Indian Institute of Information Technology Sri City, Chittoor

Bachelor of Technology (B.Tech.)

(Electronics and Communication Engineering)

Curriculum and Syllabi

2020 Batch onwards

Indian Institute of Information Technology Sri City, Chittoor
630 Gnan Marg, Sri City - 517 646, Andhra Pradesh, India

Indian Institute of Information Technology Sri City, Chittoor

Background

Indian Institute of Information Technology Sri City, Chittoor known as IIIT Sri City (IIITS) was established in 2013 by the Ministry of Education, Government of India as an Institute of National importance by an Act of Parliament. IIITS is one among the 20 Institutes across India, focusing on Information Technology education, research and development. IIITS was set up by the Government of India along with Government of Andhra Pradesh and Industry Partners represented by Sri City Foundation as a Public-Private-Partnership (PPP) institution. The Institute is governed by the Board of Governors consisting of eminent personalities from the Government, Industry and Academia. The institute is completing 8 successful years. Thanks to the initial mentoring by IIIT Hyderabad, IIITS has achieved a significant position among IIITs in terms of attracting qualified faculty members, good campus placements record, excellent research culture, etc.

IIITS offers BTech, MTech, and PhD programmes in the areas of Computer Science & Engineering and Electronics & Communications Engineering. The 144- credit BTech curriculum follows a practice-theory-practice approach by giving more opportunity for practical learning through curricular and co-curricular components. The unique BTech Honours programme focuses on UG-Research. IIITS offers BTech specializations in AI & ML, Cyber Security, Data Science and Cyber Physical Systems. The institute offers two MTech programmes- AI & ML and Cyber Security with focus on developing graduates required for the industry. In addition to Full-time PhD programmes, Part-time PhD programmes are also offered to support IT professionals and research scientists.

Aligning with expectations of NEP 2020, it was proposed to revisