009.

Course Code: HSMC-201
Course Title: Communication Skills
Total Hours: 30

L	T	P	Cr
2	0	0	2

Course Objectives

The program aims to enhance students' English language skills through guided activities, employability training, and hands-on experiences through case studies, mini-projects, and presentations.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To help the students become independent users of the English language.
CLO2: To acquire basic proficiency in reading & listening, comprehension, writing and speaking skills.
CLO3: To be able to understand spoken and written English language, particularly the language of their chosen technical field.
CLO4: To be able to converse fluently.
CLO5: To be able to produce on their own clear and coherent texts.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I Hours 10	**Vocabulary Building** The concept of Word Formation Root words from foreign languages and their use in English Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.	CLO1, CLO2
	Learning Activities: Reading Assignments, Technical vocabulary building, presentations	
Units II Hours 12	**Basic Writing Skills** Sentence Structures Use of phrases and clauses in sentences Importance of proper punctuation Creating coherence Organizing principles of paragraphs in documents Techniques for writing precisely	CLO1
	Learning Activities: Reading Assignments, Technical vocabulary building, presentations	

III Units **13 hours**	**Identifying Common Errors in Writing:** Subject-verb agreement Noun-pronoun agreement Misplaced modifiers Articles, Prepositions, Redundancies, Clichés **Nature and Style of sensible Writing:** Describing Defining Classifying Providing examples or evidence Writing introduction and conclusion	CLO3
	Learning Activities: : Peer Editing Sessions, debates and discussions, Role-Playing Exercises	
IV Units 10 hours	**Writing Practices:** Comprehension, Précis Writing, Essay Writing **Oral Communication:** (This Module involves interactive practice sessions in Language Lab) Listening Comprehension Pronunciation, Intonation, Stress and Rhythm Common Everyday Situations: Conversations and Dialogues Communication at Workplace Interviews Formal Presentations	CLO4, CLO5
	Learning Activities: Reading Assignments, Technical vocabulary building, presentations	

Textbook

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

Reference Books

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Course Code: HSLC-201
Course Title: Communication Skills Lab
Total Hours: 30

L	T	P	Cr
0	0	2	1

Course Objectives

The program aims to enhance students' English language skills through guided activities, employability training, and hands-on experiences through case studies, mini-projects, and presentations.

Course Learning Outcomes

By the end of the Communication Skills Lab course, students will be able to:
CLO1: Demonstrate improved verbal and non-verbal communication skills in professional and social contexts.
CLO2: Develop active listening, comprehension, and presentation skills through interactive activities.
CLO3: Apply appropriate language, tone, and body language for formal communication, including interviews and group discussions.
CLO4: Draft structured and professional written content such as emails, reports, and resumes.
CLO5: Exhibit enhanced confidence and fluency in spoken English through role-plays, mock sessions, and presentations.

List of Experiments

1. Self-introduction and public speaking practice
2. Listening comprehension exercises using audio-visual media
3. Group discussion on current or technical topics
4. Mock interview sessions with feedback
5. Role-play for professional conversations (e.g., client interaction, workplace scenarios)
6. Presentation skills: prepare and deliver a short presentation with visual aids
7. Reading aloud and pronunciation drills for fluency and clarity
8. Writing formal and informal emails
9. Resume and cover letter writing workshop
10. Report writing based on case studies or technical topics
11. Debate and argumentation practice on socially relevant topics
12. Non-verbal communication exercises (body language, eye contact, gestures)
13. Vocabulary enrichment and grammar correction sessions
14. Telephone and video call etiquette practice
15. Time-bound extempore speaking on random topics

Course Code: ESC-201
Course Title: Object Oriented Programming with C++
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives:
This course aims to teach fundamental C++ programming concepts, advanced class features, operator overloading techniques, inheritance, functions, exception handling, file I/O operations, and Standard Template Library (STL) usage.

Course Learning Outcomes
Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Demonstrate a solid understanding of C++ programming basics and differentiate between C++ and C syntax.
CLO2: Implement and utilize advanced class features and operator overloading to write efficient and effective C++ programs.
CLO3: Apply the principles of inheritance and function management, including the use of virtual and friend functions, in complex C++ applications.
CLO4: Effectively handle exceptions and manage file input/output operations to ensure robust and error-free C++ programs.
CLO5: Employ the Standard Template Library (STL) to develop reusable and efficient code, leveraging containers, algorithms, and iterators.

Units/ Hours	Contents	Mapping with Course Learning Outcome
Units I Hours 12	Basics of C++ and Object-Oriented Programming Concepts C++ programming basics: input and output directives, the setw manipulator, type conversions, syntax similarities and differences with C language. Object and classes: introduction to classes, objects, encapsulation, abstraction, polymorphism, implementation of class in C++, creating objects, C++ object as data types, constructor, object as function arguments, the default copy constructor, returning object from function, structures and classes.	**CLO1**
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	

Units II Hours 12	Advanced Class Features and Operator Overloading Classes objects and memory: static class data. Arrays as class member data: arrays of object, string, the standard C++ String class. Concept of Namespace, Nested Namespaces, Namespaces and Classes, Extending Namespace Operator overloading: overloading unary operations, overloading binary operators, data conversion, pitfalls of operators overloading and conversion keywords, explicit and mutable.	**CLO2**
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	
Units III Hours 11	Inheritance and Functions Inheritance: concept of inheritance, generalization and specialization, derived class and base class, derived class constructors, member functions, public and private inheritance, aggregation. Functions: virtual function, friend function, static function, assignment and copy initialization, this pointer, dynamic type information.	**CLO3**
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	
Units IV Hours 10	Exception Handling, File I/O, and Standard Template Library Exception handling: list of exceptions, catching exception, handling exception. Streams and files: streams classes, stream errors, disk file I/O with streams, file pointers, error handling in file I/O with member function, overloading the extraction and insertion operators, memory as a stream object, command line arguments, printer output. Standard Template Library (STL): overview of Standard Template Library, containers, algorithms, iterators, other STL elements, container classes, vectors.	**CLO4**
	Learning Activities: Interactive Lectures and Demonstrations, Hands-on Coding Labs, Peer Programming and Code Reviews, Project-Based Learning	

Text books

1. The C++ Programming Language, 4th Edition, B. Stroutstrup, Pearson Education, 2013.
2. Problem solving with C++: The Object of Programming, 9th Edition, Walter Savitch, Pearson Education, 2017

Suggested Readings

1. The Complete Reference C++, 4th Edition, Herbert Schildt, Tata McGraw Hill, 2017.
2. OOP in C++, 3rd Edition, T. Gaddis, J. Walters and G. Muganda, Wiley Dream Tech Press, 2002
3. Object Oriented Programming in C++, 3rd Edition, R. Lafore, Galigotia Publications Pvt Ltd, 1999.

Course Code: ESCLC-201
Course Title: Object Oriented Programming with C++ Laboratory
Total Hours: 30

L	T	P	Cr
0	0	2	1

Course Objective

To provide practical knowledge of object-oriented programming concepts using C++, including classes, inheritance, operator overloading, file handling, exception handling, and use of STL through hands-on implementation.

Course Learning Outcomes:

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To illustrate the concept of OO Programming using programs.
CLO2: To implement the Classes and Objects.
CLO3: To develop programs to illustrate Inheritance and operator overloading.
CLO4: To be able to employ the exception Handling and File handling.

Laboratory/ Practical

1. Implementation of function overloading.
2. Implementation of classes and objects.
3. Implementation of different type of constructors.
4. Implementation of functions in classes.
5. Implementation of operator overloading.
6. Implementation of different types of inheritance.
7. Implementation of Streams.
8. Implementation of various operations on files.
9. Implementation of exception handling.
10. Implementation of STL.

Course Code: ESC-202
Course Title: Workshop/Manufacturing Practices
Total Hours: 15

L	T	P	Cr
1	0	0	1

Course Objectives

The program aims to provide students with hands-on experience in Civil, Mechanical, Electrical, and Electronics Engineering, including plumbing, carpentry components, gas welding, foundry operations, electrical measurement, and soldering.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To fabricate components with their own hands.
CLO2: To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
CLO3: To design small devices of their interest by assembling different components.

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit-I (5 hours)	Manufacturing Methods-casting, forming, machining, joining, advanced manufacturing methods. CNC machining, Additive manufacturing.	CLO1
Unit-II (3 hours)	Fitting operations & power tools. Carpentry	CLO2
Unit-III (3 hours)	Plastic moulding, glass cutting Metal casting	CLO3
Unit-IV (4 hours)	Welding (arc welding & gas welding), brazing.	CLO4

Textbooks

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai**.**

Reference Books

1. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
2. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
3. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
4. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017

Course Code: ESC-202
Course Title: Workshop/Manufacturing Practices - Laboratory
Total Hours: 60

L	T	P	Cr
0	0	4	2

Practical

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Course Code: AU-201
Course Title: Sports and Yoga
Total Hours: 30

L	T	P	Cr
2	0	0	0

Course Objectives:

The program aims to educate students about health and fitness principles, encourage them to engage in physical and yogic activities, develop a safe, progressive, and efficient activity plan, and promote physical activity as a lifetime health pursuit.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: To practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation, learn breathing exercises and healthy fitness activities

CLO2: To explain techniques for increasing concentration and decreasing anxiety.

CLO3: To perform yoga movements in various combinations and forms, assess current personal fitness levels.

CLO4: To demonstrate nutritional practices as related to health and physical performance.

CLO5: To identify and apply injury prevention principles related to yoga and physical fitness activities, correctly apply biomechanical and physiological principles elated to exercise and training.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I (8 hours)	**Introduction to Physical Education;** Meaning & definition of Physical Education Aims & Objectives of Physical Education Changing trends in Physical Education **Olympic Movement:** Ancient & Modern Olympics (Summer & Winter) Olympic Symbols, Ideals, Objectives & Values Awards and Honours in the field of Sports in India Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.) **Physical Fitness, Wellness & Lifestyle:** Meaning & Importance of Physical Fitness & Wellness Components of Physical fitness Components of Health related fitness Components of wellness Preventing Health Threats through Lifestyle Change Concept of Positive Lifestyle	CLO1
	Learning Activities: Quiz and group discussion	

Units II (7 hours)	**Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga:** Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.) Define Anatomy, Physiology & Its Importance **Kinesiology, Biomechanics & Sports:** Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports Newton's Law of Motion & its application in sports. Friction and its effects in Sports. **Postures** Meaning and Concept of Postures. Causes of Bad Posture. Advantages & disadvantages of weight training. Concept & advantages of Correct Posture. Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis. Corrective Measures for Postural Deformities **Learning Activities:** Interactive Lectures and Demonstrations	CLO1, CLO3
III Units **(8 hours)**	**Yoga** Elements of Yoga Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana) Relaxation Techniques for improving concentration - Yog-nidra **Yoga & Lifestyle:** Asana as preventive measures. Hypertension, Obesity, Back Pain, Diabetes, Asthma: **Psychology & Sports:** Definition & Importance of Psychology in Physical Edu. & Sports Define & Differentiate Between Growth & Development Adolescent Problems & Their Management Emotion: Concept, Type & Controlling of emotions Meaning, Concept & Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety & Fear and its effects on Sports Performance. Motivation, its type & techniques. Understanding Stress & Coping Strategies. **Learning Activities:** Interactive Lectures and Demonstrations	CLO2, CLO3

Unit 4 (7 hours)	**Training and Planning in Sports:** Meaning of Training, Warming up and limbering down Skill, Technique & Style Meaning and Objectives of Planning. Tournament – Knock-Out, League/Round Robin & Combination **Doping** Meaning and Concept of Doping, Prohibited Substances & Methods, Side Effects of Prohibited Substances **Sports Medicine** First Aid – Definition, Aims & Objectives. Sports injuries: Classification, Causes & Prevention. Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries **Sports / Games** Following subtopics related to any one Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc. History of the Game/Sport. Latest General Rules of the Game/Sport. Specifications of Play Fields and Related Sports Equipment. Important Tournaments and Venues. Sports Personalities. Proper Sports Gear and its Importance.	CLO4
	Learning Activities: Demonstration and practical	

Text Books

1. Modern Trends and Physical Education by Prof. Ajmer Singh.

References

1. Light On Yoga by B.K.S. Iyengar.
2. Health and Physical Education – NCERT (11th and 12th Classes)

Course Code: HSMC H-201
Course Title: Universal Human Values-II: Understanding Harmony and Ethical Human Conduct
Total Hours: 45

L	T	P	Cr
2	1	0	3

Course Objectives:

To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature. Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: To identify holistic way of life
CLO2: To illustrate socially responsible behaviour
CLO3: To defend environmentally responsible work
CLO4: To justify ethical human conduct
CLO5: To develop Competence and Capabilities for Maintaining Health and Hygiene

Units/Hours	Contents	Mapping with Course Learning Outcome
Units I **12 Hours**	**Introduction to Value Education** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations **Tutorial 1**: **Practice Session PS1** Sharing about Oneself **Tutorial 2: Practice Session PS2** Exploring Human Consciousness **Tutorial 3: Practice Session PS3** Exploring Natural Acceptance	**CLO1, CLO2**

Units II **10 Hours**	**Harmony in the Human Being** Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health **Tutorial 4: Practice Session PS4** Exploring the difference of Needs of Self and Body **Tutorial 5: Practice Session PS5** Exploring Sources of Imagination in the Self **Tutorial 6: Practice Session PS6** Exploring Harmony of Self with the Body	**CLO2**
Units III **11 Hours**	**Harmony in the Family and Society** Harmony in the Family – the Basic Unit of Human Interaction 'Trust' – the Foundational, Value in Relationship 'Respect' – as the Right Evaluation Other Feelings, Justice in Human-to-Human Relationship Understanding Harmony in the Society Vision for the Universal Human Order **Tutorial 7: Practice Session PS7** Exploring the Feeling of Trust **Tutorial 8: Practice Session PS8** Exploring the Feeling of Respect **Tutorial 9: Practice Session PS9** Exploring Systems to fulfil Human Goal **Harmony in the Nature/Existence** Understanding Harmony in the Nature Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature Realizing Existence as Co-existence at All Levels The Holistic Perception of Harmony in Existence **Tutorial 10: Practice Session PS10** Exploring the Four Orders of Nature **Tutorial 11: Practice Session PS11** Exploring Co-existence in Existence	**CLO3, CLO4**

Unit IV **12 Hours**	**Implications of the Holistic Understanding – a Look at Professional Ethics** Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies Strategies for Transition towards Value-based Life and Profession **Tutorial 12: Practice Session PS12** Exploring Ethical Human Conduct **Tutorial 13: Practice Session PS13** Exploring Humanistic Models in Education **Tutorial 14: Practice Session PS14** Exploring Steps of Transition towards Universal Human Order	**CLO4**

Textbook

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R

Reference Books

1. Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-
3. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
4. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
5. The Story of Stuff (Book).

Course Code: MC-201
Course Title: Mentoring and Professional Development
Total Hours: 30

L	T	P	Cr
0	0	2	0

Guidelines regarding Mentoring and Professional Development

The objective of mentoring will be development of

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A (Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B (Outdoor Activities)

1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

SEMESTER-III

Course Code: PCC CS-301
Course Title: Introduction to Data Science
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course provides an introduction to the field of Data Science, covering essential concepts in data manipulation, exploratory data analysis, statistical modeling, and machine learning. The course emphasizes practical skills using modern data science tools and programming languages like Python and R.

Course Learning Outcomes

Course learning outcomes (CLOs): After completion of the course, students would be able to:
CLO1: Understand the data science process and basic concepts of data collection, cleaning, and preprocessing.
CLO2: Perform exploratory data analysis and data visualization.
CLO3: Apply statistical and machine learning methods to derive insights from data.
CLO4: Use programming tools (Python/R) and libraries for real-world data science problems.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 Hours	Introduction to Data Science: Definition, Data Science Process, Roles in Data Science. Data Collection and Preprocessing: Data formats, Cleaning, Handling missing data, Feature engineering.	CLO1
	Learning Activities: Load and clean a dataset using Python (pandas).	
Unit II 11 Hours	NumPy: Arrays, indexing, slicing, broadcasting, mathematical operations Pandas: DataFrames and Series, reading and writing data, indexing, filtering Handling missing values, type conversions, Grouping, aggregation, sorting,Merging and joining datasets	CLO2
	Learning Activities: Perform EDA on real-world datasets.	
III Units 11 Hours	Data Visulisation: Importance of visual storytelling in data science, Matplotlib and Seaborn:Line, bar, histogram, box, scatter, pair plots, heatmaps. Styling and customizing plots, Visualizing time series data, Introduction to interactive visualization (Plotly basics	CLO3
	Learning Activities: Build and evaluate ML models using scikit-learn.	

IV Units 11 Hours	Time Series Analysis: Introduction to time series data, Date-time indexing and resampling in Pandas, Time series decomposition, Moving averages and smoothing, Trend and seasonality detection, Handling missing timestamps and irregular data.	CLO4
	Learning Activities: Tune and evaluate models on real datasets.	

Transactional Modes:

- Lecture cum Demonstration
- Blended Learning
- Hands-on Labs
- Group Projects
- Use of Data Science Tools and Platforms

Suggested Readings:

1. Provost, F., & Fawcett, T. (2013). Data Science for Business. O'Reilly Media.
2. Grus, J. (2019). Data Science from Scratch (2nd ed.). O'Reilly Media.
3. McKinney, W. (2022). Python for Data Analysis (3rd ed.). O'Reilly Media.
4. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). An Introduction to Statistical Learning (2nd ed.). Springer.
5. Research Articles from SCI & Scopus indexed Journals.

Course Code: PCC LC-301
Course Title: Introduction to Data Science Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

This course provides an introduction to the field of Data Science, covering essential concepts in data manipulation, exploratory data analysis, statistical modeling, and machine learning. The course emphasizes practical skills using modern data science tools and programming languages like Python and R.

Course Learning Outcomes

CLO1: Apply Python programming and relevant libraries (NumPy, Pandas) to collect, clean, manipulate, and prepare datasets for analysis.
CLO2: Perform exploratory data analysis (EDA) using statistical summaries and visual techniques to discover insights and relationships.
CLO3: Develop data visualizations using Matplotlib, Seaborn, and Plotly to effectively communicate data-driven findings.
CLO4: Analyze and interpret time series data using decomposition, resampling, and trend analysis techniques in Pandas.

List of Experiments

.

1. To load a dataset and perform cleaning operations such as handling missing values, dropping irrelevant columns, and renaming headers using Pandas.
2. To perform array manipulations, slicing, indexing, broadcasting, and matrix operations using NumPy.
3. To manipulate DataFrames using grouping, aggregation, sorting, merging, and joining.
4. To conduct initial analysis on a dataset using Pandas for insights.
5. To visualize data distributions and relationships using various types of plots.
6. To enhance plot readability and aesthetics using titles, axis labels, legends, and use themes/colors to customize bar charts, heatmaps, and pair plots using Seaborn and Matplotlib..
7. To create interactive line charts, bar graphs, and scatter plots with hover info and slider/dropdown features.
8. To handle time-indexed data using Pandas: convert date columns, set datetime index, and apply resampling (e.g., monthly average prices).
9. To analyze the components of time series data such as trend and seasonalit.
10. To perform univariate and multivariate exploratory data analysis using Pandas and Seaborn

Course Code PCC CS-302
Course Title: Data Structure & Algorithms
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

To become familiar with different types of data structures and their applications. To introduce the students to recent developments in Data Structure & Algorithmic design.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the fundamental data structures, their implementation and some of their standard applications.
CLO2: Select and implement appropriate searching and sorting techniques for solving a problem based on their characteristics.
CLO3: Apply tree and graph data structures for specific applications.
CLO4: Design and analyse algorithms using appropriate data structures for real-world problems.

Units/ Hours	Contents	Mapping with Course Learning Outcome
UNIT I 12 hours	**Introduction to Data Structures and Linear Data Structure** **Basic Terminologies:** Notion of data structures, Advantage of Good Data Structure, Data Structure Operations: insertion, deletion, traversing, searching, sorting, merging. **Analyzing algorithms:** Basics of algorithm and its analysis, Complexity classes, Time and space trade-off in algorithms. Strategies for choosing the appropriate data structure. **Linear Data Structures:** Arrays, Strings and String processing, Linked lists (Singly, Doubly, Circular), Implementations and Applications.	CLO1
	Learning Activities: Brainstorming, Assignment-based learning.	
UNIT II 10 Hours	**Abstract Data Structures** **Abstract data types, their implementation, and applications.** **Stacks** (using Arrays and Linked-list), Stack Applications: Reversing list, Factorial Calculation, Infix	CLO1 CLO4

	to postfix Transformation, Evaluating Arithmetic Expressions and Towers of Hanoi. **Queues** (using Arrays and Linked-list), Circular Queues, DeQueues, Priority queue, Bounded queue, Applications of Queues- Round Robin Algorithm.	
	Learning Activities: Brainstorming, assignment-based learning, and implementation of different algorithms.	
UNIT III Hours 12	**Non-Linear Data Structure** **Trees and their applications:** Introduction to a binary tree, tree traversal algorithms, Binary search tree, AVL Tree, B Tree, etc., and common operations on these trees. **Graphs:** Basic concepts, Representation (Adjacency Matrix, Adjacency Lists), Graph Traversals (BFS & DFS).	CLO3
	Learning Activities: Problem-solving and solution design, Exercise-based learning, and web-based animation of different data structures. (VisuAlgo Project).	
UNIT IV 11 Hours	**Searching and Sorting Algorithms** **Searching:** Linear Search, Binary Search. **Introduction to internal and external sort:** Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Counting Sort, Radix Sort. Heap, Heap Sort. Hash tables: Hash functions, Chaining, Open Addressing (Linear Probing).	CLO2 CLO4
	Learning Activities: Assignment-based learning, visual modeling, and web-based animation of different algorithms (VisuAlgo Project).	

Text Books

1. Introduction to Algorithms, Cormen H. T., Leiserson E. C., Rivest L. R., and Stein C, MIT Press,3rd ed., 2009
2. Data Structures, Algorithms and Applications in C++, Sahni S., Universities Press 2nd ed. 2005 Page 34 of 56

Reference Books

1. Data Structures and Algorithms Made Easy, Karumanchi N., Career Monk Publications, 5th ed., 2017
2. Data structures and algorithms in C++, Adam Drozdek, 4th edition.

Course Code: PCC LC-302
Course Title: Data Structure & Algorithms - Laboratory
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

The objective of this laboratory course is to provide practical exposure to the implementation of fundamental data structures and algorithms. Students will develop skills in applying concepts such as arrays, linked lists, stacks, queues, trees, and graphs to solve computational problems efficiently. The course emphasizes problem-solving using algorithmic techniques, analyzing performance, and writing modular and optimized code.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Demonstrate the use of electrical components and instruments safely.

Laboratory/ Practical

1. Implementation of various data structures such as Arrays, Stacks, Queues, Lists, Binary tree traversals, BST, AVL trees, Graphs traversals, Sorting and Searching techniques.
2. Simulate a stack, queue, circular queue and dequeue using a one-dimensional array as storage element. The program should implement the basic addition, deletion and traversal operations.
3. Represent a sparse matrix using array. Implement addition and transposition operations using the representation.
4. Implement singly, doubly and circularly connected linked lists illustrating operations like addition at different locations, deletion from specified locations and traversal.
5. Implementation of binary tree with operations like addition, deletion, traversal.
6. Depth first and breadth first traversal of graphs represented using adjacency matrix and list.
7. Implementation of binary search in arrays and on linked Binary Search Tree.
8. Implementation of different sorting algorithm like insertion, heap, bubble and many more sorting algorithms.

Course Code: ESC-301
Course Title: Digital Electronics
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to introduce students to the fundamental concepts of digital electronics, including number systems, Boolean algebra, logic gates, and combinational and sequential circuits. The course will also cover semiconductor logic families, memory technologies, and data conversion techniques. By the end of the course, students will be able to design and analyze digital circuits for real-world applications, preparing them for advanced studies and competitive exams like GATE.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Apply Knowledge of Number Systems and Boolean Algebra
CLO2: Design and Analyze Combinational and Sequential Circuits
CLO3: Understand Semiconductor Logic Families and Memory Technologies
CLO4: Analyze Data Conversion Techniques and Programmable Logic Devices (PLDs)

Units/ Hours	Contents	Mapping with Course Learning Outcome
Unit 1 15 Hours	**Number Systems, Logic Gates, and Boolean Algebra** **Number Systems & Codes**: Binary, Octal, Decimal, and Hexadecimal Number System, Signed & Unsigned Numbers, 1's and 2's Complement, Binary Arithmetic (Addition, Subtraction, Multiplication, and Division), BCD Code, Excess-3 Code, Gray Code, ASCII, Hamming Code (Error Detection & Correction) **Boolean Algebra & Simplification**: Boolean Postulates and Theorems, De Morgan's Theorems, Sum of Products (SOP) & Product of Sums (POS), Karnaugh Map (K-Map) and Quine-McCluskey Method **Logic Gates & Implementations**: Basic Gates: AND, OR, NOT, Universal Gates: NAND, NOR, XOR, XNOR Gates, Logic Circuit Implementation Using Gates Tutorial: Functional Completeness (NAND & NOR), Implementation of Boolean Functions Using Multiplexers	CLO1

	Decoders	
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	
Unit-II 15 Hours	**Combinational Circuits & Arithmetic Logic** **Combinational Circuits**: Multiplexers, Demultiplexers, Encoders, Decoders, Priority Encoders, Parity Generator & Checker, Binary Code Converters **Arithmetic Circuits**: Half Adder, Full Adder, Ripple Carry Adder, Half Subtractor, Full Subtractor, Carry Look-Ahead Adder, Binary Multiplier & Divider Tutorial: Fast Adders: Carry Look-Ahead Adder & Carry Save Adder, Concept of Hazards in Digital Circuits (Static & Dynamic Hazards)	CLO2
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation-based learning, Group Projects, interactive online resources	
Unit-III 15 Hours	**Sequential Circuits, Memory & Semiconductor Logic** **Flip-Flops & Registers**: SR, JK, D, T Flip-Flops, Master-Slave Flip-Flops & Edge-Triggered Flip-Flops, Flip-Flop Excitation Tables, SISO, SIPO, PISO, PIPO Shift Registers **Counters & FSMs**: Ripple Counters (Asynchronous), Synchronous Counters (Up/Down, Mod-N), Ring Counter, Johnson Counter, Finite State Machines (FSMs) – Mealy & Moore Machines, State Reduction & Assignment **Semiconductor Logic Families**: Diode Logic (DL), Transistor Logic (DTL, TTL, ECL), CMOS Logic & Comparison with TTL, Fan-In, Fan-Out, Propagation Delay, Noise Margin Tutorial: Setup Time, Hold Time, and Propagation Delay in Flip-Flops, Tristate Buffers and Bus System.	CLO2 CLO3
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	

Unit –IV 15 Hours	**A/D & D/A Conversion, Memory, and PLDs** **Data Converters (DAC/ADC):** Digital-to-Analog Conversion (R-2R, Weighted Resistor)**,** Analog-to-Digital Conversion (Successive Approximation, Flash, Dual Slope) **Memory Technologies:** RAM, ROM, PROM, EPROM, EEPROM, Flash Memory**,** Volatile vs. Non-Volatile Memory **Programmable Logic Devices (PLDs)**: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field Programmable Gate Arrays (FPGA) Tutorial: Sample & Hold Circuits in ADC, Memory Classification & Timing Issues in Digital Circuits	CLO3 CLO4
	Learning Activities: Hands-on Circuit Building, Problem-solving Exercises, simulation based learning, Group Projects, interactive online resources	

Textbook

1. R. P. Jain**,** ***Modern Digital Electronics*****,** 5th Edition**, McGraw Hill Education,** 2019**.**

Reference Books

2. M. Morris Mano & Michael D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog*, 6th Edition, Pearson Education India, 2023.
3. Anand Kumar, *Fundamentals of Digital Circuits*, 4th Edition, Prentice Hall India, 2023.
4. Thomas L. Floyd, *Digital Fundamentals*, 11th Edition, Pearson, 2022.
5. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, *Digital Systems: Principles and Applications*, 12th Edition, Pearson, 2023.
6. John F. Wakerly, *Digital Design: Principles and Practices*, 5th Edition, Pearson, 2020

Course Code: ESC LC- 301
Course Title: Digital Electronics - Laboratory
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

The objective of this laboratory course is to provide hands-on experience in designing and testing digital electronic circuits. Students will learn to implement combinational and sequential logic circuits using basic gates, multiplexers, decoders, flip-flops, counters, and shift registers. The course aims to bridge theoretical concepts with practical applications through simulation and hardware-based experiments, fostering a deeper understanding of digital systems and logic design.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: Familiarization with Digital Trainer Kit and Breadboard Implementation
CLO2: Understanding of TTL Logic Gates and Their Realization
CLO3: Design and Implementation of Combinational Circuits
CLO4: Design and Implementation of Sequential Circuits
CLO5: Study of Data Converters (ADC & DAC) and Shift Registers

Laboratory/ Practical

1. Study of Logic Gates: Truth Table Verification of Basic & Universal Gates
2. Implementation of Half Adder and Full Adder Using Logic Gates
3. Implementation of Half Subtractor and Full Subtractor Using Logic Gates
4. Design and Implementation of 4-Bit Binary-to-Gray & Gray-to-Binary Code Converter
5. 4-Bit and 8-Bit Comparator Using IC7485
6. Multiplexer: Truth Table Verification and Realization of Half Adder & Full Adder
7. Demultiplexer: Truth Table Verification and Realization of Half Subtractor & Full Subtractor
8. Flip-Flops: SR, JK, T, and D Flip-Flops – Truth Table Verification
9. Asynchronous Counter: 4-Bit Up Counter & Mod-N Counter Using IC7490/IC7493
10. Synchronous Counter: 4-Bit Up/Down Counter & Mod-N Counter Using IC74192/IC74193
11. Shift Registers: Implementation of SISO, SIPO, PISO, PIPO Using IC7495
12. Digital-to-Analog Converter (DAC) Operation Using IC0808/0800
13. Analog-to-Digital Converter (ADC) Operation Using an 8-Bit ADC

Course Code: ESC-302
Course Title: IT Workshop
Total Hours: 60

L	T	P	Cr
1	0	4	3

Course Objectives

The course is designed to provide hands-on experience with essential Information Technology tools and software. It aims to develop practical skills in basic computer operations, office automation tools, internet usage, and foundational programming environments. By the end of the course, students will be equipped to efficiently use IT resources for academic and professional tasks, enhancing their technical competency and digital literacy.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Write fundamental programs in MATLAB/ Scilab, creating variables and mathematical functions.
CLO2: Understand how to program matrix operations, array operations and how to solve the system of linear equations.
CLO3: Program the fundamentals concepts of basic Plotting consisting of simple and multiple data sets in one plot.
CLO4: Understand how to program M-file scripts, M- file functions, Input –output Arguments and program control flow operators, loops, flow structures.
CLO5: Use the debugging process and debugging M-files Prerequisites remark:
Familiarity with some mathematical notation, ideas and concepts covered at the pre-college levels.

Units/ Hours	**Contents**	**Mapping With Course Learning Outcome**
Units I Hours 12	**Introduction to MATLAB** History, basic features, strengths and weaknesses, good programming practices and plan your code. **Working with variables, workspace and miscellaneous commands:** Creating MATLAB variables, overwriting variable, error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating-point number, managing the workspace, keeping track of your work session, entering multiple statements per line, miscellaneous commands	CLO1
	Learning Activities: Hands on training and practical assignments	

Units II Hours 13	**Matrix, array and basic mathematical functions** Matrix generation, entering a vector, entering a matrix, matrix indexing, colon operator, linear spacing, creating a sub-matrix, dimension, matrix operations and functions matrix generators, special matrices, array and array operations, solving linear equations, other mathematical functions.	CLO2
	Learning Activities: Hands on training and practical assignments	
Units III Hours 10	**Basic plotting** Overview, creating simple plots, adding titles, axis labels, and annotations, multiple data sets in one plot, specifying line styles and colours.	CLO3
	Learning Activities: Hands on training and practical assignments	
Units IV Hours 12	**Introduction to programming** Introduction, M-File Scripts, script side-effects, M-File functions, anatomy of a M-File function, input and output arguments, input to a script file, output commands. **Control flow and operators:** "if ... end" structure, relational and logical operators, "for ... end" loop, "while ... end" loop, other flow structures, operator precedence, saving output to a file.	CLO4
	Learning Activities: Hands on training and practical assignments	
Units V Hours 13	**Debugging M-files** Debugging process, preparing for debugging, setting breakpoints, running with breakpoints, examining values, correcting and ending debugging, correcting an M-file.	CLO5
	Learning Activities: Hands on training and practical assignments	

Text Books:

1. Digital Image Processing using MATLAB, Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,Pearson mEducation, Inc., 2004.

2. MATLAB: A PracticalIntroduction to Programming and Problem Solving, StormyAttaway Butterworth-Heinemann.

Reference Books:

1.https://www.mathworks.com/content/dam/mathworks/mathworks-dot-com/moler/exm/book.pdf2.

2.https://www.mathworks.com/help/releases/R2014b/pdf_doc/matlab/getstart.pdf

Course Code: BSC-301
Course Title: Mathematics III (Differential Calculus)
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives

The objective of this course is to equip students with numerical and analytical techniques essential for solving real-world scientific and engineering problems. Students will develop a strong foundation in various numerical methods including equation solving, interpolation, numerical integration, differential equations, and transform calculus. The course also introduces fundamental concepts of probability and statistical distributions relevant for data analysis and decision-making.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Apply numerical methods such as Bisection, Newton-Raphson, and interpolation techniques to solve algebraic and transcendental equations.
CLO2: Use numerical differentiation, integration, and matrix-solving methods to analyze mathematical problems.
CLO3: Solve ordinary and partial differential equations using numerical techniques like Runge-Kutta, Milne's predictor-corrector, and finite difference methods.
CLO4: Utilize Laplace and Fourier transforms in solving differential equations and analyze random phenomena using various probability distributions.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 Hours	**Numerical Methods** Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae.	CLO1
	Learning Activities: Lecture and Discussion, Interactive Demonstration	
Unit II 10 Hours	**Numerical Methods – 2** Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Solution of Simultaneous Linear Algebraic Equations by Gauss's Elimination, Gauss's Jordan, Crout's methods, Jacobi's, GaussSeidal, and Relaxation method.,	CLO2

	Learning Activities: Lecture and Discussion, Interactive Demonstration	
Unit III 11 Hours	**Numerical Methods – 3** Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. RungeKutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Partial differential equations: Finite difference solution two-dimensional Laplace equation and Poission equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.	CLO 3
	Learning Activities: Lecture and Discussion, Interactive Demonstration.	
Unit IV 12 Hours	**Transform Calculus:** Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace Transform method, Fourier transforms. **Concept of Probability**: Probability Mass function, Probability Density Function, Discrete Distribution: Binomial, Poisson's, Continuous Distribution: Normal Distribution, Exponential Distribution	CLO4
	Learning Activities: Lecture and Discussion, Interactive Demonstration.	

Text Books

1 P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2nd Edition, Reprint 2012.
2. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.
7. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
8. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
9. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968. Statistics
Numerical Methods – 3: (10 hours): Ordinary differential equations: Taylor's series, Euler and modified.

Course Code: HSMC-301
Course Title: Humanities-I
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to develop students' understanding of the human condition and the interrelationship between society, culture, and technology. It encourages critical thinking, ethical reasoning, and effective communication by engaging with fundamental concepts from literature, philosophy, psychology, and sociology. Through this course, students will be able to appreciate diverse perspectives, enhance their interpersonal skills, and understand the societal impact of engineering and technology.

Course Learning Outcomes: After the completion of the course, student will be able to:
CLO1: To develop strong natural familiarity with humanities
CLO2: To facilitate elimination of conflict and strife in the individual and society.
CLO3: Students shall be able to relate philosophy to literature, culture, society and lived experience can be considered.

Units/ Hours	**Contents**	**Mapping With Course Learning Outcome**
Units I Hours 12	The difference between knowledge (Vidya) and Ignorance (Avidya): Upanishads; Six systems orthodox and Heterodox Schools of Indian Philosophy. Greek Philosophy Origin of the Universe: NasidiyaSukta: "Who really knows?" Brhadaranyaka Upanishad; Chandogya Upanishad: Non-self, Self, real and unreal. Taittiriya Upanishad: SikshaValli.	CLO1
	Learning Activities: Discussions, Assignments	
Units II Hours 11	Plato's Symposium: Lack as the source of desire and knowledge. Socratic's method of knowledge as discovery. Language: Word as root of knowledge (Bhartrahari'sVakyapadiyam) Fourteen Knowledge basis as a sources of Vidya: Four Vedas; Six auxiliary sciences (Vedangas); Purana, Nyaya, Mimamsa and Dharma Sastras.	CLO2

	Learning Activities: Discussions, Assignments	
Units III Hours 10	Knowledge as Power: Francis Bacon. Knowledge as both power and self-realization in Bagavad Gita. Knowledge as oppression: M. Foucault. Discrimination between Rtam and Satyam in Indian Philosophy. Knowledge as invention: Modern definition of creativity; scientific activity in the claim that science invents new things at least through technology.	CLO3
	Learning Activities: Discussions, Assignments	
Units IV Hours 12	Knowledge about the self, transcendental self; knowledge about society, polity and nature. Knowledge about moral and ethics codes. Tools of acquiring knowledge: Tantrayuktis, a system of inquiry (Caraka, Sushruta, Kautilya, Vyasa	CLO4
	Learning Activities: Debates and Quiz	

READINGS

1. Copleston, Frederick, History of Philosophy, Vol. 1.Great Britain: Continuum.
2. Hiriyanna, M. Outlines of Indian Philosophy, MotilalBanarsidass Publishers; Fifth Reprint edition (2009)
3. Sathaye, Avinash, Translation of NasadiyaSukta
4. Ralph T. H. Griffith. The Hymns of the Ṛgveda. MotilalBanarsidass: Delhi: 1973.
5. Raju, P. T. Structural Depths of Indian Thought, Albany: State University of New York Press.
6. Plato, Symposium, Hamilton Press.
7. KautilyaArtha Sastra. Penguin Books, New Delhi.
8. Bacon, Nova Orgum
9. Arnold, Edwin. The Song Celestial.
10. Foucault, Knowledge/Power.
11. Wildon, Anthony, System of Structure.
12. Lele, W.K. The Doctrine of Tantrayukti. Varanasi: Chowkamba Series.
13. Dasgupta, S. N. History of Indian Philosophy, MotilalBanasidas, Delhi.
14. Passmore, John, Hundred Years of Philosophy, Penguin.

ASSESSMENT (indicative only):

Ask students to do term papers, for example, writing biographical details of founders, sustainers, transmitters, modifiers, rewriters; translating monographs of less known philosophers such as K. C. Bhattacharys, Daya Krishna, Gopinath Bhattacharya; comparative study of philosophical system such as MadhyasthaDarshan.

SEMESTER-IV

Course Code: PCC CS-401
Course Title: Discrete Mathematics
Total Hours: 60

L	T	P	Cr
3	1	0	4

Course Objectives:

The primary objective of the Discrete Mathematics course is to provide students with a strong foundation in mathematical concepts that are essential for understanding computer science and engineering. The course aims to introduce key topics such as logic, sets, relations, functions, combinatorics, graph theory, and mathematical reasoning, which are fundamental to the development of algorithms, data structures, and software systems. It emphasizes problem-solving skills, mathematical proof techniques, and the application of discrete structures to real-world computing problems. By the end of the course, students should be able to analyze and solve complex problems in computer science using discrete mathematical tools and principles.

Course Learning Outcomes:
After the completion of the course, student will be able to:

CLO1: To understand the basic concept of Artificial Intelligence and mathematical models behind them
CLO1: Understand examples in Computer Science through mathematical terminology and notation.
CLO2: Construct direct, and indirect, proofs of basic theorems.
CLO3: Understand the differences between a mathematical proof, a heuristic, and a conjecture.
CLO4: Learn how to divide a problem, or a proof, into smaller cases.
CLO5: Formulate mathematical claims and be able to construct counterexamples.
CLO6: Apply the knowledge of mathematics to solve real-world problems.

Units/ Hours	**Contents/Learning activities**	**Mapping with Course Learning Outcome**
Units I Hours 12	Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Units II Hours 11	Proof Methods and Strategies: Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency, Case analysis, Induction. **Learning Activities:** Interactive Lectures and Demonstrations	CLO2
Units III Hours 10	Extended Euclid's Greatest Common Divisor algorithm, The Fundamental Theorem of Arithmetic, Modular arithmetic, Coprimality (or Euler's totient function), Chinese Remainder Theorem. **Learning Activities:** Interactive Lectures and Demonstrations, Weekly assignments.	CLO3
Units IV Hours 11	Permutation & Combination, Inclusion- Exclusion, Pigeon-hole principle, Generating functions, Recurrence. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO4
Units V Hours 7	Connected components, Paths, Cycles, Trees, Hamiltonian/ Eulerian Walks, Coloring, Planarity, Matching. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO5
Units VI Hours 9	Languages of Propositional logic and First-order logic, expressing natural language sentences in languages of propositional and first-order logic, expressing natural language predicates in the language of first-order logic. Semantics of First- order logic: interpretation and its use in evaluating a formula. Optional advanced topics if there is extra time: Semantic entailment, Validity and Satisfiability. What is a proof system? E.g. natural deduction or analytical tableau. Notions of Consistency and Completeness of a logic. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO6

Suggested text books / Online lectures or tutorials:

1. Liu, C. L., & Mohapatra, D. P. (2008). Elements of Discrete Mathematics. Tata McGraw-Hill.
2. Rosen, K. H. (2019). Discrete Mathematics and Its Applications. (8^{th} Edition) ISBN10: 125967651X ISBN13: 9781259676512.
3. Huth, M., & Ryan, M. (2004). Logic in Computer Science: Modelling and Reasoning about Systems (2nd ed.). Cambridge University Press.
4. Cohen, D. I. A. (1978). Basic techniques of combinatorial theory. John Wiley.
5. Niven, I., Zuckerman, H. S., & Montgomery, H. L. (1991). An introduction to the theory of numbers. John Wiley & Sons.
6. Mitzenmacher, M., & Upfal, E. (2017). Probability and computing: Randomization and probabilistic techniques in algorithms and data analysis. Cambridge University Press.
7. C. J. Date (2019). Database Design and Relational Theory. Normal Forms and All That Jazz.

Course Code: PCC CS-402
Course Title: Computer Organization & Architecture
Total Hours: 60

L	T	P	Cr
3	0	0	3

Course Objectives

To elaborate basic computer organization, control unit and central processing unit. It helps the students to perform binary addition, subtraction, multiplication and division. This helps to know the key skills of constructing cost-effective computer systems and assist students in understanding various memory devices to facilitate students in learning IO communication.

Course Learning Outcomes

CLO1: To elaborate the key components of a computer organization, control unit and central processing unit and how the instructions are executed.
CLO2: To perform binary addition, subtraction, multiplication and division.
CLO3: To explain key skills of constructing cost-effective computer systems.
CLO4: To assist students in understanding various memory devices, memory hierarchy and efficiency achieved due to the use of cache and How the data is stored and input-output is performed in computers

Units/Hours	Contents	Mapping with Course Learning Outcome
Units I 14 Hours	**Introduction:** Historical overview, economic trends, underlying technologies, Data Representation- Data Types, Complements. Fixed-Point Representation, Floating-Point Representation. Error Detection and Correction, Addition, Subtraction, Multiplication and Division algorithms and hardware. **Register Transfer and Micro operations:** Register transfer language, Inter-Register Transfer, Arithmetic Micro operations, Logic and Shift micro-operations Language, Control functions.	CLO1
Unit II 16 Hours	**Arithmetic Logic Unit**: Arithmetic, logic and shift micro operations. Constructing an arithmetic logic shift unit. Basic Computer Architecture and Design: Computer registers, Computer Instructions-Instruction Set Completeness. Classifying Instruction Set Architecture.	CLO2

	Basic steps of Instruction Execution, Hardwired Control, Micro programmed Control. Horizontal and Vertical Microprogramming. Interrupts.	
Unit III 14 Hours	**Central Processing Unit:** General Register Organization. Stack Organized CPU. Instruction Formats, Addressing Modes. Data Transfer and Manipulation. RISCVs CISC. Pipelining: Parallel and pipeline Processing, Pipeline Control, Pipeline Implementations, Conflicts Resolution, and Pipeline Hazards. Vector Processing, and Array Processors.	CLO3
Unit IV 16 Hours	**Memory Organization:** Memory Systems: principle of locality, principles of memory hierarchy Caches, associative memory, main memory, Virtual memory, Paging and Segmentation, Memory Interleaving. Input Output Organization: I/O performance measures, types and characteristics of I/O devices, I/O Modes Programmed I/O, Interrupt Initiated I/O and DMA. Buses: connecting I/O devices to processor and memory, interfacing I/O devices to memory, processor, and operating system. Parallel Computers: Classification, SIMD, MIMD Organizations, Connection Networks, Data Flow Machines, and Multithreaded Architectures.	CLO4

Suggested text books / Online lectures or tutorials:

- T1 “Computer Organization and Design: The Hardware/Software Interface”, David A. Patterson and John L. Hennessy, 5th Edition, Elsevier.

Suggested reference books / Online resources:

- R1 “Computer Organisation & Architecture”, Smruti Ranjan Sarangi, McGraw Hill
- R2 “Computer System Architecture”, Mano M. Morris, Pearson.
- R3 “Computer Organization and Embedded Systems”, 6th Edition by Carl Hamacher, McGraHill Higher Education
- R4 “Computer Architecture and Organization”, 3rd Edition by John P. Hayes, WCB/McGraw-Hill

- R5 “Computer Organization and Architecture: Designing for Performance”, 10th Edition by William Stallings, Pearson Education.
- R6 “Computer System Design and Architecture”, 2nd Edition by Vincent P. Heuring and Harry F. Jordan, Pearson Education.
- R7 http://web.cecs.pdx.edu/~harry/riscv/RISCV-Summary.pdf

Online simulators and tools:

- RIPES: https://freesoft.dev/program/108505982
- GEM5: https://www.gem5.org/documentation/learning_gem5/introduction/
- CACTI: https://github.com/HewlettPackard/cacti
- PIN:https://www.intel.com/content/www/us/en/developer/articles/tool/pin-a-binary-instrumentation-tool downloads.html
- TEJAS: https://www.cse.iitd.ac.in/~srsarangi/archbooksoft.html
- XILINX(VHDL/Verilog tools): https://www.xilinx.com/support/university/students.html

Course Code: PCC LC-402
Course Title: Computer Organization & Architecture - Laboratory
Total Hours: 30

L	T	P	Cr
0	0	4	2

Course Objectives:
To provide hands-on experience in computer organization and architecture, focusing on processor design, memory systems, instruction sets, and assembly programming. The course aims to develop practical skills in understanding machine-level operations and system performance optimization.

Course Learning Outcomes
CLO1: Demonstrate the practical implementation of key concepts in computer organization, including CPU architecture, memory hierarchy, and I/O systems.
CLO2: Develop and debug assembly language programs, understanding machine-level operations and instruction formats.
CLO3: Analyze the performance of different hardware components and identify optimization techniques at the architectural level.
CLO4: Implement and simulate basic processor design and memory management systems to understand their real-world applications.
CLO5: Apply the knowledge of computer architecture to solve problems related to data representation, instruction execution, and system design.

Laboratory/ Practical
1. Write an ARM/RISC-V assembly program to generate Happy Numbers / Autonomic Numbers /Hardy–RamanujanNumbers.
2. Implement a **4-function calculator** using ARM/RISC-V assembly language.
3. Develop an assembly program to **sort an integer array using merge sort (recursive)**.
4. Evaluate an **arithmetic expression given as a string** using recursive functions in assembly.
5. Design and implement a **simple game** (e.g., number guessing, basic puzzle) in assembly.
6. Simulate the above programs on an instruction set simulator (e.g., RARS for RISC-V, Keil for ARM).
7. Simulate and analyze pipeline stalls using **RIPES or similar tools** for:
    - Data hazards
    - Control hazards
    - With/without forwarding
8. Rearrange instruction sequences to **minimize pipeline stalls** and compare performance.
9. Observe pipeline behaviour for loops, conditional statements, and function calls.
10. Use **gem5 simulator** to run a benchmark and record:
    - IPC (Instructions per Cycle)
    - Cache hit rate
    - Number of conflict misses and block replacements
11. Vary cache configurations (size, associativity, block size) and analyze the impact.
12. Modify block replacement policy (e.g., LRU to Random) and observe performance.
13. Calculate **access time, power, and area** using tools like **CACTI**.

Course Code: PCC CS-403
Course Title: Design and Analysis of Algorithms
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to:

To provide students with the knowledge and skills necessary to design and analyze algorithms for solving computational problems. To introduce the students to recent developments in the area of algorithmic design.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: Analyse the complexity of algorithms and implement it in a specific scenario.

CLO2: Apply common algorithmic techniques such as greedy, dynamic programming, etc. to standard computational problems

CLO3: Develop efficient algorithms for various computationally challenging problems solving in computing.

CLO4: Apply tree and graph data structures for specific applications.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I Hours 12	**Complexity Analysis & Divide and Conquer Algorithms Introduction and Complexity Analysis:** Analysing algorithms, Complexity classes, Time and space trade-offs in algorithms, Recurrence relations, Analysis of iterative and recursive algorithms, and Masters' theorem. **Divide and Conquer:** Fundamentals of divide and conquer strategy, Applications such as Linear-time algorithm for finding the median, Closest pair of points, merge sort, quick sort, etc. **Learning Activities**: **Activities**: Assignment-based learning, visual modelling, and web-based animation of different algorithms (VisuAlgo Project).	CLO1
Units II Hours 12	**Greedy Algorithms and Dynamic Programming** **Greedy Algorithms:** Elements of greedy strategy, Applications such as activity selection, Huffman Coding, job sequencing, fractional knapsack problem, Kruskal's algorithm for minimum spanning trees, etc.	CLO2, CLO3

	Dynamic Programming: Notion of sub-problems and optimal substructure, Computing Fibonacci numbers: Why divide-and-conquer is inefficient, Dynamic Programming Applications: Subset sum problem, (Integer), 0/1 knapsack problem, Longest common subsequence, Matrix chain multiplication.	
	Learning Activities: **Activities**: Brainstorming, assignment-based learning, and implementation of different algorithms.	
III Units 10 hours	**Backtracking, Branch and Bound Algorithms, Problem Classes** **Backtracking:** Introduction, Applications such as N queen problem, the sum of subsets, graph coloring, etc. **Branch and Bound Algorithm:** General method, Applications such as 0/1 knapsack problem, Traveling salesperson problem, etc. **Problem Classes:** P, NP, NP-Hard, and NP-complete,	CLO2, CLO3
	Learning Activities: **Activities**: Problem-solving and solution design, Exercise-based learning.	
IV Units 15 hours	**Graph & Algorithms** **Graphs & Algorithms:** Introduction to graphs, Cut-sets, strongly connected components, and Topological sort. **Shortest Path Algorithms:** Dijkstra's algorithm (single-source shortest path), Bellman-Ford algorithm (handles negative weights), Floyd-Warshall algorithm (all-pairs shortest paths) **Max flow:** Ford Fulkerson algorithm, max flow- min cut.	CLO4
	Learning Activities: Activities: Brainstorming, assignment-based learning, and implementation of different algorithms.	

Text Books

1. Cormen H. T., Leiserson E. C., Rivest L. R., and Stein C., Introduction to Algorithms, MIT Press (2009) 3rd ed.
2. Horwitz E., Sahni S., Rajasekaran S., Fundamentals of Computers Algorithms, Universities Press (2008) 2nd ed.

Reference Books

1. Levitin A., Introduction to the design and analysis of algorithms, Pearson Education (2008) 2nd ed.
2. Aho A.V., Hopcraft J. E., Dulman J. D., The Design and Analysis of Computer Algorithms, Addsion Wesley (1974) 1st ed.
3. Sedgewick R. and Wayne K., Algorithms, Addison-Wesley Professional (2011), 4th ed.

Course Code: PCC LC-403
Course Title: Design and Analysis of Algorithms - Laboratory
Total Hours: 30

L	T	P	Cr
0	0	4	2

Course Objectives:
To provide hands-on experience in implementing and analyzing algorithms using techniques like divide and conquer, dynamic programming, greedy methods, and backtracking. The course focuses on evaluating algorithm efficiency, optimizing solutions, and applying them to real-world problems using languages like C, C++, or Python.

Course Learning Outcomes
CLO1: Implement and evaluate algorithms using appropriate programming languages and tools.
CLO2: Analyze and compare the time and space complexity of algorithms using Big-O notation.
CLO3: Apply different algorithm design techniques such as divide and conquer, dynamic programming, greedy methods, and backtracking to solve computational problems.
CLO4: Develop solutions for real-world problems by selecting and optimizing algorithms based on their efficiency and resource constraints.
CLO5: Understand and implement graph-based algorithms, sorting algorithms, and search algorithms, analyzing their performance in different scenarios.
CLO6: Demonstrate the ability to debug and test algorithmic implementations for correctness and efficiency.
Laboratory/ Practical

1. Sort a given set of elements using the Quicksort method and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
2. Implement a parallelized Merge Sort algorithm to sort a given set of elements and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
3. Obtain the Topological ordering of vertices in a given digraph.
4. Compute the transitive closure of a given directed graph using Warshall's algorithm.
5. Implement 0/1 Knapsack problem using Dynamic Programming.
6. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
7. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal’s algorithm.
8. Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s algorithm.
9. Implement All-Pairs Shortest Paths Problem using Floyd's algorithm.
10. Implement N Queen's problem using Back Tracking.

Course Code: PCC CS-404
Course Title: Advance Programming using Python
Total Hours: 60

L	T	P	Cr
4	0	0	0

Course Objectives:
To equip students with a solid foundation in Python programming, covering data types, object-oriented concepts, and exception handling, while introducing basic machine learning implementation and application development for Windows and Android platforms.

Course Learning Outcomes
Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand fundamentals of Python programming.
CLO2: Work with external libraries and frameworks
CLO3: Develop efficient and scalable code by applying object-oriented programming principles.
CLO4: Apply functional programming techniques
CLO5: Debug, test, and optimize Python programs
CLO6: Design and implement complex Python applications

Units/Hours	**Content/Activities**	**Mapping with Course Learning Outcome**
UNIT-1 (15 hrs)	**Fundamentals of Python Programming**: Features and applications, Creating Virtual Environments in Python, Memory Management, Python vs similar languages and tools, keywords, identifiers, statements, indentation, Syntax and Style-Data Types, Literals, variables, operators and expressions, text, and numbers. **Control Flow-** if-else statements, looping statements, range() function, break, continue and pass statements, loop variations, match statements. **Working with Data Structures-** Lists, tuples, sets, and dictionaries, basic list operators, replacing, inserting, removing an element, searching and sorting lists, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries.	**CLO1**

	Learning Activities: Download and install Python and frameworks like Anaconda and PyCharm. Creating Virtual Environments, Jupyter Notebooks. Home assignments: Examples of looping, creating various data structures in Python. Give students broken or badly styled code and ask them to fix errors related to indentation, syntax, naming conventions, etc.	
UNIT-2 (15 hrs)	**Strings and text file handling**: manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab separated), String manipulations: subscript operator, indexing, slicing a string. **Functions, Modules and Packages:** Defining functions, passing arguments and returning values, formal and actual arguments, named arguments, recursive functions, Lambda function, Modules: importing and creating a module, reloading a module. Packages: introduction to PIP, using Python packages, absolute and relative import, namespace package. **Python Object Oriented Programming:** Python Classes and Objects**,** Python Scope and namespaces, Creating a Python class and its objects, Accessing Class Attributes Using Objects, Creating Multiple Objects of a Python Class, Python methods and constructors, Python inheritance, polymorphism, and encapsulation, Private Variables, Iterators and Generators.	**CLO2** **CLO3**
	Learning Activities: Working with data files, importing, manipulating, and saving. Installing and Uninstalling Python packages. Interactive lectures, Home assignments. Students write a script that lists files in a directory, filters by extension, or renames/moves files. Provide messy text (e.g., logs, tweets); students extract usernames, hashtags, or reformat data. Provide a messy script and have students clean it up using proper function definitions, return values, and parameters. Students build a class to model a real-world entity (e.g., Book, BankAccount, Student) with attributes and methods.	

UNIT-3 (15 hrs)	**Errors and Exceptions:** Introduction, syntax errors, examples of exceptions, exceptions raising and handling, else with and except statement, assert statement and custom exceptions. **Multithreading:** Python Multithreading. **GUI in Python:** Creating GUIs in Python using Tkinter and Event handling, Widgets - label, button, check button, entry, list box, radio button, scrollbar, text, container, frame, menu, label frame, message, combo box, scale, canvas. Events and binds, handling keyboard, mouse and other events.	**CLO4** **CLO5**
	Learning Activities: Handling errors and exceptions: Provide intentionally broken code snippets with a mix of syntax and runtime errors. Students must identify the type of error and fix it. Students build a mini-application (e.g., login system, banking app) and raise custom exceptions like InvalidPasswordError or InsufficientFundsError. Creating GUIs using Tkinter. Home assignments, Presentations	
UNIT-4 (15 hrs)	**Machine Learning using Python:** Data collection, Python tools to collect online data, Data Preprocessing, Feature extraction, Supervised and Unsupervised Machine learning techniques and their Implementation in Python. Concept of Overfitting and Underfitting and how to handle them, Performance evaluation of Machine Learning models: Confusion Matrix, Accuracy, Precision, Recall, F-score (Micro v/s Macro), AUC-ROC curve. **Python for Mobile App Development:** Working with Kivy. Creating and packaging of Web/Mobile Apps.	**CLO5** **CLO6**
	Learning Activities: Collecting data from public sources and websites. Mini ML projects. Using Kivy to design and develop Android mobile apps. Assignments in the form of small projects and their presentations.	

Recommended Books:

1. T.R. Padmanabhan, Programming with Python, Springer.
2. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning.
3. Paul Barry, Head First Python, O'Reilly Media
4. David Beazley, Brian K. Jones, Python Cookbook: Recipes for Mastering Python 3, O'Reilly Media
5. Manaranjan Pradhan, Machine Learning using Python, Wiley
6. Ahmed Fawzy and Mohamed Gad, Building Android Apps in Python Using Kivy with Android Studio, Aspress.

Course Code: HSMC-401
Course Title: Management 1 (Organizational Behaviour/ Finance & Accounting
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives:
To develop an understanding of the individuals and groups behaviour inside organizations should further enhance your skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations

Course Learning Outcomes
Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the fundamental concepts, nature, and models of organizational behavior, including the impact of environmental and organizational factors on behavior.
CLO2: Analyze individual behavior in organizations through personality traits, learning styles, attitudes, values, perception, and emotional intelligence.
CLO3: Evaluate group dynamics, communication, conflict management, team building, and leadership theories to enhance interpersonal effectiveness in organizations.
CLO4: Apply the principles of motivation, organizational change, stress management, organizational culture, and development strategies to improve organizational effectiveness and employee well-being.

Units/ Hours	**Contents/Learning activities**	**Mapping with Course Learning Outcome**
Units I Hours 12	Focus and Purpose Definition, need and importance of organizational behaviour – Nature and scope – Frame work – Organizational behavior models, Organization and the environmental factors. Organizational Theory, Organizational behavior modification. Misbehavior –Types **Learning Activities:** Interactive Lectures and Demonstrations.	CLO1
Units II Hours 11	Individual Behavior Personality – Types – Factors influencing personality – Theories. Learning – Types of learners – The learning process – Learning theories. . Attitudes – Characteristics – Components – Formation – Measurement- Values.	CLO2

	Perceptions – Importance – Factors influencing perception – Interpersonal perception- Impression Management. Emotions and Moods in workplace	
	Learning Activities: Interactive Lectures and Demonstrations	
Units III Hours 10	Group Behavior Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Interpersonal Communication Team building - Interpersonal relations – Group decision making techniques. Meaning of conflict and its types, Conflict Redressal process Leadership and Power Leadership – Meaning, importance, traits, styles and Theories. Leaders Vs Managers. Sources of power – Power centers – Power and Politics. Motivation at work – importance, need, types and its effects on work behavior. Motivation Theories : Maslow's, Herzberg, etc.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations, Weekly assignments.	
Units IV Hours 12	Dynamics of Organizational Behavior Organizational culture and climate – Factors affecting organizational climate – Importance. Organizational change – Importance – Stability Vs Change – Proactive Vs Reaction change – the change process – Resistance to change – Managing change. Stress – Work Stressors – Prevention and Management of stress – Balancing work and Life. Organizational Development – Characteristics & objectives. Organizational effectiveness. Benchmarking- TQM and Six Sigma (Overview)	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Guidelines for Case analysis / presentations

Students should be given case studies as assignment and asked to present the same in the class for discussions, or seminars may be arranged on current issues related to the subject and marks be given on the basis of students' performance. (Cases or Seminars can be given on individual basis or on group basis).

Recommended Books:

1. Human Behavior at work Keith Devis
2. Organizational Behavior Concepts, Skills and Practices Kinicki Kreitner Dimension of Organizational Behavior T. Herbert
3. Organization & Management R. D. Agrawal
4. Organizational Behavior and Performance Aszilagyl & Walace

5. Organizational BehaviorK. Aswathapa
6. Organizational Behavior Jit Chandan
7. Organizational Behavior V. Ghosh
8. Organizational Behavior Gregory Morehead
9. Organizational Behavior Fred Luthans
10. Organizational Behaviorn Rosy Joshi
11. Organizational Behavior Stephen Robbins

Course Code: MC-401
Course Title: Environmental Sciences
Finance & Accounting
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives:
To develop an understanding of the individuals and groups behaviour inside organizations should further enhance your skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations

Course Learning Outcomes
CLO1: Understand the concept of natural resources, their classification, and the environmental issues associated with their use and over-exploitation.
CLO2: Comprehend the structure, functions, and types of ecosystems, and evaluate the interactions within ecosystems, including food chains, food webs, and ecological pyramids.
CLO3: Assess the importance of biodiversity and the threats to it, with a focus on endangered species, habitat loss, and conservation efforts at global, national, and local levels.
CLO4: Analyze social and environmental issues, with an emphasis on sustainable development, climate change, environmental ethics, and the role of public awareness in solving environmental problems.

Units/ Hours	**Contents/Learning activities**	**Mapping with Course Learning Outcome**
Units I Hours 12	Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. Focus and Purpose Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.	CLO1

	Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	
	Learning Activities: Interactive Lectures and Demonstrations.	
Units II Hours 11	Ecosystems Concept of an ecosystem. Structure and function of an ecosystem. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of following ecosystems: Forest ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	CLO2
	Learning Activities: Interactive Lectures and Demonstrations	
Units III Hours 10	Biodiversity and its conservation Introduction – Definition: genetic, species and ecosystem diversity. Biodiversity at global, National and local levels. India as a mega-diversity nation Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India	CLO3
	Learning Activities: Interactive Lectures and Demonstrations, Weekly assignments.	
Units IV Hours 12	Social Issues and the Environment From Unsustainable to Sustainable development Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, Nuclear accidents and holocaust. Case Studies. Public awareness.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Activities

Nature club (bird watching, recognizing plants at institute/at home, recognizing local animals, appreciating biodiversity

Impart knowledge and inculcate the habit of taking interest and understanding biodiversity in and around the college campus. The students should be encouraged to take interest in bird watching, recognizing local plants, herbs and local animals. The students should be encouraged to appreciate the difference in the local biodiversity in their hometown, in the place of their study and other places they visit for vacation/breaks etc.

Following activities must be included.

Identify a tree fruit flower peculiar to a place or having origin from the place. Making high resolution big photographs of small creatures (bees, spiders, ants.

mosquitos etc.) especially part of body so that people can recognize (games on recognizing animals/plants).

Videography/ photography/ information collections on specialties/unique features of different types of common creatures.

Search and explore patents and rights related to animals, trees etc. Studying miracles of mechanisms of different body systems.

Awareness Activities

a) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
b) Slogan making event
c) Poster making event
d) Cycle rally
e) Lectures from experts
f) Plantation
g) Gifting a tree to see its full growth
h) Cleanliness drive
i) Drive for segregation of waste
i) To live with some eminent environmentalist for a week or so to understand his work
j) To work in kitchen garden for mess
k) To know about the different varieties of plants
l) Shutting down the fans and ACs of the campus for an hour or so
m) Visit to a local area to document environmental assets river/forest/grassland/hill/mountain /lake/Estuary/Wet lands.

Recommended books

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. BharuchaErach,TheBiodiversityn of India, Mapin PublishingPvt.Ltd. Ahmedabad – 380 013, India

3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
6. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7. Heywood, V.H &Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
8. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
9. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
10. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
11. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
12. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
13. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
14. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia.

SEMESTER-V

Course Code: PCC CS-501
Course Title: Computer Networks
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course enables students to define and understand key concepts of computer networks, including the OSI and TCP/IP models, various network topologies, as well as the principles of modulation, multiplexing, and switching techniques. Learners will be able to analyze and differentiate between different LAN technologies and data communication protocols. They will also gain the ability to explain routing strategies and mechanisms for end-to-end communication. Furthermore, students will demonstrate knowledge of secure network applications and describe their functionalities in real-world contexts.

Course Learning Outcomes

After the completion of the course, student will be able to:
CLO1: Explain fundamental networking concepts and architectures
CLO2: Analyze and compare different LAN technologies and data communication protocols
CLO3: Evaluate and apply routing algorithms and end-to-end communication mechanisms
CLO4: Understand secure network applications and protocols.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	**Introduction:** Goals and Applications of Networks, Network structure and architecture, OSI reference model, TCP/IP Protocol suite, Layering principles, Network Topology Design, connecting devices, Physical Layer Transmission Media, Basic idea of modulation and multiplexing, Switching methods. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO1
Units II 11 Hours	**Local Area Networks:** LAN topologies: Bus topology, Ring topology, Token passing rings, FDDI, Star topologies, Asynchronous transfer mode, Ethernet, IEEE standards 802.3, 802.5. Wireless LANs: IEEE 802.11 and Bluetooth. Reliable Data Delivery: Error detection and Correction, Error control (retransmission techniques, timers), Flow control (Acknowledgements, sliding window), Medium Access sub	CLO2

	layer - Channel Allocations, LAN protocols - ALOHA protocols, CSMA, CSMA/CD, Overview of IEEE standards.	
	Learning Activities: Interactive Lectures and Demonstrations.	
Units III 12 Hours	End-to-end Delivery, routing and Forwarding: Routing versus forwarding, Static and dynamic routing, Unicast and Multicast Routing. Distance-Vector, Link-State, Shortest path computation, Dijkstra's algorithm, Network Layer Protocols (IP, ICMP), IP addressing, sub netting and super netting (CIDR), IPV4 and IPV6, Address mapping-ARP, RARP. **Process-to-process Delivery:** UDP and TCP segment formats, connection establishment and termination, Principles of congestion control, Approaches to Congestion control, Quality of service, Flow characteristics, Techniques to improve QoS. Brief introduction to session and presentation layer.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Units IV 11 Hours	**Network applications and security:** Naming and address schemes (domain name system, IP addresses, Uniform Resource Identifiers, etc.), HTTP as an application layer protocol, Remote login, Electronic mail, SMTP, WWW and SNMP. Security in computer networks: principles of cryptography, symmetric key, public key, authentication protocols.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books:

1. A.S. Tanenbaum and D.J. Wetherall, Computer Networks, 5th edition, Pearson, 2013.
2. J.F. Kurose and K.F. Ross, Computer networking: a top-down approach, 6th edition, Pearson, 2017. (6th edition is low-cost Indian edition. 7th edition is high-cost, may be used if available.)

Reference books:

1. William Stalling, "Data and Computer Communication", Pearson Education, 7th Edition, 2nd Indian Reprint 2010.
2. Behrouz A. Fourouzan,Data Communications and Networking, 2/e Tat McGrawhill,2006.
3. R. Jain, The art of computer systems performance analysis, Wiley India, 1991.
4. S.K. Bose, An Introduction to Queueing Systems, Springer Science + Business Media New York, 2012.
5. Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach, 6th Edition

Course Code: PCC LC-501
Course Title: Computer Networks Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:

To provide hands-on experience in computer networking fundamentals, including network architecture, protocols, and configuration. The lab focuses on implementing and analyzing protocols across all layers, using simulation tools, socket programming, and basic network security techniques.

Course Learning Outcomes

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

CLO1: Identify and interpret network models, topologies, and connecting devices using simulation tools.

CLO2: Configure and simulate wired and wireless networks, evaluate protocol performance.

CLO3: Implement error detection, flow control, and medium access protocols in a net env.

CLO4: Apply routing algorithms and perform IP addressing including subnetting and supernetting.

CLO5: Develop and test network applications using socket programming.

CLO6: Analyze and troubleshoot application-layer and transport-layer protocols using packet analyzers (e.g., Wireshark).

CLO7: Demonstrate basic network security concepts including encryption and authentication.

List of Experiments

1. Study and explain OSI and TCP/IP models using diagrams or network simulation tools.
2. Configure different network topologies (Bus, Star, Ring) using Cisco Packet Tracer.
3. Simulate various transmission media (coaxial, fiber optic, wireless) and observe performance.
4. Implement and visualize modulation and multiplexing techniques using basic tools.
5. Configure Ethernet LAN using switches and hubs in a simulated environment.
6. Setup and analyze wireless networks using IEEE 802.11 (WiFi) and Bluetooth protocols.
7. Implement error detection methods such as Parity Bit, CRC (Cyclic Redundancy Check).
8. Simulate and compare ALOHA, CSMA/CD protocols using network simulation tools (e.g., NS2/NS3).
9. Configure and analyze static and dynamic routing protocols like RIP and OSPF.
10. Perform subnetting and supernetting calculations; implement using Packet Tracer.
11. Capture and analyze IP, ICMP, ARP, and RARP packets using Wireshark.
12. Write socket programs in Python to demonstrate TCP and UDP communication.
13. Simulate congestion control and QoS (Quality of Service) parameters.
14. Configure and analyze application layer protocols such as HTTP, FTP, SMTP using Wireshark or Telnet.
15. Implement basic cryptographic algorithms (symmetric and public key) in Python or Java.
16. Simulate and observe DNS resolution using `nslookup`, `dig`, or network tools.
17. Mini Project: Design a network scenario demonstrating end-to-end communicat**ion** with security features..

Course Code: PCC CS-502
Course Title: Introduction to Database Systems
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of database concepts, architectures, and techniques. It aims to develop foundational knowledge of data modelling, relational databases, and SQL programming, along with the ability to design, implement, and manage efficient databases. By integrating theoretical knowledge with hands-on practice, the course equips students with the skills to analyze complex data requirements, ensure data integrity and security, and optimize database performance. It also fosters critical thinking for addressing real-world data management challenges in modern information systems and applications.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: define database concepts, data processing, and DBMS.
CLO2: explain E-R model, relational model, SQL, and PL/SQL.
CLO3: use SQL and PL/SQL for database creation and management.
CLO4: analyze schemas, normalize databases, and optimize queries.
CLO5: design efficient databases using transactions, indexing, and recovery.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	Data processing requirement, Characteristics of an ideal data processing system, traditional file-based system data dependency, database management system, database schema architecture. E-R data model: entities, attributes, relationships, generalization, specialization, specifying constraints, ER Models to Tables.	CLO1, CLO2
	Learning Activities: Lecture sessions - In-class activity: Identify and classify entities and relationships from real-world scenarios, Tutorial on converting ER diagrams to relational schemas	

Units II 11 Hours	Introduction to Relational Database, relation, keys, relational model integrity rules, introduction to Relational Algebra, Introduction to Relational Calculus Introduction to SQL: DDL, DML, and DCL, PL/SQL: cursor, stored function, stored procedure, triggers, error handling, and package.	CLO2, CLO3
	Learning Activities: Hands-on lab: Create and manage databases using SQL, Practice exercises on relational algebra, Lab assignments on PL/SQL procedures and triggers	
Units III 12 Hours	Database Design and Normalization: Functional Dependencies, Normalization - 1NF, 2NF, 3NF, BCNF, 4NF and 5NF. Concept of Denormalization. Query Processing: External sort, Joins using nested loops, indexed nested loops. Overview of Query Optimization: equivalent expressions, and concept of cost-based optimization	CLO4
	Learning Activities: Case study: Normalize a given database and analyze its performance, Group activity: Cost-based query optimization example, Tutorial on denormalization scenarios	
Units IV 11 Hours	Transaction Management: Concept of Transaction, States of Transaction and ACID properties, Concurrency control, Need of Concurrency control, concept of Lock, Two phase locking protocol. Introduction to Recovery Management, Need of Recovery Management, Concept of Stable Storage, Log Based Recovery Mechanism, Checkpoint. Overview of Physical Storage (Hard Disks, Flash/SSD/RAM), sequential vs random I/O, Reliability via RAID, Indexing, B+-Trees	CLO5
	Learning Activities: Lab activity: Simulate transactions and concurrency scenarios, Concept mapping exercise on ACID and recovery steps, Demo on indexing & B+-Trees using sample data sets.	

Text Books

1. Database System Concepts, 7th Edition, Silberschatz, Korth and Sudarshan, McGraw-Hill. Indian Edition released 2021
2. Fundamentals of Database Systems, 7th Edition, Elmasri and Navathe, Pearson Pubs, 2017
3. Principles of Database Management, Lemahieu, Broucke and Baesens, Cambridge University Press, 2018

Suggested Readings

1. Software:

a. Relax Relational algebra calculator: https://dbis-uibk.github.io/relax/landing
b. SQL: PostgreSQL/MySQL/MariaDB, or SQLite in browser
c. B+-tree visualization: https://www.cs.usfca.edu/~galles/visualization/BPlusTree.html
d. MongoDB e. Various DB systems playground: https://www.pdbmbook.com/playground

Course Code: PCC LC-502
Course Title: Introduction to Database Systems Lab
Total Hours: 45

L	T	P	Cr
0	0	4	2

Course Objectives

To equip students with practical skills in designing, implementing, and managing relational databases using SQL and DBMS tools, covering key concepts like normalization, data integrity, transactions, and database security.

Course Learning Outcomes: After the completion of the course, student will be able to:

CLO1: Develop a strong understanding of the fundamental concepts of databases, including DBMS architecture, SQL, and database design.

CLO2: Design and implement relational databases, ensuring effective normalization and reducing redundancy.

CLO3: Write and optimize SQL queries for various database operations, including data retrieval, updates, and joins.

CLO4: Understand and implement database integrity constraints to ensure data consistency and reliability.

CLO5: Apply transactions, triggers, stored procedures, and security mechanisms to manage and protect databases.

CLO6: Manage database backups, recovery, and performance optimization using indexing and efficient querying techniques.

CLO7: Design and implement databases for real-world applications, demonstrating the ability to solve practical problems using a database management system.

List of Experiments:

1. Introduction to Database Management Systems (DBMS) and Setting up a Database Environment (e.g., MySQL, Oracle, SQL Server).
2. Creating a Database, Tables, and Defining Data Types.
3. Inserting, Updating, and Deleting Data in Tables.
4. Writing SQL Queries to Retrieve Data (SELECT, WHERE, GROUP BY, HAVING).
5. Using Joins (INNER JOIN, LEFT JOIN, RIGHT JOIN, FULL JOIN) in SQL Queries.
6. Implementing Subqueries and Nested Queries.
7. Creating and Using Indexes to Improve Query Performance.
8. Implementing and Using Views in SQL.
9. Data Integrity Constraints: Primary Key, Foreign Key, Unique, Not Null, and Check Constraints.
10. Implementing Transactions and Understanding ACID Properties.
11. Designing and Implementing a Relational Database Model for a Real-World Problem.
12. Normalization of Database Tables up to Third Normal Form (3NF).
13. Using Triggers and Stored Procedures in SQL.
14. Backup and Recovery Operations in a Database.
15. Implementing Security Measures and User Privileges in Database Systems.

Course Code: PCC CS-503
Course Title: Machine Learning
Total Hours: 60

L	T	P	Cr
3	1	0	4

Course Objectives:

The course aims to introduce the core concepts and motivation behind machine learning, focusing on its application in solving complex computational problems. It will explore fundamental algorithms and techniques such as regression, classification, and dimensionality reduction, which form the foundation of machine learning. Students will gain a deep understanding of various learning paradigms, including supervised and unsupervised learning, model evaluation techniques, and the concept of generalization. The course also provides exposure to advanced models like neural networks and deep learning frameworks, enabling students to understand the evolution and power of modern machine learning methods. Ultimately, the course will equip students with the skills to implement, evaluate, and optimize machine learning algorithms on real-world data, preparing them for practical applications in the field of artificial intelligence.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Explain the role of machine learning, formulate ML problems, and apply probability-based reasoning like Bayes Rule.
CLO2: Implement and analyze foundational ML algorithms like PCA, KNN, Linear Regression, and Decision Trees with an understanding of model generalization.
CLO3: Evaluate and apply algorithms such as Random Forest, SVM, K-Means, Logistic Regression, and Naive Bayes to classification and clustering tasks.
CLO4: Design and train neural networks, understand gradient-based optimization, and implement deep learning models such as MLPs and CNNs for classification and regression.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
	Introduction to Machine Learning: Motivation and role of machine learning in computer science and problem- solving. Representation (features), linear transformations, Appreciate linear transformations and matrix vector operations in the context of data and representation. Problem formulations (classification and regression). Appreciate the probability distributions in the context of	

Unit I 11 Hours	data, Prior probabilities and Bayes Rule. Introduce paradigms of Learning (primarily supervised and unsupervised. Also, a brief overview of others)	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Units II 11 Hours	**Fundamentals of ML** PCA and Dimensionality Reduction, Nearest Neighbours and KNN, Linear Regression, Decision Tree Classifier, Notion of Generalization and concern of Overfitting, Notion of Training, Validation and Testing; Connect to generalisation and overfitting	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Units III 12 Hours	**Selected Algorithms** Ensembling and RF, Linear SVM, K Means, Logistic, Regression, Naive Bayes	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Units IV 11 Hours	**Neural Network Learning** Role of Loss Functions and Optimization, Gradient Descent and Perceptron/Delta Learning, MLP, (iv)Backpropagation, MLP for Classification and Regression, Regularisation, Early Stopping, Introduction to Deep Learning and CNNs	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Suggested text books / Online lectures or tutorials:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (23 April 2020)
2. Tom M. Mitchell- Machine Learning - McGraw Hill Education, International Edition
3. Aurélien Géron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition

Reference Books:

1. Ian Goodfellow, Yoshoua Bengio, and Aaron Courville Deep Learning MIT Press Ltd, Illustrated edition
2. Christopher M. Bishop Pattern Recognition and Machine Learning - Springer, 2nd edition
3. Trevor Hastie, Robert Tibshirani, and Jerome Friedman - The Elements of Statistical Learning: Data Mining, Inference, and Prediction - Springer, 2nd edition

Course Code: PCC CS-504
Course Title: Operating Systems
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide students with a thorough understanding of Operating System (OS) concepts, including system architecture, system calls, and the various components that form the backbone of modern OS. It will delve into process management, exploring scheduling, synchronization, and communication techniques that ensure smooth execution of tasks. The course will also cover memory management techniques such as paging, segmentation, and virtual memory, which are crucial for efficient resource utilization. In addition, students will evaluate different file systems, I/O management strategies, and network operating systems,

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Explain OS design issues, system architecture, and key components.
CLO2: Analyze process scheduling, synchronization, and inter-process communication.
CLO3: Compare and apply different memory management techniques.
CLO4: Assess file systems, I/O mechanisms, network OS, and security threats.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	**Concepts of Operating Systems:** Computer system overview, concept of an operating system, multiprogramming, multiprocessing, multi user, time sharing, Multitasking, personal system, parallel system, real time system, general system architecture, System components, operating system services, system calls, system programs, system structure, Approaches to OS design and implementation. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO1
Units II 11 Hours	**Processes Management:** Concept of process, process states, process state transitions, process control block, operations on processes, Process scheduling , scheduling criteria, Inter process Communication, Concurrent processes. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO2

Units III 12 Hours	**Memory Management:** Logical and physical address space, storage allocation and management techniques, swapping concepts of multi programming, paging, segmentation, virtual Memory, demand paging. **Input/output And Data Management:** Directory structure and implementation, protection file system structure, allocation methods, free space management, Storage management, buffering, swap space management, RAID Technologies	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Units IV 11 Hours	Network operating system, distributed operating system, access control, Client server computing, Tiny Operating System for low-power wireless devices. **OS Security Threats:** Types of Threats in Operating System, Malware, Viruses, Worms, Rootkits and defence against Security threat, Logging, Auditing, and Recovery.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books:

1. 1.Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts", 2018, 10th Edition, Wiley, United States.
2. Operating Systems: Three Easy Pieces Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau Arpaci-Dusseau Books, LLC (online version)
3. Design of the UNIX Operating System Maurice J. Bac Pearson Education India; First edition
4. Advanced Programming in the UNIX® Environment W. Richard Stevens, Stephen A. Rago Pearson Education India; Third edition
5. 5.Xv6, a simple Unix-like teaching operating system Frans Kaashoek, Robert Morris, and Russ Cox

References Books

1. Andrew S. Tanenbaum, "Modern Operating Systems", 2016, 4th Edition, Pearson, United Kingdom.
2. William Stallings, "Operating Systems: Internals and Design Principles", 2018, 9th Edition, Pearson, United Kingdom.
3. N Chauhan, "Principles of Operating Systems" 1st ed. 2018
4. Think OS, A Brief Introduction to Operating Systems. Allen B. Downey
5. Linux Kernel Development, Robert Love, Pearson Education India; 3rd edition
6. Operating Systems: Principles and Practice, Thomas Anderson, Michael Dahlin, Recursive Books; 2nd Edition,
7. Computer Systems: A Programmer's Perspective, Randall E. Bryant, David R.O' Halloran, Pearson Education India; 3rd edition.
8. The C Programming Language, Brian Kernighan, Dennis Ritchie, Pearson Education.

Course Code: PCC LC-504
Course Title: Operating Systems Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:

To provide students with a solid understanding of operating system concepts, including process and memory management, file systems, system calls, and security. The course emphasizes OS architecture, scheduling, synchronization, and modern OS challenges.

Course Learning Outcomes

CLO1: Gain hands-on experience in implementing process management techniques such as process creation, scheduling, synchronization, and communication.
CLO2: Demonstrate the ability to implement memory management techniques including paging, segmentation, and virtual memory.
CLO3: Apply file management concepts to create, organize, and manipulate files using system calls.
CLO4: Analyze the working of I/O management and device handling in an operating system.
CLO5: Implement basic OS concepts like process scheduling algorithms, file systems, and memory allocation in a simulated environment.
CLO6: Develop programs for process synchronization and inter-process communication using semaphores, pipes, and shared memory.
CLO7: Explore real-world issues such as deadlock detection and prevention, memory fragmentation, and file management strategies.

List of Experiments

1. Implementation of Process Creation and Termination
2. Process Scheduling Algorithms (e.g., FCFS, SJF, Round Robin)
3. Simulation of CPU Scheduling Algorithms
4. Implementation of Semaphore Operations for Process Synchronization
5. Implementation of Producer-Consumer Problem using Semaphores
6. Implementation of Memory Management Techniques (Paging, Segmentation)
7. Implementation of Virtual Memory using Paging and Page Replacement Algorithms
8. Implementation of File Management System and Directory Management
9. Implementation of I/O System Management (Device Management, Buffering, Caching)
10. Implementation of Deadlock Detection and Prevention Algorithms
11. Simulation of File Allocation Strategies (e.g., Contiguous, Linked, Indexed)
12. Implementation of Inter-Process Communication (IPC) using Message Queues
13. Implementation of Disk Scheduling Algorithms (e.g., FCFS, SCAN, C-SCAN)
14. Simulation of Memory Allocation Algorithms (e.g., First Fit, Best Fit, Worst Fit)
15. Implementation of Multithreading in an Operating System Environment

Course Code: HSMC-501
Course Title: Humanities II
Total Hours: 45

L	T	P	Cr
3	1	0	4

Course Objectives

The course aims to help students understand the need, content, and process of value education while fostering the ability for self-exploration and a deeper understanding of human aspirations. It enables students to comprehend harmony within the self, family, society, and nature. Additionally, the course sensitizes learners to the importance of sustainable living and ecological balance, and strives to instil ethical competence and a sense of responsibility in both professional and social life.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Recognize the purpose of life and practice self-exploration for happiness and prosperity.
CLO2: Distinguish between needs of the self and the body and ensure health and well-being.
CLO3: Apply values like trust and respect to build harmonious relationships and society.
CLO4: Understand ecological harmony and practice coexistence with nature.
CLO5: Demonstrate ethical behaviour and contribute to people- and eco-friendly professional practices.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	**Process for Value Education** Purpose and motivation for the course, recapitulation from Universal Human Values-I Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity-A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and	CLO1

	living in harmony at various levels.	
	Learning Activities: Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.	
Units II 11 Hours	**Understanding Harmony in the Human Being - Harmony in Myself!** Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail Programs to ensure Sanyam and Health.	CLO2
	Learning Activities: Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.	
Units III 12 Hours	**Understanding Harmony in the Family and Society- Harmony in Human- Haman Relationship** Understanding values in human-human relationship; meaning of justice (nine universal values in relationships) and program for its fulfilment to ensure happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.	CLO3

	Learning Activities: Include practice sessions to reflect on relationship in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives	
Units IV 11 Hours	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence** Understanding the harmony in the Nature Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature Understanding Existence as Co-existence of mutually interacting units in all- pervasive space Holistic perception of harmony at all levels of existence.	CLO4
	Learning Activities: Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources	
Units V 11 Hours	**Implications of the above Holistic Understanding of Harmony on Professional Ethics** Natural acceptance of human values Definitiveness of Ethical Human Conduct Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco -friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations. Sum up.	CLO5
	Learning Activities: Include practice Exercises and Case Studies will be taken up in Practice (tutorial)	

Reading:

3.1 Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference books:

1. Jeevan Vidya: Ek Parichaya,A. Nagaraj
2. Jeevan Vidya: Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers,New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj –Pandit Sunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Course Code: MC-502
Course Title: Constitution of India/ Essence of Indian Knowledge Tradition
Total Hours: 30

L	T	P	Cr
2	0	0	0

Course Objectives:

This course is designed to introduce students to the history and philosophy underlying the Indian Constitution. It provides a comprehensive understanding of the structure, functions, and powers of the Union and State governments. The course familiarizes students with fundamental rights, duties, and directive principles enshrined in the Constitution. It also explains the functioning of local administration and grassroots governance, while developing awareness about the electoral process and the pivotal role of the Election Commission in ensuring democratic practices.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the making, structure, and key features of the Indian Constitution.
CLO2: Explain the roles and powers of the President, Prime Minister, and Parliament.
CLO3: Describe the structure and functioning of state governments and the role of the Governor and Chief Minister.
CLO4: Analyze the framework and functioning of local self-government institutions.
CLO5: Evaluate the electoral system and the responsibilities of the Election Commission.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	**The Constitution - Introduction** The History of the Making of the Indian Constitution, Preamble and the Basic Structure, and its interpretation, Fundamental Rights and Duties and their interpretation, State Policy Principles **Learning Activities**: Interactive Lectures and Demonstrations.	CLO1
Units II 11 Hours	**Union Government,** Structure of the Indian Union**,** President – Role and Power**,** Prime Minister and Council of Ministers**,** Lok Sabha and Rajya Sabha **Learning Activities**: Interactive Lectures and Demonstrations.	CLO2
Units III 12 Hours	**State Government** Governor – Role and Power, Chief Minister and Council of Ministers, State Secretariat	

	Learning Activities: Interactive Lectures and Demonstrations.	CLO3
Units IV 11 Hours	**Local Administration** District Administration, Municipal Corporation, Zila Panchayat	
	Learning Activities: Interactive Lectures and Demonstrations.	CLO4
Units V 11 Hours	**Election Commission** Role and Functioning**,** Chief Election Commissioner**,** State Election Commission	CLO5
	Learning Activities: Interactive Lectures and Demonstrations.	

Suggested Learning Resources:

S. No.	Title of Book	Author	Publication
1	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008
2	The Constitution of India	B.L. Fadia	Sahitya Bhawan; New edition (2017)
3	Introduction to the Constitution of India	DD Basu	Lexis Nexis; Twenty-Third 2018 edition

Suggested Software/Learning Websites:

1. https://www.constitution.org/cons/india/const.html
2. http://www.legislative.gov.in/constitution-of-india
3. https://www.sci.gov.in/constitution
4. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL ID	NPTEL Course Name	Instructor	Host Institute
1	12910600	Constitution Of India And Environmental Governance: Administrative And Adjudicatory Process	Prof. Sairam Bhat, Prof. M. K. Ramesh	National Law School Of India University

SEMESTER-VI

Course Code: PCC CS-601
Course Title: Software Engineering
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to introduce students to the fundamental principles of software engineering, including software development life cycle models, requirement analysis, design, testing, and maintenance. It equips students with practical skills to design and develop reliable, efficient, and scalable software systems using industry-relevant tools and methodologies.

Course Learning outcomes: After the completion of the course, student will be able to:

CLO1. Analysis of different software development process models.
CLO2. Extract and analyze software requirements specifications for different projects.
CLO3. Develop some basic level of software architecture/design and apply standard coding practices.
CLO4. Apply different testing and debugging techniques and analyze their effectiveness.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 12 Hours	Introduction to Software Engineering: The evolving role of software, Changing Nature of Software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, the unified process.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations	
Unist II 11 Hour	Software Requirements: Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management. System models: Context Models, Behavioral models, Data models, Object models, structured methods.	CLO2
	Learning Activities: Interactive Lectures and Demonstrations	

Unit III 11 Hours	Design Engineering: Design process and Design quality, Design concepts, the design model. Creating an architectural design: Software architecture, Data design, Architectural styles and patterns, Architectural Design. Object-Oriented Design: Objects and object classes, An Object-Oriented design process, Design evolution. Performing User interface design: Golden rules, User interface analysis and design, interface analysis, interface design steps, Design evaluation. Testing Strategies: A strategic approach to software testing, test strategies for conventional software, Black-Box and White-Box testing, Validation testing, System testing, the art of Debugging.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations	
Unit IV 11 Hours	Product metrics: Software Quality, Metrics for Analysis Model, Metrics for Design Model, Metrics for source code, Metrics for testing, Metrics for maintenance. Metrics for Process and Products: Software Measurement, Metrics for software quality. Risk management: Reactive vs. Proactive Risk strategies, software risks, Risk identification, Risk projection, Risk refinement, RMMM, RMMM Plan. Quality Management: Quality concepts, Software quality assurance, Software Reviews, Formal technical reviews, Statistical Software quality Assurance, Software reliability, The ISO 9000 quality standards. CASE Tools: Types of CASE tools, advantages and components of CASE tools, Unified Modelling Language (UML), Hands on practice of CASE tools.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations	

TEXT BOOKS, AND/OR REFERENCE MATERIAL

1. Software Engineering- K.K. Agarwal&Yogesh Singh, New Age International Publishers
2. Software Engineering, an Engineering approach- James F. Peters, WitoldPedrycz, John Wiely.
3. Software Engineering principles and practice- Waman S Jawadekar, The McGraw-Hill Companies.
4. Software Engineering, A practitioner's Approach- Roger S. Pressman, 6th edition. McGrawHill International Edition.
5. Software Engineering- Sommerville, 7th edition, Pearson education

Course Code: PCC CS-602
Course Title: Introductory Cyber Security
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to introduce students to the fundamental principles, concepts, and practices of cyber security. It aims to develop an understanding of the core aspects of information security, including the confidentiality, integrity, and availability (CIA) triad, common threats and vulnerabilities, encryption and authentication mechanisms, network security measures, and malware analysis techniques. The course is designed to equip students with the ability to identify, assess, and mitigate various types of cyber threats and to apply appropriate security controls in web, mobile, and networked environments. Through practical exercises and case-based learning, students will gain the skills necessary to understand and respond to modern cybersecurity challenges

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: understand core cybersecurity concepts, including the CIA Triad and common threats.
CLO2: apply encryption techniques like DES, AES, and hashing algorithms for data security.
CLO3: identify and mitigate web and mobile security risks.
CLO4: implement network security measures such as firewalls, IDS/IPS, DNSSEC, and IPSec.
CLO5: perform basic malware analysis and apply techniques to detect and respond to malicious software.

Activities : Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	Introduction and basic terminology: Cyber Security and CIA Triad, basic cyber threats to CIA, cyber-attack surfaces, Analysis of recent cyber-security incidents. Classical Encryption: Symmetric Cipher models, Vigenere cipher, Stream ciphers, Block Ciphers: Substitution and permutation networks (SPN), Feistel structure, description of Data Encryption Standard (DES). Advanced Encryption Standard (AES).	CLO1, CLO2
	Learning Activities: Lecture & Discussion on real-world cyber incidents, Demonstration: DES and AES encryption	

	using online tools or Python, Group activity: CIA triad application on sample case	
Units II 11 Hours	Hashing: MD5, SHA-256, Digital Signature, Digital Certificate and PKI. Authentication, Authorization and Privileges: Importance of strong Authentication, distinction between authorization and authorization, access control, Mandatory and Discretionary Access control, role based authorization, privilege and privilege escalation. Web Security: User Side, Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data, Email Attacks, XSS, CSRF, SQL Injection, Command Injection concepts, examples of these attacks and mitigation techniques. OWASP Mobile Top 10 Vulnerabilities	CLO2, CLO3
	Learning Activities: Lab: Hashing using tools or Python, Activity: Simulate SQL injection & its prevention, Case Study: OWASP Top 10 vulnerabilities, Role Play: Authentication vs. Authorization scenarios	
Units III 11 Hours	Network Security: Network Concepts, Threats to Network Communications, Denial of Service, Distributed Denial-of-Service Strategic Defenses: Security Countermeasures, Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Vulnerabilities related to Network Protocols, DNSSEC, IPSec, WLAN Security: WLAN Vulnerabilities and attack, WLAN security protocols.	CLO4
	Learning Activities: Network simulation using Wireshark or Packet Tracer, Activity: DNS spoofing demo and mitigation strategy, Case discussion: IDS/IPS effectiveness, Quiz: WLAN security mechanisms	
Units IV 11 Hours	Basic Malware Analysis: Various malware classes and their characteristics, Difference between static analysis and dynamic analysis, Signature vs. behavioural detection techniques. Introduction to Mobile Application Security: Common Threats in Mobile Applications - API vulnerabilities, Insecure Data Transmission, Weak Authentication and Authorization;	CLO3, CLO5

	Security Challenges in Mobile Environments, OWASP Mobile Top 10 Vulnerabilities.	
	Learning Activities: Lab: Basic static malware analysis using strings/hex tools, Demonstration: Reverse engineering using open-source tools, Mobile app threat modeling activity, Discussion: Malware life cycle and prevention strategies.	

Text Books

1. Ross J. Anderson, Security Engineering, Third Edition, Wiley, Nov 2020.
2. Cryptography and Network Security by William Stallings.

Suggested Readings

1. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws 2nd Edition by D Stuttard and M Pinto
2. The Hacker Playbook: Practical Guide to Penetration Testing (vol. 1 and 2) by Peter Kim.

Course Code: PCC LC-602
Course Title: Introductory Cyber Security Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:

The Introductory Cyber Security Lab aims to provide students with practical hands-on experience in various cybersecurity tools and techniques. The course is designed to help students understand the fundamental security measures necessary to protect information systems from malicious attacks. It seeks to familiarize students with ethical hacking practices, security protocols, and encryption methods, ensuring they can apply defence mechanisms in real-world scenarios. The course also focuses on the practical aspects of securing networks, configuring security systems like firewalls and intrusion detection systems, and applying ethical hacking skills to assess and protect against vulnerabilities in networked environments.

Course Learning Outcomes

CLO1: Apply fundamental cybersecurity concepts and techniques to identify and mitigate common security threats and vulnerabilities in computer systems and networks.
CLO2: Demonstrate the use of various cybersecurity tools, including firewalls, intrusion detection systems, and encryption techniques, to secure networks and systems.
CLO3: Develop skills in ethical hacking practices, including penetration testing and vulnerability assessment, to evaluate the security posture of networked systems.
CLO4: Analyze and configure security protocols to ensure secure communication and data protection within various network environments.
CLO5: Understand the ethical and legal implications of cybersecurity practices and apply them in real-world scenarios to protect organizational assets.

List of Experiments

1. Introduction to Cyber Security Tools and Virtual Labs
2. Exploring Linux Command Line and Basic System Security
3. Password Cracking and Security Practices
4. Network Scanning and Enumeration
5. Packet Sniffing and Protocol Analysis
6. Web Application Vulnerability Testing
7. Introduction to Metasploit Framework
8. Implementing Symmetric and Asymmetric Encryption
9. Firewall and IDS/IPS Configuration
10. Understanding Phishing and Email Spoofing Techniques
11. Secure File Transfer and Communication
12. Introduction to Digital Forensics Basics
13. Implementing Two-Factor Authentication (2FA)
14. Log Analysis and System Monitoring
15. Mini Project / Case Study

Elective-I

Course Code: PEC - 601
Course Title: Information Security System
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course is designed to introduce fundamental mathematical concepts that are essential for understanding and implementing cryptographic algorithms. Students will gain an in-depth understanding of classical encryption techniques, symmetric key cryptography, and the principles behind block ciphers. The course will further explore advanced encryption techniques, including public-key cryptography, and will delve into critical concepts such as message authentication, hash functions, and digital signatures. Emphasis will be placed on the role of these techniques in ensuring data integrity, authentication, and non-repudiation, providing students with a comprehensive understanding of the security mechanisms that underlie modern cryptographic practices.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Apply mathematical principles such as modular arithmetic, Fermat's theorem, and Euler's theorem cryptographic algorithms
CLO2: Analyze classical encryption methods, block cipher techniques, and evaluate the security of symmetric key cryptographic systems.
CLO3: Demonstrate knowledge of advanced encryption techniques and public-key cryptography, and assess their effectiveness in securing communication.
CLO4: Implement cryptographic hash functions, message authentication codes, and digital signatures to ensure data integrity, authentication, and security in real-world applications.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	Mathematics of Cryptography- Prime and Composite Numbers, Greatest Common Divisor, Euclidean algorithm, Modulo arithmetic, Fermat's little theorem, Multiplicative Inverse, Euler's theorem and Totient function, Discrete logarithm, Random Number Generation.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Units II 11 Hours	Overview: Services, Mechanisms, and Attacks, A Model for Network, Security. **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Stegnography. Block Ciphers and The Data Encryption Standard: Simplified DES, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, Block Cipher Modes of Operation. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO2
Units III 12 Hours	Advanced Encryption Standard: Evaluation Criteria for AES, The AES Cipher. Public-Key Cryptography and RSA: Principles of Public-Key Cryptosystems, the RSA Algorithm. Key Management and Other Public-Key Cryptosystems: Key Management, Diffie-Hellman Key Exchange. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO3
Units IV 11 Hours	Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs. Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm, and HMAC. Digital Signatures: Digital Signatures, Digital Signature Standard. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO4

Text Books:

1. Prakash C. Gupta, Cryptography and Network Security, PHI, 1st ed., 2015
2. B. A. Forouzan, D Mukhopadhyay, Cryptography and Network Security, TMH, 3rd 2015

Reference Books:

1. William Stallings, “Cryptography and network Security”, Pearson Education 2015.
2. Atul Kahate, Cryptography and Network Security, TMH, 2nd ed., 2008

Course Code: PEC-602
Course Title: Blockchain Technology
Total Hours: 45

L	T	P	Cr
3	0	0	3

The course aims to provide students with a solid foundation in the concepts, design, and implementation of distributed systems. It focuses on understanding the challenges of distributed computing, including communication, synchronization, fault tolerance, scalability, and security. Students will learn key distributed algorithms and architectures, enabling them to design and analyze efficient and reliable distributed applications.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Analyze algorithms for public digital ledger to share information in a trustworthy and secure way
CLO2: Design applications of Blockchain from cryptocurrencies to various other domains, including business process management, smart contracts, IoT and so on.
CLO3: Evaluate the security aspects along with various use cases from different application domains

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 11 Hours	**Introduction to Blockchain:** History of Digital Money to Distributed Ledgers, Design Primitives: Protocols, Security, Consensus, Permissions, Privacy Blockchain Architecture and Design: Basic crypto primitives: Hash, Signature; Hashchain to Blockchain; Basic consensus mechanisms	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit II 12 Hours	Concept of Double Spending, hashing, Proof of Works, Bitcoin Network and payments, Bitcoin Networks Wallets, Bitcoin Payments, Innovation in Bitcoin, Bitcoin Clients and APIs. Introduction to Blockchain Platforms: Ethereum, Hyperledger, IOTA, EOS, Multichain, Bigchain etc. Advantages and Disadvantages, Ethereum vs Bitcoin, design a new Blockchain,	CLO2

	Potential for disruption, Design a distributed application, Blockchain Applications.	
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 10 Hours	Consensus: Requirements for the consensus protocols, Proof of Work (PoW), Scalability aspects of Blockchain consensus protocols Permissioned Blockchains: Design goals, Consensus protocols for Permissioned Blockchains	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 12 Hours	Hyperledger Fabric I: Decomposing the consensus process, Hyper ledger fabric components, Chaincode Design and Implementation Hyperledger Fabric II: Beyond Chaincode, fabric SDK and Front End, Hyperledger composer tool Use case I: Blockchain in Financial Software and Systems (FSS): Settlements, KYC, Capital markets, Insurance Use case II: Blockchain in trade supply chain: Provenance of goods, visibility, trade supply chain finance, invoice management discounting, etc Use case III: Blockchain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system social welfare systems Blockchain Cryptography, Privacy and Security on Blockchain	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

TEXT BOOKS, AND/OR REFERENCE MATERIAL

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos, OReilly, 2018
2. Blockchain for new economy by Melanie Swa, OReilly
3. https://www.hyperledger.org/projects/fabric

Course Code: PEC-603
Course Title: Principle of Distributed Systems
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide students with a solid foundation in the concepts, design, and implementation of distributed systems. It focuses on understanding the challenges of distributed computing, including communication, synchronization, fault tolerance, scalability, and security. Students will learn key distributed algorithms and architectures, enabling them to design and analyze efficient and reliable distributed applications.

Course outcomes

On completion of the course students will be able to

CLO1: Analyze algorithms for coordination, communication, security and synchronization in distributed systems

CLO2: Design and Implement distributed file systems and distributed algorithms for deadlocks.

CLO3: Evaluate the effectiveness and shortcomings of their solutions

CLO4: Understanding of Distributed transactions and algorithms

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 11 Hours	Characterization of Distributed Systems: Introduction, Examples of distributed Systems, Resource sharing and the Web Challenges. System Models: Architectural models, Fundamental Models Theoretical Foundation for Distributed System: Limitation of Distributed system, absence of global clock, shared memory, Logical clocks, Lamport's& vectors logical clocks, Causal ordering of messages, global state, and termination detection.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations	
Unit II 11 Hours	Distributed Mutual Exclusion: Classification of distributed mutual exclusion, requirement of mutual exclusion theorem, Token based and non-token based algorithms, performance metric for distributed mutual exclusion algorithms. Distributed Deadlock Detection: system model, resource Vs communication deadlocks, deadlock prevention, avoidance, detection & resolution, centralized dead lock detection, distributed dead lock detection, path pushing algorithms, edge chasing algorithms.	CLO2
	Learning Activities: Interactive Lectures and Demonstrations	

Unit III 12 Hours	Agreement Protocols: Introduction, System models, classification of Agreement Problem, Byzantine agreement problem, Consensus problem, Interactive consistency Problem, Solution to Byzantine Agreement problem, Application of Agreement problem, Atomic Commit in Distributed Database system. Distributed Objects and Remote Invocation: Communication between distributed objects, Remote procedure call, Events and notifications, Java RMI case study. Security: Overview of security techniques, Cryptographic algorithms, Digital signatures Cryptography pragmatics, Case studies: Needham Schroeder, Kerberos, SSL& Millicent. Distributed File Systems: File service architecture, Sun Network File System, The Andrew File System, Recent advances. **Learning Activities**: Interactive Lectures and Demonstrations	CLO3
Unit IV 11 Hours	Transactions and Concurrency Control: Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering, Comparison of methods for concurrency control. Distributed Transactions: Flat and nested distributed transactions, Atomic Commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery. Replication: System model and group communication, Fault - tolerant services, highly available services, Transactions with replicated data. Distributed Algorithms: Introduction to communication protocols, Balanced sliding window protocol, Routing algorithms, Destination based routing, APP problem, Deadlock free Packet switching, Introduction to wave & traversal algorithms, Election algorithm.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations	

TEXT BOOKS, AND/OR REFERENCE MATERIAL

1. Singhal & Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill
2. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson Ed.
3. Gerald Tel, "Distributed Algorithms", Cambridge University Press
4. Nancy Lynch, Distributed Algorithms, Morgan Kaufmann. 5. Andrew S. Tanenbaum, Distributed Operating Systems, ACM P.

Course Code: PEC-604
Course Title: Microprocessor and Microcontroller
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide students with a solid foundation in the concepts, design, and implementation of distributed systems. It focuses on understanding the challenges of distributed computing, including communication, synchronization, fault tolerance, scalability, and security. Students will learn key distributed algorithms and architectures, enabling them to design and analyze efficient and reliable distributed applications.

Course outcomes

After the completion of the course, the students will be able to:
CLO1: Understand the architecture and organization of microprocessor along with instruction coding formats.
CLO2: Understand, write structured and well-commented programs in assembly language with an ability to test and debug them in the laboratory.
CLO3: Understand software/ hardware interrupts and further writes programs to perform I/O using handshaking and interrupts.
CLO4: Understanding of digital interfacing and system connections.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 12 Hours	INTEL 8086 Microprocessor: Pin Functions, Architecture, Characteristics and Basic Features of Family, Segmented Memory, Addressing Modes, Instruction Set, Data Transfer Instructions, Arithmetic, Logical, Shift and Rotate Instructions, String Instructions, Flag Control Instructions, Transfer of Control Instructions, Processor Control Instructions, Programming Examples, Interrupt Structures, Multitasking and Multiprogramming, MIN/MAX Modes of 8086, Co-processors 8087 and 8089.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations	

Unit II 11 Hours	Interrupts: 8086 Interrupts and Types, 8254 Software-Programmable Timer/Counter, 8259A Priority Interrupt Controller, Software Interrupt Applications. Digital and Analog Interfacing: Programmable Parallel Ports and Handshake Input/output, Interfacing Keyboards and Alphanumeric Displays, Interfacing Microcomputer Ports to Devices, Developing the Prototype of a Microcomputer Based Instrument	CLO2
	Learning Activities: Interactive Lectures and Demonstrations	
Unit III 11 Hours	Memories, Coprocessors, and EDA Tools: 8086 Maximum Mode and DMA Data Transfer, Interfacing and Refreshing Dynamic RAMs, The 8087 Math Coprocessor, Computer Based Design and development Tools	CLO3
	Learning Activities: Interactive Lectures and Demonstrations	
Unit IV 11 Hours	Introduction to 8051 Microcontroller : 8051-architecture and pin diagram, Registers, Timers Counters, Flags, Special Function Registers, Addressing Modes, Data types, instructions and programming, Single –bit operations, Timer and Counter programming, Interrupts programming, Serial communication, Memory accessing and their simple programming applications. Hardware interfacing: I/O Port programming, Bit manipulation, interfacing to a LED, LCD, Keyboard, ADC, DAC, Stepper Motors and sensors.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations	

TEXT BOOKS, AND/OR REFERENCE MATERIAL

1. Hall Douglas V, “Microprocessors and Interfacing”, Tata McGraw-Hill 1989.
2. Berry B Brey ,“The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386 And 80486, Pentium and Pentium ProProcessor Architecture, Programming and Interfacing”, Pearson Education 2003.
3. MathurAditya P, “Introduction to Microprocessors” Tata McGraw-Hill 1989.
4. Ray A Kbhurchandi, K M, “Advanced microprocessors and peripherals“,Tata McGraw Hill 2000.
5. James L Antonakos, “An Introduction to the Intel Family of Microprocessors: A Hands-On Approach Utilizing the 80x86 Microprocessor Family”, First Edition. Cengage Learning, New Delhi

Elective-II

Course Code: PEC-621
Course Title: Internet of Things
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide foundational knowledge of Internet of Things (IoT) concepts, including its key characteristics, challenges, and the functional architecture of IoT systems. It seeks to introduce students to various IoT communication architectures, protocols, and networking technologies that are essential for implementing IoT applications. The course will familiarize students with core IoT technologies, including Radio Frequency Identification (RFID), Wireless Sensor Networks (WSNs), and Cloud Computing, which are integral to building effective IoT systems. Furthermore, the course intends to equip students with practical skills through hands-on experience in programming microcontrollers, interfacing sensors, and developing real-world IoT applications, thereby bridging theoretical knowledge with practical implementation.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Explain the fundamental concepts, characteristics, and architecture of IoT, including its design challenges and issues.
CLO2: Compare and apply various IoT communication protocols and technologies.
CLO3: Utilize IoT-enabling technologies like Big Data Analytics, Cloud Computing, and Embedded Systems to develop IoT solutions.
CLO4: Develop and implement IoT applications by programming microcontrollers, interfacing sensors, and establishing communication with external devices.

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	**IoT Fundamentals**: Definition and Characteristics of Internet of Things (IoT) - Challenges and Issues - Physical Design of IoT - Logical Design of IoT - IoT Functional Blocks. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO1
Units II	**IoT Communication Architectures and Protocols** Control Units – Communication modules – Bluetooth – Zigbee – WiFi	

10 Hours	– GPS - IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP) – MQTT - Wired Communication - Power Sources.	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Units III 12 Hours	**Technologies Behind IoT:** Four pillars of IoT paradigm: RFID, Wireless Sensor Networks, Supervisory Control and Data Acquisition (SCADA) - M2M - IoT Enabling Technologies: Bigdata Analytics, Cloud Computing, Embedded Systems.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Units IV 12 Hours	**Programming the Microcontroller for IoT:** Environment: Board, IDE, shields – Programming: syntax, variables, types, operators, constructs and functions – Sketch: skeleton, compile and upload. Working principles of sensors – IoT deployment for Arduino/Equivalent platform – Reading from Sensors, Communication: Connecting microcontroller with mobile devices - Communication through Bluetooth - Wi-Fi and USB. Business models for IoT - Green energy buildings and infrastructure - Smart farming.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 2019, 1st Edition, Wiley Publications, USA.

Reference Books

1.Bahga, Arshdeep, and Vijay Madisetti. Internet of Things: A Hands-on Approach, 2014,1st Edition, Universities press, India.

2. Vlasios Tsiatsis, Jan Holler, Catherine Mulligan, Stamatis Karnourskos and David Boyle. Internet of Things: Technologies and Applications for a New Age of Intelligence, 2018, 2nd Edition, Academic Press, USA.

Course Code: PEC - 622
Course Title: Digital Image Processing
Total Hours: 60

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to provide students with a solid foundation in the field of digital image processing, covering both the theoretical aspects and practical applications. The course introduces students to the representation, processing, and analysis of digital images using various techniques. Emphasis is placed on image enhancement, filtering, restoration, color image processing, compression, segmentation, and morphological operations. Students will also learn how to apply these techniques using tools such as MATLAB or Python. This course aims to develop the ability to implement and evaluate image processing algorithms and apply them to solve real-world problems in computer vision, medical imaging, remote sensing, and related fields.

Course Learning Outcomes

CLO1: Understand the fundamentals of digital images, image formation, and perception.
CLO2: Apply image enhancement and filtering techniques in both spatial and frequency domains.
CLO3: Analyze and perform image restoration, segmentation, and morphological operations.
CLO4: Implement and evaluate image processing algorithms using software tools and apply them in real-world applications.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	**Fundamentals of Digital Image Processing** Introduction to image processing systems, Digital image representation, sampling, quantization, Elements of visual perception, Image acquisition and digitization, Basic operations on images: arithmetic, logical, geometric	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit II 12 Hours	**Image Enhancement and Filtering** Intensity transformations: contrast stretching, thresholding, histogram equalization, Spatial domain filtering: smoothing and sharpening filters, Frequency domain filtering: Fourier Transform, filtering in frequency domain, Homomorphic filtering	CLO2

	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 11 Hours	**Image Restoration, Compression and Morphological Processing** Noise models, restoration filters: inverse, Wiener, and constrained least squares, Image compression: predictive, transform coding, JPEG, Morphological operations: dilation, erosion, opening, closing , Applications in binary and grayscale image	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	**Image Segmentation and Applications** Edge detection: Sobel, Prewitt, Canny, Region-based segmentation: region growing, splitting, and merging, Thresholding: Otsu's method Feature extraction and basic object recognition, Applications in medical imaging, surveillance, document processing	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Textbook

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson Education, 2022.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Latest Reprint, PHI Learning, 2021.

References and Online Resources

1. S. Sridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2022.
2. NPTEL Course: Digital Image Processing by Prof. P.K. Biswas, IIT Kharagpur
3. MATLAB Image Processing Toolbox Documentation
4. OpenCV Python Tutorials – https://docs.opencv.org/

Course Code: PEC -623
Course Title: Building Cloud and Big Data Applications
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide students with a comprehensive understanding of cloud computing architectures, service models, and the integration of big data technologies within cloud environments. Students will explore the development and deployment of scalable, reliable, and secure applications using public and private cloud platforms. The course introduces key cloud providers and emphasizes hands-on experience with services like compute, storage, networking, and containerization. Additionally, students will gain practical exposure to big data ecosystems, particularly Hadoop and Spark, and learn how to design end-to-end data processing pipelines on the cloud. By the end of the course, students will be capable of building real-world cloud-native and big data-driven applications

Course Learning Outcomes

CLO1: Understand cloud computing models, architectures, and core services offered by major cloud providers.
CLO2: Design and deploy scalable cloud applications using IaaS, PaaS, and SaaS models
CLO3: Explain and use big data frameworks such as Hadoop and Spark for data storage and analytics.
CLO4: Build integrated cloud-big data applications with efficient data ingestion, processing, and visualization.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 13 Hours	Cloud Computing Fundamentals Introduction to cloud computing, service models (IaaS, PaaS, SaaS), Cloud deployment models: public, private, hybrid, Virtualization and containerization (Docker, Kubernetes basics), Cloud providers: AWS, Azure, Google Cloud – overview of services, Introduction to serverless computing	CLO1
	Learning Activities: Interactive Lectures and Demonstrations	

Unit II 12 Hours	Building and Deploying Cloud Applications Setting up cloud environments, Compute (EC2, GCE), Storage (S3, Blob), Networking (VPC, subnets), Auto-scaling, load balancing, and monitoring, CI/CD pipelines in the cloud (GitHub Actions, Jenkins, Cloud Build), Case study: Deploying a web application on the cloud	CLO2
	Learning Activities: Interactive Lectures and Demonstrations	
Unit III 10 Hours	Big Data Concepts and Frameworks Introduction to big data, characteristics (3Vs: volume, velocity, variety), Hadoop ecosystem: HDFS, MapReduce, YARN, Apache Spark architecture: RDDs, DataFrames, Spark SQL, Big data tools: Hive, Pig, HBase, Comparison of Hadoop and Spark	CLO3
	Learning Activities: Interactive Lectures and Demonstrations	
Unit IV 10 Hours	Cloud-Based Big Data Application Development Data ingestion tools: Apache Flume, Kafka, Data processing workflows on cloud (e.g., using AWS EMR, GCP Dataproc), Real-time data analytics using Spark Streaming, Data visualization using Power BI / Tableau / Google Data Studio, Capstone: Build a data pipeline on the cloud	CLO4
	Learning Activities: Interactive Lectures and Demonstrations	

Textbook

1. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, Mastering Cloud Computing, 2nd Edition, McGraw Hill, 2022.
2. Tom White, Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media, 2023.
3. Matei Zaharia et al., Learning Spark: Lightning-Fast Big Data Analysis, 2nd Edition, O'Reilly Media, 2022.

References and Online Resources

1. NPTEL Course: Cloud Computing by Prof. B. Ravindran, IIT Madras
2. NPTEL Course: Big Data Computing by Prof. Rajiv Misra, IIT Patna
3. AWS Educate and Azure for Students – Free student access
4. Apache Hadoop and Spark official documentation

Course Code: PEC-624
Course Title: Deep Learning
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

To introduce and familiarize students with popular deep learning architectures, enabling them to understand and implement Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Autoencoders.

Course outcomes:

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand Deep Learning Architecture
CLO2: Apply Advanced ML Techniques:
CLO3: Design and Optimize Models
CLO4: Conduct Practical Experiments
CLO5: Evaluate Model Performance

Units/Hours	Contents	Mapping with Course Learning Outcome
Unit I 11 Hours	**Introduction to Deep Learning**: Overview of neural networks, deep learning vs. traditional ML, applications. **Convolutional Neural Networks (CNNs)** : Architecture (convolution, pooling, fully connected layers), activation functions, popular models (e.g., VGG, ResNet). **Loss Functions for CNNs**: Cross-entropy, mean squared error, regularization (L1/L2), designing task-specific loss functions. **Training CNNs**: Backpropagation, gradient descent variants (SGD, Adam), overfitting prevention (dropout, batch normalization).	CLO1
	Activities: Implement a CNN for image classification (e.g., CIFAR-10 dataset) using TensorFlow	
Unit II 12 Hours	**Recurrent Neural Networks (RNNs)** (3 hours): RNN architecture, LSTMs, GRUs, handling sequential data, applications in NLP and time-series. **Training RNNs**: Backpropagation through time, vanishing/exploding gradients, loss functions for sequential tasks (e.g., CTC loss). **Autoencoders**: Architecture (encoder-decoder), types (vanilla, denoising, variational), applications in feature learning and anomaly detection. **Advanced Training Techniques** :(Hyperparameter tuning, early stopping, learning rate scheduling for RNNs and Autoencoders.	CLO2, CLO3

	Activities: Implementation above theory with Python code	
Unit III 12 Hours	**Transfer Learning**: Fine-tuning pre-trained models, feature extraction, applications in low-data scenarios (e.g., ImageNet weights for medical imaging). **Domain Adaptation**: Techniques for handling distribution shifts, adversarial domain adaptation, applications in cross-domain tasks. **Semi-Supervised Learning**: Pseudo-labeling, co-training, combining labeled and unlabeled data for improved performance. **Evaluation Metrics**: Accuracy, F1-score, domain adaptation metrics (e.g., A-distance), robustness analysis.	CLO3 CLO5
	Activities: Implementation and designing with Python Libraries	
Unit IV 10 Hours	**Active Learning**: Query strategies (uncertainty sampling, diversity sampling), applications in reducing labeling costs. **Self-Supervised Learning**: Contrastive learning, pretext tasks (e.g., SimCLR, BYOL), applications in vision and NLP. **Incremental Learning**: Continual learning, catastrophic forgetting mitigation, class-incremental scenarios. **Few-Shot Learning**: Meta-learning, prototypical networks, applications in low-data tasks.	CLO4 CLO3
	Activities: Implementation and usage of tools over the cloud	

Suggested Readings:

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). **Deep Learning**. MIT Press
2. Chollet, F. (2021). **Deep Learning with Python** (2nd ed.). Manning Publications.
3. Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2024). **Dive into Deep Learning**. Cambridge University Press.
4. Buduma, N., & Locascio, N. (2022). **Fundamentals of Deep Learning** (2nd ed.). O'Reilly

Course Code: PCC CS-603
Course Title: Theory of Computation
Total Hours: 60

L	T	P	Cr
3	1	0	4

Course Objectives

To develop a strong foundation in formal languages, automata theory, and computability. The course enables students to understand computational models like finite automata and Turing machines, analyze grammar and language classifications, and explore the limits of computation.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:

CLO1: Understand theoretical foundations of computer science.

CLO2: Master regular languages, finite automata, pushdown automata, and Turing recognizable Languages.

CLO3: Employ finite-state machines to solve computing problems.

CLO4: Think analytically and intuitively for problem-solving situations in related areas of theory in computer science.

Units/Hours	**Content**	**Mapping with Course Learning Outcome**
UNIT-1 (10 hrs)	**Introduction:** Automata, Computability, and Complexity. Mathematical Notions and Terminology: Sets, Sequences and Tuples, Functions and Relations, Graphs, String and Languages, Boolean Logic, Basic machine, Finite State Machine (FSM), Transition graph, Transition matrix, Language and Grammars Automata and Regular Languages: Finite Automata (Formal definition and example), Formal Definition of Computation, Designing Finite Automata, The regular operations. Nondeterminism: (Formal Definition of nondeterminism), Equivalence of NFAs and DFAs, Closure under the regular operations	CLO1, CLO2

	Learning Activities: Groups create timelines of key discoveries in automata and complexity theory (e.g., Turing, Church, FSM development). Home assignments: Give examples of languages, regular languages. Design finite automata (both deterministic and nondeterministic) for a given language, Peer teaching sessions. Students work in pairs: one draws an automaton, the other walks through it with example strings and records transitions. Students design both an NFA and a DFA for the same language, then compare state counts and structure. Students apply union, intersection, and complement to DFAs/NFAs and demonstrate closure through new automata or proofs	
UNIT-2 (10 hrs)	**Regular Expressions and Finite Automata:** Regular Language, Regular Grammar and Regular Expressions, Formal definition of a regular expression, Equivalence of Regular Grammar with finite automata, Equivalence of Regular Expression with finite automata Nonregular Languages: Regular and Non-Regular Languages, The pumping lemma for regular languages, Application of the pumping lemma Finite state machines: Mealy and Moore machines, Equivalence of Moore and Mealy Machines, minimization of finite automata, Two-way finite automata	CLO2, CLO3
	Learning Activities: Home assignments, Provide regular expressions and ask students to construct equivalent finite automata (DFA/NFA), Give a finite automaton and ask students to derive the regular expression and grammar it accepts (reverse engineering). Guided practice in applying the pumping lemma to prove that a language is not regular. Group discussions on common misconceptions and strategies. Students create FSMs to simulate real-world systems (e.g., vending machine, elevator logic)	
UNIT-3 (15 hrs)	Formal Grammars and Languages: Basic definitions and examples of languages, Chomsky hierarchy, Regular grammars, context-free and context-sensitive grammars, Examples of context-free grammars, Designing context-free grammars, Ambiguity, context-free and non-context-free languages. Chomsky Normal Forms, binary operations on languages, Simplification of CFG, Elimination of useless symbols, Unit productions, Null productions, Greibach Normal form, Chomsky Normal form – Problems related to CNF and GNF. Pushdown Automata and Turing Machines: Basics of PDA, Examples of Pushdown Automata, Acceptance by PDA, Construction of PDA from CFG.	CLO2, CLO3 CLO4

	Learning activities: In pairs or groups, students create CFGs and test them with example strings. In pairs or groups, students create CFGs and test them with example strings. Given a CFG and a string, students create two different parse trees and discuss ambiguity. Provide a complex CFG and challenge students to simplify it in steps. Apply transformations to convert CFGs into Chomsky Normal Form or Greibach Normal Form. In pairs, students design PDAs on paper and then simulate example strings. Groups create posters summarizing CNF, GNF, PDA construction, or the Chomsky hierarchy	
UNIT-4 (25 hrs)	Turing Machines: TM model, Examples of Turing machines, representation and languages acceptability of TM, Design of TM, Variations of the Turing Machine, Universal TM and Other modifications, Composite and iterated TM, Church Thesis Computability and Undecidability: TM Languages: Turing Acceptable, Turing Decidable, Unrestricted Grammar, Modified Chomsky Hierarchy, Basic concepts, properties of Recursive and Recursive Enumerable Languages, Undecidability, Reducibility. Unsolvable Problem: The Halting Problem, Rice's Theorem, Post Correspondence Problem. Tractable and Intractable Problems: P and NP, NP Completeness, Cook's Theorem.	CLO2, CLO3, CLO4
	Learning activities: Home assignments related to understanding the relation between the various classes, such as decidable, Turing recognizable, and co-Turing recognizable. Assign each group a variant; they research, create a visual, and present how it differs from standard TM and whether it increases computational power. Give students a set of problems (e.g., Sudoku, Travelling Salesman, Prime Checking) and ask them to classify (P, NP, NP-complete) and justify.	

Recommended Books:

1. J E Hopcroft And J D Ullman, "Introduction to Automata Theory, Languages and Computation", Narosa Publishers.
2. K L P Mishra and N Chandrasekaran, "Theory of Computer Science", Prentice Hall Inc.
3. Harry R Lewis and Chritos H Papadimitriou, "Elements of the Theory of Computation", Pearson Education.
2. Peter Linz, "An Introduction to Formal Languages and Automata", Narosa Publishers.
3. Michael Sipser, "Introduction to the theory of computation", Cengage Learning, New Delhi.
4. E.V. Krishnamurthy, "Introductory Theory of Computer Science", East West Press.
5. John C Martin, "Introduction to Languages and Theory of Computation", McGraw Hil

SEMESTER-VII

Course Code: PCC CS-702
Course Title: Compiler Design
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to introduce students to the fundamentals of compiler design, covering all essential phases of a compiler. It helps students understand the principles, algorithms, and techniques involved in lexical analysis, syntax and semantic analysis, code generation, and optimization

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Describe the structure and functioning of a compiler and the role of each phase.
CLO2: Construct lexical analysers and parsers for simple grammars.
CLO3: Apply syntax-directed translation and intermediate code generation.
CLO4: Analyze and implement basic code optimization and generation techniques

Unit/ Hours	**Contents**	Mapping with Course Learning Outcome
Unit I 13 Hours	Introduction to Compiler: Compiler structure, Phases of a compiler, Lexical Analysis, Role of Lexical Analyzer, Regular Expressions, Finite Automata, Lex tools. Syntax Analysis: Context-Free Grammars, Parse Trees, Ambiguity, Top-Down and Bottom-Up Parsing, LL(1) Parsing, Recursive Descent Parsing.	CLO1
	Learning Activities: Design simple lexical analyzers using Regular Expressions and simulate DFA.	
Unit II 10 Hours	Parsing Techniques: LR Parsers, SLR, LALR, Canonical LR Parsers, Shift-Reduce Parsing, Parser Generators (YACC). Syntax-Directed Translation: Syntax-directed definitions, Translation schemes, Implementation of Syntax-directed translation.	CLO2
	Learning Activities: Build parsers using context-free grammar rules and tools like YACC.	
Unit III 11 Hours	Intermediate Code Generation: Three-address code, Syntax trees, DAGs, Intermediate code for control structures, Backpatching. Type Checking and Semantic Analysis: Type systems, Type checking, Symbol tables, Scope resolution.	CLO3

	Learning Activities: Generate intermediate code from high-level constructs and manage symbol tables**.**	
Unit IV 11 Hours	Code Optimization and Code Generation: Principal sources of optimization, Peephole optimization, Control flow and data flow analysis, Code generation algorithms. Runtime Environments: Storage organization, Stack allocation, Heap allocation, Activation records.	CLO4
	Learning Activities: Implement peephole optimization and register allocation.	

Suggested Readings:

1. Aho, A. V., Lam, M. S., Sethi, R., & Ullman, J. D. (2006). Compilers: Principles, Techniques and Tools (2nd ed.). Pearson Education.
2. Dhamdhere, D. M. (2011). Compiler Construction: Principles and Practice. McGraw Hill Education.
3. Appel, A. W. (2002). Modern Compiler Implementation in C. Cambridge University Press.
5. Cooper, K. D., & Torczon, L. (2011). Engineering a Compiler (2nd ed.). Morgan Kaufmann.
6. Research Articles from SCI & Scopus indexed Journals.

Course Code: PCC LC-702
Course Title: Compiler Design - Laboratory
Total Hours: 30

L	T	P	Cr
0	0	4	2

Course Objectives

The course aims to provide students with a solid understanding of the principles and techniques used in compiler design. Students will gain practical experience in implementing the phases of a compiler, such as lexical analysis, syntax analysis, semantic analysis, and code generation. The lab will focus on using tools like Lex and Yacc to design and implement different components of a compiler. Through hands-on exercises, students will learn to write a scanner, parser, and other components of a compiler to enhance their understanding of compiler construction and optimization. The course will also help students develop problem-solving skills to tackle real-world challenges in compiler design and improve their ability to analyze and optimize code.

Course Learning Outcomes

CLO1: Understand the theoretical concepts and techniques used in compiler design.
CLO2: Develop practical skills in implementing compiler phases, including lexical analysis, syntax analysis, and semantic analysis.
CLO3: Gain hands-on experience using Lex and Yacc to build a basic compiler.
CLO4: Analyze and implement parsing algorithms for syntax checking and error handling.
CLO5: Design and implement code generation and optimization techniques to improve the performance of the generated code.
CLO6: Apply problem-solving techniques to build a complete compiler from scratch.

Laboratory/ Practical

1. Write a program to implement a lexical analyzer using regular expressions.
2. Implement a DFA (Deterministic Finite Automaton) for identifier and number recognition
3. Use LEX tool to perform lexical analysis on simple input.
4. Write a program to implement a recursive descent parser for arithmetic expressions.
5. Use YACC tool to build a syntax analyzer.
6. Write a program to evaluate expressions using syntax-directed translation.
7. Generate three-address code for control structures (if-else, loops).

Elective-III

Course Code: PEC-701
Course Title: Advance Computer Networks
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide students with a comprehensive understanding of reliable transport protocols, such as TCP and SCTP, which are crucial for ensuring reliable communication in networked systems. It focuses on congestion control strategies and resource allocation techniques, emphasizing queuing disciplines, TCP congestion control mechanisms, and the importance of Quality of Service (QoS) in network performance. The course will also introduce next-generation networking concepts, including unicast and multicast routing protocols, and IPv6 addressing, to prepare students for the future of network communications. Additionally, students will examine the IEEE 802.11 protocol, which plays a vital role in wireless networking. Through this course, students will gain the necessary knowledge and skills to design and analyze robust networking systems.

Course Learning Outcomes

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

CLO1: Analyze and apply TCP and SCTP mechanisms to ensure reliable communication in networking environments.

CLO2: Evaluate and implement congestion control techniques and resource allocation strategies to enhance network performance.

CLO3: Explain network protocols for next-generation networks, including unicast and multicast routing protocols, and IPv6 addressing.

CLO4: Demonstrate a deep understanding of wireless LAN technologies, and IEEE 802.11 protocols.

Unit	**Contents**	**Mapping with Course Learning Outcome**
Unit-I 11 Hours	**Reliable Protocol:** Transmission Control Protocol (TCP): Error Control, Flow Control, Congestion Control, Timers, And TCP Options: NOP, MSS, Window Scale Factor, Timestamp, SACK-Permitted and SACK Options. **Stream Control Transmission Protocol (SCTP):** Introduction, Services, Features, Packet Format, State Transition Diagram, Flow Control, Error Control, Congestion Control.	CLO1

	Learning Activities: Interactive Lectures and Demonstrations.	
Unit-II 11 Hours	**Congestion Control and Resource Allocation:** Issues In Resource Allocation: Network Model, Taxonomy, Evaluation Criteria; Queuing Disciplines: FIFO, Fair Queuing; TCP Congestion Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery; Congestion-Avoidance Mechanisms: Random Early Detection (RED), Source-Based Congestion Avoidance; Quality of Service: Application Requirements, Integrated Services (RSVP), Equation-Based Congestion Control.	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit-III 11 Hours	**Next Generation Network:** Unicast Routing Protocols: RIP, OSPF; Multicasting and Multicast Routing Protocols: Introduction, Multicast Addresses, IGMP, Multicast Routing, Routing Protocols, Mbone. **Internet Protocol Version 6:** IPV6 Addressing: Introduction, Address Space Allocation, Global Unicast Addresses, Auto configuration, Renumbering; IPV6 Protocol: Packet Format, Transition from Ipv4 TO Ipv6.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit-IV 12 Hours	**Wireless LAN:** Infrared vs. Radio Transmission, Infrastructure and Ad Hoc Networks. IEEE 802.11, System Architecture, Protocol Architecture, Physical Layer, Medium Access Control Layer, MAC Management.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books:

1. Behrouz A. Forouzan , “TCP/IP Protocol Suite”, McGraw- Hill, 4/e, 2015.
2. Larry L. Peterson & Bruce S. Davie, “Computer Network: A System Approach”, Morgan Kaufmann, 5/e, 2012.

Reference Books

1. Jochen Schiller, “Mobile Communications”, Pearson Addison-Wesley, 2/e, 2010.
2. James F. Kurose, Keith W. Ross, “Computer Networking”, Pearson, 2016.
3. Charles M. Kozierok, “The TCP/IP Guide”, No starch press, 2018.

Course Code: PEC 702
Course Title: Generative AI Technologies
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course explores modern technologies for handling big data efficiently, including distributed storage systems, NoSQL databases, vector databases, and GPU-based processing. The course also introduces emerging trends in Generative AI, Agentic modeling, and multimodal data processing, preparing students to build intelligent and scalable data-driven systems.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand architectures and frameworks for big data storage and processing.
CLO2: Work with NoSQL and vector databases for large-scale and AI-driven applications.
CLO3: Utilize GPU-based tools and parallel programming for accelerating data processing.
CLO4: Apply emerging techniques in Generative AI, multimodal systems, and agentic modeling.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit-I 11 Hours	Big Data Concepts and Ecosystem: Characteristics of big data (Volume, Velocity, Variety), Hadoop ecosystem, MapReduce, Spark. Distributed Storage: HDFS, Object stores (S3, MinIO), Data Lakes.	CLO1
	Learning Activities: Setup Hadoop/Spark environment and process sample datasets.	
Unit-II 12 Hours	NoSQL Databases: Key-value, Document, Column-family, and Graph databases (e.g., MongoDB, Cassandra, Neo4j). Vector Databases: Introduction to vector embeddings, FAISS, Pinecone,Weaviate.	CLO2
	Learning Activities: Build a semantic search engine using a vector database.	
Unit-III 10 Hours	GPU-based Processing: CUDA fundamentals, RAPIDS.ai, PyTorch for parallel data operations. Accelerated Analytics: Use of Dask, cuDF, and TensorRT.	CLO3

	Learning Activities: Accelerate data pipelines using GPU programming and libraries.	
Unit-IV 11 Hours	Generative AI Technologies: LLMs, Prompt Engineering, Fine-tuning. Tool use. Multimodal Systems: Combining text, image, and audio using models like CLIP, Flamingo, Gemini.	CLO4
	Learning Activities: Create a multimodal assistant using open-source models and Lang Chain.	

Recommended Books

1. White, T. (2015). Hadoop: The Definitive Guide (4th ed.). O'Reilly Media.
2. Kleppmann, M. (2017). Designing Data-Intensive Applications. O'Reilly Media.
3. Zaharia, M. et al. (2020). Learning Spark (2nd ed.). O'Reilly Media.
4. Banerjee, A. (2023). Generative AI with LangChain. Packt Publishing.
5. Research Articles and Documentation from NVIDIA, OpenAI, and Hugging Face.

Course Code: PEC-703
Course Title: Cloud system Engineering
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The primary objective of this course is to introduce students to the fundamental concepts, architecture, and technologies of cloud computing. It aims to equip students with the engineering skills required to design, deploy, and manage scalable, secure, and high-performance cloud systems. The course blends theoretical knowledge with hands-on exposure to popular cloud platforms and tools.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
COL1: Understand the fundamentals of cloud computing, its architecture, and service models.
COL2: Analyze cloud infrastructure components and apply virtualization techniques.
COL3: Design and deploy cloud-based solutions using industry-standard platforms.
COL4: Evaluate security, performance, and cost-efficiency in cloud systems.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 14 Hours	**Introduction to Cloud Computing:** Overview and definition of Cloud Computing, Characteristics and benefits of Cloud Computing, Service models: IaaS, PaaS, SaaS, Deployment models: Public, Private, Hybrid, Community, Enabling technologies: Grid Computing, Utility Computing, and Virtualization, Cloud computing architecture and components, Business scenarios and applications	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 16 Hours	**Virtualization and Cloud Infrastructure:** Introduction to virtualization, Hypervisors: Type I and Type II, Virtual machines and containers, Tools and technologies: VMware, VirtualBox, Docker, Kubernetes, Infrastructure as a Service (IaaS), Resource provisioning and orchestration, Introduction to cloud service providers: AWS, Azure, GCP	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 14 Hours	**Cloud Storage and Security:** Cloud storage types: Object, Block, File storage, Data redundancy and replication, Data management in cloud, Cloud security architecture, Threats and vulnerabilities in cloud, Identity and Access Management (IAM), Encryption techniques and data privacy, Legal and compliance aspects: GDPR, HIPAA, ISO standards.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 16 Hours	**Cloud Application Development and Case Studies:** Cloud-native application development, Microservices architecture and REST APIs, DevOps in cloud: CI/CD pipelines, Infrastructure as Code (IaC), Serverless computing and Function as a Service (FaaS), Edge computing and future trends, Case studies: Cloud in healthcare, education, e-commerce	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Mastering Cloud Computing, McGraw Hill Education
2. Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Pearson Education
3. Arshdeep Bahga, Vijay Madisetti, Cloud Computing: A Hands-On Approach, Universities Press
4. Michael J. Kavis, Architecting the Cloud, Wiley
5. Toby Velte, Anthony Velte, Cloud Computing: A Practical Approach, McGraw Hills.

Course Code: PEC-704
Course Title: Embedded Systems Design
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to introduce students to the fundamentals of embedded systems, including their architecture, design, and real-time constraints. It aims to develop an understanding of hardware-software co-design, microcontrollers, and interfacing techniques. Through theoretical knowledge and hands-on practice, students will learn to design, program, and debug embedded systems used in real-world applications such as consumer electronics, automotive, and industrial automation.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
COL1: After the course completion, the student will be able to 1. Understand the general process of embedded system development
COL2: Understand General System Theory, how to apply embedded system and how to differentiate this from the traditional mechanistic theory.
COL3: Evaluate how architectural and implementation decisions influence performance and power dissipation.
COL4: Evaluate how architectural and implementation decisions influence performance and power dissipation.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 12 Hours	**Introduction:** Introduction to Embedded Systems, Classification of Embedded System, Concept of Embedded System Design, and Design challenges: Processor technology, IC technology, Design technology and Trade-offs. Hardware and Software Co-Design in Embedded System: Buffers and latches, Reset circuit, Chip, Timers and counters and watch dog timers, Universal asynchronous receiver, transmitter (UART), Pulse width modulators, LCD controllers. Development of fixed ROM image, Code generation tools: Emulator, Simulator and Debugger. .	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 11 Hours	**Embedded software development environments:** Challenges and issues in embedded software development, Device drivers, System calls and Programming languages: assembly languages, high level languages like C/C++, Source Code Engineering tool for Embedded C/C++. Introduction to Embedded Java.	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 11 Hours	**Processor and memory Organization:** Custom Single Purpose Processor Hardware, General-Purpose Processor: Introduction, Basic Architecture, Application Specific Instruction Set Processors (ASIPS), Microcontrollers and Digital Signal Processors. Memory writes ability, Storage performance, Tradeoff s, Memory hierarchy and cache.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	**Software Engineering in Embedded System:** Software Engineering practice in the embedded Software development process. Software models used in designing, Unified Modeling language, Software maintenance. Embedded Operating System: Operating system services, Embedded Operating system, Real Time Operating system, Interrupt latency and Response time, Interrupts Routines in RTOS, Introduction to VxWorks and Micro OS II.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. David E Simon, “An Embedded Software Primer”, 1/e Pearson Education 1999.
2. Raj Kamal, “Embedded Systems”, Tata McGraw-Hill 2004.
3. Bruce Powel Douglass, “Real-Time UML: Developing Efficient Objects for Embedded Systems”, 2/E Addison Wesley 2004.
4. Muhammad Ali Mazidi, Janice GillispieMazidi, “The 8051 Micro controller & Embedded Systems”, 1/e Pearson Education 2000.
5. Valvano, “Embedded Microcomputer Systems : A real time interfacing”,Cengage Learning, New Delhi

Course Code: PEC – 705
Course Title: Natural Language Processing
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to introduce students to the core problems in Natural Language Processing (NLP) This course introduces core challenges in NLP, blending linguistic theory with statistical modeling. Students will explore formal grammars, learn to construct and evaluate empirical NLP systems using rigorous methods, and develop proficiency in statistical techniques for language modeling. Emphasis is placed on both supervised and unsupervised learning approaches to build and analyze effective NLP algorithms.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand and analyze core NLP challenges by identifying their linguistic and statistical foundations, and propose appropriate solutions using modern computational techniques.
CLO2: Apply formal grammar models to represent and process various linguistic phenomena, demonstrating a strong grasp of syntax, morphology, and language structure.
CLO3: Design and evaluate NLP systems using proper experimental methodology, including data preparation, training, testing, and performance analysis.
CLO4: Develop statistical and probabilistic models for language tasks such as language modeling, parsing, and tagging, using both supervised and unsupervised learning approaches

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 Hours	Finding the Structure of Words: Words and Their Components, Issues and Challenges, Morphological Models Finding the Structure of Documents: Introduction, Methods, Complexity of the Approaches, Performances of the Approaches	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 11 Hours	Lexicalsyntax: Hidden Markov Models(Forward and Viterbi algorithms and EM training). Syntax Analysis: Parsing Natural Language, Treebanks: A Data-Driven Approach to Syntax, Representation of Syntactic Structure, Parsing Algorithms, Models for Ambiguity Resolution in Parsing, Multilingual Issues	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 11 Hours	Semantic Parsing: Introduction, Semantic Interpretation, System Paradigms, Word Sense Systems, Software. Predicate-Argument Structure, Meaning Representation Systems, Software. Discourse Processing: Cohesion, Reference Resolution, Discourse Cohesion and Structure	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	Language Modeling: Introduction, N-Gram Models, Language Model Evaluation, Parameter Estimation, Language Model Adaptation, Types of Language Models, Language-Specific Modeling Problems, Multilingual and Cross lingual Language Modeling	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. Multilingual natural Language Processing Applications: From Theory to Practice – Daniel M. Bikel and Imed Zitouni, PearsonPublication.
2. Natural Language Processing and Information Retrieval: Tanvier Siddiqui, U.S. Tiwary.
3. Speech and Natural Language Processing - Daniel Jurafsky & James H Martin, Pearson Publications.

Course Code: PEC – 706
Course Title: IoT Communication Protocols
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to provide students with a comprehensive understanding of communication protocols in the Internet of Things (IoT) ecosystem. It aims to explore various IoT communication models, protocol stacks, and the challenges associated with designing and implementing efficient communication systems. Through theoretical knowledge and practical insights, students will learn to analyze, select, and apply appropriate communication protocols for diverse IoT applications.

Course Learning Outcomes

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

CLO1: Understand the architecture and fundamental concepts of IoT communication protocols.

CLO2: Analyze various IoT communication models and protocol stacks.

CLO3: Evaluate the performance and suitability of different communication protocols for specific IoT applications.

CLO4: Design and implement efficient communication solutions addressing real-world IoT challenges.

Units/Hours	Contents	Mapping with Course Learning Outcome
Units I 12 Hours	Overview of IoT Communication:Definition and characteristics of IoT, Importance of communication in IoT systems. IoT Communication Models: Device-to-Device (D2D), Device-to-Cloud (D2C), Device-to-Gateway (D2G), and Back-End Data Sharing models. IoT Communication APIs: RESTful APIs and WebSockets.Application Layer Protocols: HTTP, CoAP, MQTT, AMQP. IoT Enabled Technologies:Wireless Sensor Networks (WSN), Cloud Computing, Embedded Systems.IoT Levels and Templates. Domain-specific IoTs: Home, City, Environment, Energy, Agriculture, Industry.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Units II	IMachine-to-Machine (M2M) Communication:Concepts and applications. Differences and similarities between IoT and M2M. Software Defined Networks (SDN):Basics and role in	CLO2

12 Hours	IoT.Benefits and challenges Network Function Virtualization (NFV):Concepts and implementation in IoT.Comparison with SDN. IoT System Management:NETCONF and YANG models.Simple Network Management Protocol (SNMP).NETOPEER tool for network configuration.	
	Learning Activities: Interactive Lectures and Demonstrations.	
Units III 10 Hours	IoT Communication Protocols: Link Layer Protocols: IEEE 802.15.4, Bluetooth, Zigbee, Z-Wave. Network Layer Protocols:IPv4/IPv6, 6LoWPAN, RPL (Routing Protocol for Low-Power and Lossy Networks). Transport Layer Protocols:TCP, UDP, QUIC. Application Layer Protocols:MQTT, CoAP, AMQP, XMPP. Protocol Selection Criteria:Factors influencing the choice of protocols in IoT applications.	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	Security in IoT Communication:Common threats and vulnerabilities.Security measures and best practices. Emerging Communication Technologies:LoRaWAN, NB-IoT, Sigfox.5G and its impact on IoT communication. Future Trends:Integration of AI and Machine Learning in IoT communication.Edge and Fog Computing. Standardization efforts and interoperability challenges.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Textbook

Dr. Vijendra Pratap Singh, Mr. Neeraj Kumar.., "IoT Communication Protocols", ISBN: 978-81- 961690-9-1,Deccan International Academic Publishers,2023.

Reference Books:

1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014. 21102024 MKV-TEMPLATE for IPCC (26.04.2022)

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc19_cs65/preview

https://archive.nptel.ac.in/courses/106/105/106105166/

https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Open Elective-I

Course Code: OEC-701
Course Title: Augmented and Virtual Reality
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to introduce students to the emerging fields of Augmented Reality (AR) and Virtual Reality (VR), their underlying technologies, applications, and development platforms. Students will explore the differences and synergies between AR and VR, understand the hardware and software architecture involved, and gain hands-on exposure to popular tools such as Unity3D, ARKit, ARCore, and OpenXR. The course emphasizes both theoretical concepts such as tracking, rendering, and interaction design, as well as practical implementation of immersive applications. It prepares students to design, prototype, and evaluate AR/VR systems for diverse domains such as education, gaming, healthcare, and industry

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the principles, components, and differences between AR and VR systems.
CLO2: Explain the working of sensors, displays, tracking systems, and rendering in AR/VR environments.
CLO3: Develop simple AR and VR applications using appropriate development tools and SDKs.
CLO4: Analyze and evaluate the usability and impact of AR/VR applications in real-world scenarios.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 Hours	**Introduction to AR and VR** Overview of AR and VR, History and evolution of immersive technologies, Key differences and similarities between AR and VR, Applications and impact across domains: education, gaming, industry, healthcare, Hardware platforms: AR glasses, HMDs, mobile AR/VR	CLO1

	Learning Activities: Interactive Lectures and Demonstrations.	
Unit II 12 Hours	**AR/VR Systems and Technology** Tracking technologies: optical, magnetic, inertial, hybrid, Sensors and input devices (IMUs, GPS, cameras), Displays: HMDs, smart glasses, projectors, Rendering pipeline and stereoscopic 3D, Spatial mapping and environmental understanding	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 11 Hours	**AR/VR Development Platforms and Tools** Introduction to Unity 3D and Unreal Engine, SDKs: ARKit, ARCore, Vuforia, WebXR, Creating virtual environments and scenes, Object interaction and physics simulation, Building cross-platform AR/VR experiences	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 10 Hours	**Evaluation and Applications of AR/VR** Human-computer interaction in immersive environments, Usability, accessibility, and UX considerations, Motion sickness and ergonomic issues, Case studies and real-world applications, Future trends: Mixed Reality, Metaverse, Haptic feedback	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. Alan B. Craig, Understanding Augmented Reality: Concepts and Applications, 2nd Edition, Elsevier/Morgan Kaufmann, 2022.
2. Grigore C. Burdea and Philippe Coiffet, Virtual Reality Technology, 4th Edition, Wiley, 2021.
3. Tony Parisi, Learning Virtual Reality, O'Reilly Media, 2015

Course Code: OEC-702
Course Title: Human Computer Interaction
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

To equip students with foundational knowledge and skills in designing, developing, and evaluating user-centric interfaces, with emphasis on interaction styles, prototyping, usability, and emerging technologies in Human-Computer Interaction.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1:Understand the interplay between humans, tasks, technology, and contexts in interactive system design.
CLO2: Identify key human factors that influence effective human-computer interaction.
CLO3: Apply HCI principles, guidelines, and techniques in designing user interfaces.
CLO4: Evaluate and prototype interactive systems using appropriate HCI methods and tools.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 15 Hours	Introduction to Human-computer Interaction - Methodology for Designing User-computer Interfaces -Task analysis - Conceptual, semantic, syntactic, and lexical models.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit II 15 Hours	Design of an interactive system - Interaction Styles -Question and answer -Form-based - Command language Menus -Natural language -Direct manipulation -Virtual Reality - Augmented Reality -Other emerging interaction styles.	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III	Design and Evaluation Process -Prototyping -Testing and evaluating interface designs - Guidelines and criteria for designing UI, UI Software and Specifications -Languages and tools for specifying and building interfaces -Dialogue independence –UIMSLanguages and software abstractions - Programming support tools -. Basic Interaction Tasks, Techniques, and Devices.	CLO3

15 Hours	**Learning Activities:** Interactive Lectures and Demonstrations.	
Unit IV 10 Hours	Human Performance -Scientific foundations for designing user interfaces -Visual presentation of information Graphical design -Designing experiments - Introduction to Research in HumanComputer Interaction -Why do HCI research? -Research prototypes -Interdisciplinary nature of HCI research -Examples of HCI research. New Interaction Techniques -New modes of human-computer communication -Voice Gesture - Eye movement Tangible user interfaces -Brain-computer interfaces - Case Study.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Textbook and References

1. Wilbert O Galitz, “The Essential Guide To User Interface Design”, Wiley Dreamatech, 3 rd edition, 2007 Ben Shneidermann, “Designing The User Interface - Strategies for Effective HumanComputer Interaction”, 4th Edition, Pearson Education Asia, 2004
2. Alan Dix, Janet Fincay, GreGoryd, Abowd, and Russell Bealg, “Human – Computer Interaction”, 3rd edition, Pearson, 2003
3. Yvonne Rogers , Helen Sharp, and Jenny Preece, “Interaction Design: Beyond Human - Computer Interaction”, 3rd edition, Wiley, 2011

Course Code: OEC-703
Course Title: Cyber Law and Ethics
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to provide students with a comprehensive understanding of the legal, ethical, and regulatory issues surrounding the use of technology in the modern digital age. It covers critical areas such as data privacy, intellectual property rights, cybercrimes, digital evidence, and legal compliance. Students will also learn the ethical considerations involved in technology development and use, including ethical hacking, corporate governance, and the impact of cyber laws on the IT industry. The course prepares students to navigate the complex landscape of cyber laws, ensuring they are well-equipped to address legal challenges and make informed decisions related to technology in their professional careers

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the foundational concepts of cyber laws and their application in the digital world.
CLO2: Analyze and evaluate the ethical and legal implications of various technologies such as data privacy, digital signatures, and online transactions.
CLO3: Identify and address issues related to cybercrimes, intellectual property, and digital evidence.
CLO4: Apply legal principles to technology and cybersecurity practices while adhering to ethical standards.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 Hours	**Introduction to Cyber Law** Overview of Cyber Laws, Legal framework in India: Information Technology Act 2000 and amendments, Global cyber law frameworks: European Union, USA, China, Data protection and privacy laws (GDPR, CCPA), Jurisdiction and international cybercrime laws	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 10 Hours	**Intellectual Property and Cyber Crimes** Intellectual Property Rights (IPR): Copyright, Trademark, Patent, Online piracy and digital content protection, Cybercrimes: Types, cyberstalking, phishing, identity theft, Cyber terrorism and hacking: Laws and penalties, Case studies of major cybercrimes and their legal outcomes	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 12 Hours	**Ethics in Cyber Technology** Ethical issues in cyber technology development, Ethical hacking and penetration testing: Legal boundaries, Corporate governance in cybersecurity, The role of ethical frameworks in data collection and usage, Artificial intelligence, automation, and ethical concerns	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	**Legal Compliance and Digital Evidence** Digital signatures and electronic contracts, Electronic evidence and its admissibility in court, Privacy laws: The role of consent and control over personal data, Legal implications of e-commerce and online transactions, Cybersecurity compliance: ISO/IEC 27001, NIST frameworks, PCI DSS	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Textbook

1. P. Nagpal, Cyber Law and E-Commerce, 2nd Edition, Bharat Law House, 2021
2. Brian K. O'Shaughnessy, Cyberlaw: A Legal and Ethical Perspective, 2nd Edition, Pearson, 2021

References and Online Resources

1. Subhajit Basak, Cyber Law in India, 2019 Edition, LexisNexis
2. NPTEL Course: Cyber Security and Legal Aspects
3. The Cyber Law & Ethics – Course by Prof. K. Rajagopal, IIT Madras (Available on NPTEL).

Course Code: OEC-704
Course Title: Financial Technology
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to introduce students to the rapidly evolving field of Financial Technology (FinTech) and its transformative role in the modern financial ecosystem. The course covers the core technologies and innovations driving the FinTech industry, including blockchain, digital payments, cryptocurrencies, robo-advisors, and regulatory technologies. It emphasizes the integration of financial services with emerging technologies, the legal and regulatory challenges associated with FinTech innovations, and the impact of FinTech on traditional financial institutions and financial inclusion. Students will gain a deep understanding of the operational and technical aspects of financial technology and how it is reshaping banking, insurance, and investment sectors.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the fundamentals of Financial Technology and its applications in the financial services sector.
CLO2: Analyze various FinTech innovations such as digital payments, blockchain, and robo-advisory.
CLO3: Evaluate the impact of FinTech on traditional financial institutions, market dynamics, and regulatory frameworks.
CLO4: Apply the principles of FinTech to address real-world financial challenges and understand the legal and regulatory environment.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 12 Hours	**Introduction to Financial Technology (FinTech)** Definition and scope of FinTech, Evolution of FinTech: From traditional banking to digital transformation, Key players and stakeholders in the FinTech ecosystem, Types of financial technologies: Digital Payments, Blockchain, Cryptocurrency, Robo-Advisors, Financial inclusion through FinTech	CLO1

Unit II 12 Hours	**Blockchain and Cryptocurrencies** Introduction to Blockchain: Distributed Ledger Technology (DLT), Blockchain architecture, consensus mechanisms, and smart contracts, Overview of Cryptocurrencies: Bitcoin, Ethereum, Altcoins, Blockchain applications in financial services: Payments, smart contracts, and tokenization, Regulation of cryptocurrencies and legal issues	CLO2
Unit III 11 Hours	**Digital Payments and Lending Technologies** Digital payment systems: E-wallets, mobile wallets, digital banking, Peer-to-Peer (P2P) lending platforms and crowdfunding, Real-time payment systems and instant payments, Role of AI and data analytics in credit scoring and lending, FinTech in insurance: InsurTech innovations and the future of insurance	CLO3
Unit IV 10 Hours	**Regulatory Technologies (RegTech) and Future Trends** Introduction to Regulatory Technologies (RegTech), Role of RegTech in compliance, KYC (Know Your Customer), AML (Anti-Money Laundering), Challenges in regulating FinTech: Data privacy, security, and cross-border issues, Future trends in FinTech: AI, Machine Learning, and the Digital Economy, Ethical and legal challenges in FinTech	CLO4

Textbook

1. Chris Skinner, Digital Bank: Strategies to Launch or Become a Digital Bank, 2nd Edition, Wiley, 2020
2. Arshad Khan, Financial Technology: The Transformation of Finance, 1st Edition, Springer, 2021

References and Online Resources

1. Philip J. Thomas, FinTech: The New DNA of Financial Services, Wiley, 2021
2. NPTEL MOOC: Financial Technology and Digital Transformation
3. Blockchain and Cryptocurrency Regulation – Course by Prof. S. P. Gupta, IIT Kharagpur (Available on NPTEL)

Course Code: BSC-701
Course Title: Bioinformatics
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The objective of this course is to introduce students to the interdisciplinary field of bioinformatics, covering its fundamental concepts, tools, and applications. The course aims to equip students with knowledge of biological data sources, sequence analysis, statistical methods, and computational tools essential for biological research. It emphasizes practical skills in programming, database management, and software tools such as Java, SQL, and PERL, facilitating data analysis and visualization. Additionally, the course explores the commercial, legal, and ethical dimensions of bioinformatics, preparing students for research and industry roles in the evolving landscape of computational biology.

Course Learning Outcomes

After the course completion, the student will be able to

CLO1: Apply advanced skills to critically analyse and solve problems in biotechnology.

CLO2: Use techniques, skills, and modern engineering tools necessary for engineering practice.

CLO3: Analyze protein sequences, identify proteins, and retrieve protein structures from databases. View and interpret these structures. Understand homology modelling and computational drug design.

CLO4: Design and conduct experiments, as well as to analyze and interpret data.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 12 Hours	Fundamentals of Bioinformatics and Information Technology: Introduction to bioinformatics, Experimental sources of biological data, publicly available databases, Operating systems - including Windows and UNIX, Networks - including the Intranets and the Internet Analytical Science and Bioinformatics: High throughput sequencing, Experimental determination of protein structures, Gene expression monitoring, Proteomics, Metabolomics	CLO1

Unit II 12 Hours	Statistical Methods in Bioinformatics: Basic mathematics, Vectors and matrices, Multivariate statistics - particularly exploratory methods and pattern recognition Bioinformatics Algorithms and Tools: Visualization of sequence data, Sequence alignment, Homology searching - including BLAST, Gene expression informatics, Introduction to gene finding	CLO2
Unit III 11 Hours	Applications and Commercial Aspects of Bioinformatics: Visualization of sequence data, Drug discovery, Genetic basis of disease, Personalized medicine and gene-based diagnostics, Legal, ethical and commercial ramifications of bioinformatics Bioinformatics: The Business of Research: Research methodology (focusing on computer-based research), Case studies of areas of current bioinformatics research Routes to research funding (academic and commercial), Bioinformatics business models, Intellectual property rights	CLO3
Unit IV 10 Hours	Software Engineering in Bioinformatics: Advanced programming using Java and BioJava, Advanced database work using SQL, Interfacings programs with databases. Data interoperability using XML Principles of Programming and Databases using Java and SQL: Fundamental principles of programming, Object-oriented programming using Java, Introduction to databases using Oracle. PERL programming: Data manipulation, File maintenance, Pipelining Packaging and interfacing system facilities	CLO4

Textbook

1. Bioinformatics for Dummies, Jean-Michel Claverie, Cedric Notredame, 2003, John Wiley & Sons 2. Bioinformatics Computing, Bryan P. Bergeron, 2002, Prentice Hall 3. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith, 2001, Prentice Hall 4. Beginning Perl for Bioinformatics, James Tisdall,2001, O'reilly

SEMESTER-VIII

Elective-IV

Course Code: PEC -801
Course Title: Network Routing and Switching
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

Understand the fundamentals of TCP/IP transport and application protocols, including TCP, UDP, DNS, and web resource identification. Develop skills to configure and secure network switches, including user authentication, remote access, and IPv4 settings. Gain proficiency in IPv6 addressing, subnetting, and implementation on network devices. Learn the concepts and practical implementation of building and securing a wireless LAN using Cisco devices.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Explain the principles of TCP/IP Layer 4 protocols, including error recovery, and flow control.
CLO2: Configure and verify switch interfaces, including speed, duplex, VLANs, and security settings.
CLO3: Implement and troubleshoot IPv6 addressing and subnetting for efficient network management.
CLO4: Design, configure, and secure a wireless LAN using Cisco Access Points (APs) and Wireless LAN Controllers (WLCs).

Units/Hours	Contents	Mapping with Course Learning Outcome
Unit I 12 Hours	**Introduction to TCP/IP Transport and Applications:** TCP/IP Layer 4 Protocols: TCP and UDP, Transmission Control Protocol, Connection Establishment and Termination, Error Recovery and Reliability, Flow Control Using Windowing, User Datagram Protocol, Uniform Resource Identifiers, Finding the Web Server Using DNS. **Configuring Basic Switch:** Securing the Switch CLI, Securing User Mode and Privileged Mode with Simple Passwords, Securing User Mode Access with Local Usernames and Passwords, Enabling IPv4 for Remote	CLO1

	Access, Host and Switch IP Settings, Configuring IPv4 on a Switch, Verifying IPv4 on a Switch.	
	Learning Activities: Brainstorming, assignment-based learning	
Unit II 11 Hours	**Configuring and Verifying Switch Interfaces:** Configuring Switch Interfaces, Configuring Speed, Duplex, and Description, Configuring Multiple Interfaces with the interface range Command, Administratively Controlling Interface State with shutdown, Removing Configuration with the no Command. Autonegotiation, Analyzing Switch Interface Status and Statistics. **Fundamentals of IP Version 6:** Introduction to IPv6, The Historical Reasons for IPv6, The IPv6 Protocols, IPv6 Routing, IPv6 Routing Protocols, IPv6 Addressing Formats and Conventions, Representing Full IPv6 Addresses, Abbreviating IPv6 Addresses, Expanding Abbreviated IPv6 Addresses.	CLO2
	Learning Activities: Exercise based learning and practical hands-on training	
Unit III 11 Hours	**IPv6 Addressing and Subnetting:** Global Unicast Addressing Concepts, Public and Private IPv6 Addresses, The IPv6 Global Routing Prefix, Address Ranges for Global Unicast Addresses, IPv6 Subnetting Using Global Unicast Addresses, The Mechanics of Subnetting IPv6 Global Unicast Addresses, Listing the IPv6 Subnet Identifier, List All IPv6 Subnets. **Implementing IPv6 Addressing on Routers:** Implementing Unicast IPv6 Addresses on Routers.	CLO3
	Learning Activities: Exercise based learning and practical hands-on training	
Unit IV 11 Hours	**Building a Wireless LAN:** Connecting a Cisco AP, accessing a Cisco WLC, connecting a Cisco WLC, configuring a WLAN: Configure a RADIUS Server, create a Dynamic Interface, create a New WLAN, Configuring WLAN Security, Configuring WLAN QoS, Configuring Advanced WLAN Settings, Finalizing WLAN Configuration.	CLO4
	Learning Activities: Exercise based learning and practical hands on training	

Text Books:

1. Riggs, C., & Group, T. &. F. (2019). Network Perimeter Security: Building Defense In-Depth. Auerbach Publications.

2. Northcutt S. 2005. Inside Network Perimeter Security, 2nd Ed., Pearson Education

Reference Books:

3. Stallings, W. (2017). Network Security Essentials: Applications and Standards.

4. Daimi, K. (2018). Computer and Network Security Essentials. In Springer eBooks. https://doi.org/10.1007/978-3-319-58424-9

5. Ibe, O. C. (2017). Fundamentals of Data Communication Networks. John Wiley & Sons.

6. Forouzan,B.A, 2009, Data Communications and Networking, 4th Ed. Tata McGraw Hill Education.

Course Code: PEC - 802
Course Title: Software Testing and Maintenance
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide students with essential knowledge and practical skills in software testing and maintenance, covering maintenance types, models, techniques, tools, and management strategies to ensure the long-term effectiveness and evolution of software systems..

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Identify and classify software testing and maintenance types and issues, and explain their significance in the software development life cycle.
CLO2: Apply maintenance models and estimation techniques to effectively plan, manage, and execute software testing and maintenance tasks.
CLO3: Use appropriate tools and techniques such as impact analysis, regression testing, refactoring, and reverse engineering for efficient maintenance.
CLO4: Demonstrate the ability to manage software testing and maintenance projects, including risk assessment, documentation, and reuse strategies in both legacy and modern software systems.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 11 Hours	Software testing fundamentals: objectives, principles, Software Development Life Cycle (SDLC) and Testing Life Cycle, Software testing vs debugging, Verification vs Validation, Levels of testing: unit, integration, system, acceptance, Types of testing: functional, non-functional, white-box, black-box, Test design strategies: Black-box testing: equivalence class partitioning, boundary value analysis, decision table testing, White-box testing: statement coverage, branch coverage, path coverage, Cause-effect graphing, Mutation testing	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 12 Hours	Test planning, strategies, policies, Test estimation, scheduling, Defect life cycle, defect tracking, Software Quality Assurance (SQA), Testing metrics: defect density, test effectiveness, Automation testing: need and challenges, Tools: Selenium, JUnit, TestNG, LoadRunner, QTP, Writing test scripts: Selenium WebDriver basics, Continuous integration and testing in DevOps	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 11 Hours	Introduction to Software Maintenance:Definition and importance, Maintenance in the software lifecycle, Types: Corrective, Adaptive, Perfective, Preventive, Myths and facts about maintenance, Challenges and characteristics of maintainable software, Legacy software and related issues. Software Maintenance Process and Models: Maintenance process models: Quick-Fix, Iterative, Boehm's Model, IEEE/EIA Standard 1219 and ISO/IEC 14764, Problem and modification analysis, Maintenance planning and estimation, Cost estimation models: COCOMO II, Maintenance metrics, Software configuration management in maintenance	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	Techniques, Tools, and Management in Software Maintenance: Impact analysis techniques, regression testing, and test case selection, Reverse engineering, reengineering, refactoring, and code smells, Software documentation and tools for source code analysis and version control, Automated maintenance tools: static/dynamic analysis, debugging, profiling, Software reuse and Component-Based Software Engineering (CBSE), Software Product Line Engineering, Maintenance of web and mobile applications, Open-source software maintenance and risk management, Human factors in maintenance and real-world case studies.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. Software Maintenance: Concepts and Practice – Penny Grubb, Armstrong A. Takang, *CRC Press*
2. Software Engineering – Ian Sommerville, *Pearson Education* (Chapters on Maintenance)

3. Software Evolution and Maintenance: A Practitioner's Approach – Priyadarshi Tripathy, Kshirasagar Naik, *Wiley*
4. Managing the Software Process – Watts S. Humphrey, *Addison-Wesley*
5. Software Reengineering – Chikofsky, Elliott J., *IEEE Software (Journal Article)*
6. IEEE Std 1219-1998 – Standard for Software Maintenanc ISO/IEC 14764:2006 – Software Engineering – Software Life Cycle Processes – Maintenance

Course Code: PEC - 803
Course Title: IoT Security
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course introduces key security challenges in IoT and cloud computing, focusing on vulnerabilities and risks. It covers essential cryptographic methods used to protect IoT systems and highlights the security measures implemented to enhance data protection and system resilience in both IoT and cloud environments.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the fundamental security challenges in the Internet of Things (IoT) and cloud computing environments.
CLO2: Demonstrate knowledge of IoT device architecture, including hardware components and relevant communication protocols across network layers.
CLO3: Apply authentication mechanisms such as digital certificates and biometrics to secure IoT systems and ensure reliable identity verification.
CLO4: Collect, monitor, and analyze data from IoT devices, and implement network security measures to protect communication with back-end systems.

Unit/Hours	Contents	Mapping with Course Learning Outcome
Unit I 11 Hours	FUNDAMENTALS OF IoT ECOSYSTEM: IoT security issues, how to design an IoT system, Hardware, software and network security related to IoT systems - Basics of cryptographic solutions to IoT systems.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit II 12 Hours	OVERVIEW OF CLOUD COMPUTING AND ITS SERVICES: Cloud Computing Fundamental: Cloud computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. CHALLENGES IN CLOUD COMPUTING: Benefits and challenges of cloud computing - Public vs. Private clouds, Role of virtualization in enabling the cloud	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit III 11 Hours	SECURITY CONCEPTS IN CONTEXT TO IoT DEVICES: Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, Virtualization	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 11 Hours	IoT SECURITY THREATS AND COUNTERMEASURES: System-Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyper jacking.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. David Etter, " IoT Security: Practical guide book " Create Space, 1st Edition, 2016.
2. Drew Van Duren, Brian Russell, "Practical Internet of Things Security", Packt, 1st Edition, 2016.
3. Sean Smith, "The Internet of Risky Things", O'Reilly Media, 1st Edition, 2017.
4. Brian Russell, Drew Van Duren, "Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem", 2nd Edition, 2018.

Course Code: PEC - 804
Course Title: VLSI Design
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to introduce the fundamentals of Very Large Scale Integration (VLSI) design and its role in modern electronics. It provides students with essential concepts related to MOSFET behavior, CMOS design principles, combinational and sequential logic circuit design, and the digital design flow. The course also gives an overview of fabrication techniques, layout design, and simulation tools, preparing students for advanced courses or careers in chip design and embedded systems.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the basic concepts and significance of VLSI design
CLO2: Apply CMOS design principles for logic circuit implementation
CLO3: Analyze and simulate combinational and sequential circuits using VLSI design tools
CLO4: Understand fabrication steps and layout design of ICs

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 12 Hours	Introduction to VLSI and MOS Transistor Theory Overview of VLSI and its applications, MOSFET structure, operation, and characteristics, Scaling trends, Moore's Law, NMOS, PMOS, and CMOS technologies.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	
Units II 12 Hours	CMOS Logic Design Logic gates using CMOS: Inverter, NAND, NOR, Transmission gates, pseudo-NMOS logic, Design rules and layout basics, Stick diagrams and layout of logic gates	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Units III 10 Hours	Combinational and Sequential Circuit Design Combinational circuits: Multiplexers, encoders, adders, Sequential circuits: Flip-flops, latches, registers, Timing issues: Setup/hold time, clock skew, VLSI design flow and RTL to GDSII overview	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit IV 11 Hours	Fabrication, Testing and VLSI Tools IC fabrication steps: Oxidation, lithography, etching, doping, Design for testability (DFT), fault models, Tools overview: Cadence, Synopsys, Mentor Graphics, Introduction to HDL (Verilog/VHDL) for VLSI design.	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Textbook

1. Neil H.E. Weste and David Harris**,** *CMOS VLSI Design: A Circuits and Systems Perspective*, Pearson**,** 4th Edition, 2022
2. S.M. Kang and Y. Leblebici**,** *CMOS Digital Integrated Circuits: Analysis and Design*, McGraw Hill, 4th Edition, 2023
3. John P. Uyemura**,** *Introduction to VLSI Circuits and Systems*, Wiley**,** 2009

Course Code: PEC-805
Course Title: Open Source Software
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

To introduce students to the principles, practices, and culture of Open Source Software (OSS). The course aims to develop an understanding of OSS development models, licensing, collaboration tools, and the OSS ecosystem. Students will also gain hands-on experience by contributing to or creating small projects using platforms like GitHub.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
COL1: Understand the evolution and current landscape of Open Source Software.
COL2: Analyze open source licenses and their implications on software usage and contribution.
COL3: Use common open source development tools and platforms effectively.
COL4: Participate in OSS projects by utilizing platforms like GitHub.
COL5: Collaborate in teams using OSS principles and contribute to real-world projects.

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 10 Hours	**Introduction to Open Source Software** Definition and characteristics of OSS, History and evolution of OSS, Difference between Free Software and Open Source, Popular OSS communities and foundations (e.g., Apache, Linux Foundation), Benefits and challenges of OSS. **Learning Activities**: Interactive Lectures and Demonstrations.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 11 Hours	**OSS Licensing and Legal Issues:** Types of OSS licenses: MIT, GPL, Apache, BSD, etc., License comparison and compatibility, Intellectual Property Rights in OSS, Legal risks and compliance in using OSS, Case studies on licensing conflicts and best practices	CLO2
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit III 11 Hours	**OSS Development Practices:** Version control systems (Git basics), Collaborative development using GitHub/GitLab, Code review, issue tracking, and project boards, Community building and contribution guidelines, Documentation and testing in OSS projects	CLO3
	Learning Activities: Interactive Lectures and Demonstrations.	
Unit IV 13 Hours	**OSS Platforms and Mini Project:** Exploration of GitHub and popular OSS projects, Forking, cloning, and pull requests, Identifying good first issues, Mini project: Contribute to an existing OSS project or build a small open-source tool, Project presentation and report submission	CLO4
	Learning Activities: Interactive Lectures and Demonstrations.	

Text Books and Reference Material

1. Producing Open Source Software – Karl Fogel, O'Reilly Media
2. Open Source Software: Implementation and Management – Paul Kavanagh, Elsevier
3. The Cathedral and the Bazaar – Eric S. Raymond, O'Reilly Media
4. Version Control with Git – Jon Loeliger and Matthew McCullough, O'Reilly Media
5. Understanding Open Source and Free Software Licensing – Andrew M. St. Laurent, O'Reilly Media

Open Elective-II

Course Code: OEC - 801
Course Title: Business Analytics
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to introduce students to the concepts, methods, and tools of Business Analytics. It enables them to understand how data-driven decision-making can optimize business performance. Students will gain exposure to data preparation, visualization, and analytical techniques for solving real-world business problems. The course focuses on predictive and prescriptive analytics and the use of tools like Excel, R, and Python.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the role and process of business analytics in organizations
CLO2: Apply descriptive and predictive techniques to business data
CLO3: Use data visualization tools for effective communication of insights
CLO4: Solve real-world business problems using analytical frameworks

Units/Hours	Contents	Mapping with Course Learning Outcome
Units I 11 Hours	Introduction to Business Analytics Overview and scope of Business Analytics, Business Analytics process and types, Role of data in decision-making, Tools and software for Business Analytics	CLO1
Units II 11 Hours	Descriptive Analytics Measures of central tendency and dispersion, Data visualization: Histograms, bar charts, dashboards, Excel-based analytics and data cleaning	CLO2
Units III 11 Hours	Predictive Analytics Regression analysis, classification, clustering, Forecasting techniques, Case studies using Python/R	CLO2, CLO3
Unit IV 12 Hours	Prescriptive Analytics and Case Studies Optimization models and decision trees, Real-world applications in marketing, HR, finance, operations, Business ethics and data governance	CLO4

Textbook

1. U Dinesh Kumar, Business Analytics: The Science of Data-Driven Decision Making, Wiley, 2022
2. James R. Evans, Business Analytics, Pearson, 3rd Edition, 2021

Course Code: OEC - 802
Course Title: Fundamentals of Quantum Computing
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objective

This course introduces the principles of quantum computing and its distinction from classical computation. It explores qubits, quantum gates, algorithms, and applications in cryptography and optimization. The goal is to provide foundational understanding and motivate exploration into this emerging area.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the fundamental principles of quantum mechanics and their significance for quantum computing.
CLO2: Explain the core postulates of quantum mechanics and analyze the basic components of quantum computing.
CLO3: Demonstrate knowledge of quantum logic gates and circuits.
CLO4: Evaluate the practical applications and limitations of quantum computing.

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 12 Hours	**Fundamentals of Quantum Mechanics** History of Quantum Mechanics, Why Quantum Computing, Basics of Quantum Computing- Linear Algebra: Hilber space, Bases vectors and linear independence, Operators and matrices, Inner Product, Outer Product	CLO1
Units II 11 Hours	**Fundamentals of Quantum Computing** Postulates of quantum mechanics, Introduction to Quantum Computing, Challenges for Quantum Computing, Qubits and superposition, Bloch sphere representation, Quantum parallelism.	CLO2
Units III 11 Hours	**Quantum Logic Gates and Circuits** Quantum Gates:-Pauli Gates, Hadamard Gate, CNOT, Toffoli Gate Quantum circuits and reversibility, Quantum entanglement, Bell States, Pure & Mixed Quantum States, Density Operator.	CLO3

Unit IV 11 Hours	**Applications and Challenges** Quantum cryptography (QKD), BB84, Introduction to Teleportation and Superdense Coding, Limitations and future outlook.	CLO4

Textbook

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 10th Anniversary Edition, 2021
2. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019
3. Bouwmeester, D., Ekert, A. and Zeilinger, A., (2000), The Physics of Quantum Information, Reprint edition, Springer Berlin Heidelberg.

Course Code: OEC 803
Course Title: Introduction to Web Technologies
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course introduces the core concepts of web development including front-end and back-end technologies, client-server models, HTML, CSS, JavaScript, and web hosting. It prepares students to build basic interactive web applications.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand web architecture and technologies
CLO2: Develop basic web pages using HTML, CSS, and JavaScript
CLO3: Implement simple client-server interactions
CLO4: Deploy and maintain static and dynamic websites

Units/Hours	Contents	Mapping with Course Learning Outcome
Units I 12 Hours	**Web Fundamentals** Web browsers and servers, HTTP protocol, DNS, IP, HTML structure and elements	CLO1
Units II 12 Hours	**Styling and Interactivity** CSS basics and selectors, Responsive design (media queries, flexbox), JavaScript basics: variables, functions, DOM	CLO2
Units III 11 Hours	**Advanced JavaScript and Frontend Frameworks** Event handling, form validation, Introduction to AJAX, Basics of React or Angular (overview)	CLO3
Unit IV 10 Hours	**Server-Side and Deployment** Overview of backend (Node.js, PHP basics), Databases: MySQL, MongoDB (intro), Hosting and deploying websites	CLO4

Textbook

1. Achyut S. Godbole and Atul Kahate, Web Technologies, McGraw Hill, 4th Edition, 2022
2. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley, 2023

Course Code: OEC - 804
Course Title: Technologies for Sustainable Development
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course aims to sensitize students toward sustainable development challenges and the role of modern technologies in addressing them. It introduces eco-friendly innovations, smart solutions for energy and waste management, and sustainable practices in agriculture, infrastructure, and industry. Students will gain a multidisciplinary perspective on how technology can foster environmental, economic, and social sustainability.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the concept and importance of sustainable development and related global goals.
CLO2: Identify technological solutions for energy, water, and waste management aligned with sustainability goals.
CLO3: Evaluate the environmental and social impacts of emerging technologies.
CLO4: Explore case studies of sustainable practices in agriculture, smart cities, green buildings, and industrial innovations

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 11 Hours	**Introduction to Sustainability and Global Challenges** Definition and principles of sustainable development, UN Sustainable Development Goals (SDGs), Climate change, carbon footprint, and resource depletion, Role of science and technology in sustainable development	CLO1

Units II 12 Hours	**Sustainable Energy and Environmental Technologies** Renewable energy technologies: solar, wind, hydro, bioenergy, Smart grids and energy storage systems, Water conservation and purification technologies, Waste management: recycling, composting, e-waste treatment	CLO2
Units III 12 Hours	**Sustainable Infrastructure and Smart Technologies** Smart cities: ICT for energy and transport efficiency, Green buildings: materials, design, and automation, Sustainable agriculture: precision farming, IoT, organic practices, Carbon capture and environmental monitoring technologies	CLO3, CLO4
Unit IV 10 Hours	**Case Studies and Policies for Sustainable Development** National and international policies (e.g., SDG India Index, Paris Agreement), Industry best practices in sustainability, Startups and innovations promoting sustainability, Ethical and economic aspects of sustainable technology implementation	CLO4

Textbook

1. R. K. Pachauri & L. A. Meyer, Climate Change 2022: Mitigation of Climate Change, IPCC Reports, Cambridge University Press
2. Bharat Raj Singh, Sustainable Development: Challenges and Solutions, McGraw Hill, 2021
3. Jeffrey Sachs, The Age of Sustainable Development, Columbia University Press, 2015
4. Selected readings from NITI Aayog reports and UN SDG documents

Course Code: OEC - 805
Course Title: Introduction to Cognitive Science
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course aims to provide an interdisciplinary introduction to the field of Cognitive Science, which explores how humans and machines perceive, learn, reason, and respond. Drawing insights from psychology, neuroscience, artificial intelligence, linguistics, philosophy, and anthropology, the course helps students understand the fundamental processes underlying thought and intelligence. It highlights how cognitive models are built and applied to real-world problems in artificial intelligence, HCI, education, and decision sciences. The objective is to foster an appreciation of how understanding human cognition can enhance the design of intelligent systems and interfaces

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the interdisciplinary foundations of cognitive science.
CLO2: Explain the cognitive processes such as perception, memory, attention, and language.
CLO3: Analyze how cognitive models are applied in computing and AI.
CLO4: Evaluate the impact of cognitive science on technology and human-computer interaction.

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 12 Hours	**Foundations of Cognitive Science** Introduction and history of cognitive science, Disciplines contributing to cognitive science: Psychology, AI, Linguistics, Philosophy, Neuroscience, Cognitive architecture and levels of analysis, Information processing and representational systems	CLO1
Units II 12 Hours	**Cognitive Processes** Perception and pattern recognition, Attention and consciousness, Learning and memory: Short-term, Long-term, Working memory, Language acquisition and comprehension	CLO2

Units III 11 Hours	**Cognitive Modeling and Applications** Rule-based and connectionist models, Symbolic vs sub-symbolic representations, Cognitive modeling in AI (e.g., SOAR, ACT-R), Applications in robotics, expert systems, and cognitive computing	CLO3
Unit IV 10 Hours	**Human-Machine Interaction and Ethical Considerations** Human-Computer Interaction (HCI) and usability design, Embodied cognition and affective computing, Ethics of cognitive technologies, Cognitive science in education and decision-making	CLO4

Textbook

1. Chris Skinner, Digital Bank: Strategies to Launch or Become a Digital Bank, 2nd Edition, Wiley, 2020
2. Arshad Khan, Financial Technology: The Transformation of Finance, 1st Edition, Springer, 2021

References and Online Resources

1. Philip J. Thomas, FinTech: The New DNA of Financial Services, Wiley, 2021
2. NPTEL MOOC: Financial Technology and Digital Transformation
3. Blockchain and Cryptocurrency Regulation – Course by Prof. S. P. Gupta, IIT Kharagpur (Available on NPTEL)

Open Elective-III

Course Code: OEC - 821
Course Title: Social Media Analytics
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

This course introduces students to the field of Social Media Analytics, focusing on how data generated from social platforms can be captured, processed, analyzed, and used for decision-making. The course covers the fundamentals of social media platforms, data collection techniques via APIs, sentiment analysis, trend mining, influencer identification, and visual analytics. Students will explore tools and frameworks used in real-world social media analytics and develop skills to interpret user behavior, engagement, and network dynamics. The objective is to empower students with analytical skills to draw meaningful insights from social data and apply them in domains like marketing, politics, social impact, and public sentiment.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand the structure and impact of various social media platforms and types of social data.
CLO2: Apply techniques for collecting, preprocessing, and analyzing social media data.
CLO3: Perform sentiment analysis, topic modeling, and trend identification using real-time data.
CLO4: Use visual analytics and network analysis to interpret social media behavior and influence.

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 12 Hours	**Introduction to Social Media and Social Data** Overview of social media platforms and content types, Categories of social media analytics, Applications: Business, political, crisis monitoring, customer feedback, Social data characteristics: Unstructured, real-time, voluminous, Challenges in social media analytics	CLO1

Units II 11 Hours	**Data Collection and Preprocessing** Accessing social media data: APIs (Twitter, Facebook, Instagram, YouTube), Web scraping and ethical considerations, Data storage formats: JSON, CSV, databases, Text cleaning, stopword removal, tokenization, stemming, lemmatization, Handling noisy, multilingual, and streaming data	CLO2
Units III 11 Hours	**Analytical Techniques and Tools** Sentiment analysis using NLP techniques, Trend detection and hashtag analytics, Topic modeling (LDA), Classification and clustering of posts and users, Tools: Python, Tweepy, TextBlob, NLTK, VADER, Tableau/Power BI for visualization	CLO3
Unit IV 11 Hours	**Network and Visual Analytics** Social network analysis: Graph theory basics, centrality measures, Influencer identification and community detection, Visualizing trends, sentiments, and user behaviour, Campaign impact analysis and real-time dashboarding, Case studies from Twitter trends, political campaigns, marketing, disaster response	CLO4

Textbook

1. Matthew A. Russell, Mining the Social Web, 3rd Edition, O'Reilly Media, 2021
2. Sloan, L., & Quan-Haase, A., The SAGE Handbook of Social Media Research Methods, 2017, SAGE Publications

References and Online Resources

1.Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014
2. NPTEL MOOC: Social Networks by IIT Ropar
3. Coursera: Applied Social Media Analytics by Rutgers University
4. KDnuggets, Towards Data Science, and DataCamp Blog for real-world use cases and tutorials

Course Code: OEC - 822
Course Title: Mobile Application Development
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course on Mobile Application Development is designed to equip students with the knowledge and skills to develop mobile apps for modern smartphones and tablets. It emphasizes a hands-on, project-based approach to understanding the mobile ecosystem, including design patterns, development tools, user interface design, backend integration, and deployment. Students will gain proficiency in using platforms like Android and cross-platform frameworks such as Flutter or React Native. The course also covers app lifecycle, performance optimization, data storage, and security considerations, preparing students to build real-world mobile applications with user-centric functionality.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Understand mobile platforms, development environments, and the mobile app development lifecycle.
CLO2: Design intuitive and responsive mobile user interfaces.
CLO3: Develop functional mobile applications using native or cross-platform tools.
CLO4: Integrate backend services, manage data, and deploy secure mobile applications.

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 12 Hours	**Introduction to Mobile Application Development** Evolution of mobile computing, Overview of mobile platforms: Android, iOS, and cross-platform tools (Flutter, React Native), Android architecture and development environment setup (Android Studio), App components: Activities, Services, Intents, Broadcast Receivers, Content Providers, App lifecycle and permissions	CLO1

Units II 11 Hours	**User Interface Design and Interaction** Layouts, Views, and UI controls in Android/Flutter, Event handling and touch interactions, Material Design principles, Localization and accessibility, Adaptive design: Supporting multiple screen sizes	CLO2
Units III 11 Hours	**App Functionality and Data Handling** Storage options: Shared Preferences, SQLite, Room database, Working with files and media, Connecting to RESTful APIs and using JSON/XML, Using libraries for networking (Volley/Retrofit), Push notifications and background services	CLO3
Unit IV 11 Hours	**Advanced Topics and App Deployment** Security practices in mobile apps, App monetization and in-app purchases, Performance optimization and debugging, Publishing apps on Play Store/App Store, Case study: End-to-end mobile app development project	CLO4

Textbook

1. Barry Burd, Android Application Development All-in-One For Dummies, 3rd Edition, Wiley, 2020
2. Neil Smyth, Android Studio Development Essentials, Techotopia, 2023 Edition

References and Online Resources

1. Greg Lim, Beginning Flutter: A Hands-On Guide to App Development, Apress, 2021

Course Code: OEC - 823
Course Title: Innovations in Computing
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course on Innovations in Computing is designed to introduce students to cutting-edge trends and transformative technologies that are shaping the future of computing. The objective is to foster an innovation mindset by exposing students to recent breakthroughs in areas such as Artificial Intelligence, Quantum Computing, Edge and Cloud Computing, Blockchain, IoT, and Human-Computer Interaction. Students will explore both the technical foundations and real-world applications of these innovations and analyze their impact on society, economy, and technology ecosystems. This course empowers students to think critically, identify opportunities, and explore future careers or research paths in next-generation computing.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
CLO1: Identify and describe emerging technologies and innovations in computing.
CLO2: Understand the technical principles behind disruptive computing paradigms.
CLO3: Analyze applications, challenges, and future directions of innovative computing models.
CLO4: Evaluate the societal, ethical, and economic impact of computing innovations.

Units/Hours	**Contents**	**Mapping with Course Learning Outcome**
Units I 12 Hours	**Emerging Paradigms in Computing** Overview of disruptive technologies, Artificial Intelligence and Machine Learning, Quantum Computing: Qubits, Quantum gates, Quantum supremacy, Natural Language Processing and Generative AI, Impact of innovations on automation, creativity, and decision-making	CLO1

Units II 10 Hours	**Cloud, Edge, and Distributed Intelligence** Cloud computing architectures and services (IaaS, PaaS, SaaS), Edge and Fog Computing concepts, Microservices and containerization (Docker, Kubernetes), Serverless computing and real-time analytics, Use cases in smart cities, healthcare, and logistics	CLO2
Units III 10 Hours	**Blockchain, IoT, and Cybersecurity Innovations** Blockchain architecture and consensus mechanisms, Smart contracts and decentralized applications (DApps), Internet of Things (IoT): Architecture, protocols, applications, Cybersecurity for emerging technologies: Zero Trust, AI in security, Challenges in scalability, privacy, and trust	CLO3
Unit IV 12 Hours	**Future Trends and Societal Impact** Human-Computer Interaction (HCI) and Brain-Computer Interfaces, Ethical and regulatory considerations in emerging tech, Green computing and sustainability in innovation, Case studies: GPT-4, IBM Q Experience, Metaverse, Digital Twins, Innovation ecosystems: Startups, incubators, and funding trends	CLO4

Textbook

1.Parag Kulkarni, Reinvention of Computing, Wiley, 2021

2. Peter J. Denning & Craig H. Martell, Great Principles of Computing, MIT Press, 2nd Edition, 2023

References and Online Resources

1.Emerging Technologies: AI, IoT and Quantum Computing – NPTEL Course by IIT Hyderabad

2. IEEE Spectrum and ACM TechNews for recent trends

3. McKinsey Technology Trends Outlook reports

Course Code: OEC-824
Course Title: Computer Vision
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives

The course on Computer Vision aims to equip students with a foundational understanding of how machines perceive and interpret visual data. It introduces the essential principles of image processing and computer vision, enabling students to comprehend the theory behind depth estimation and multi-camera setups. The course also provides hands-on experience with various feature extraction techniques, image segmentation approaches, classification, clustering, and motion analysis. By the end of the course, students will be capable of applying these methods to real-world applications, developing intelligent systems that analyze and respond to visual inputs.

Course Learning Outcomes

Course learning outcomes (CLOs): After the completion of the course, student will be able to:
COL1: Understand the fundamentals of computer vision
COL2: Understand depth estimation and multi camera views
COL3: Apply various feature extraction methods and perform image segmentation
COL4: Apply image classification and clustering algorithms and motion analysis real life applications

Unit/Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit I 11 Hours	Digital Image Formation and low-level processing Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Histogram Processing. Depth estimation and Multi-camera views Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.	CLO1
	Learning Activities: Interactive Lectures and Demonstrations.	

Unit II 12 Hours	Feature Extraction Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO2
Unit III 11 Hours	Image Segmentation Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean- Shift, MRFs, Texture Segmentation; Object detection. Pattern Analysis Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non parametric methods. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO3
Unit IV 11 Hours	Motion Analysis Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. **Learning Activities:** Interactive Lectures and Demonstrations.	CLO4

Text Books and Reference Material

1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer-Verlag
2. Digital Image processing By Rafael C. Gonzalez and Richard E. Woods- Pearson Education. Latest Edition
3. Digital Image Processing by A.K. Jain, PHI Latest Edtion
4. Practical Computer Vision Applications Using Deep Learning with CNNs: With Detailed Examples in Python Using TensorFlow and Kivy, Apress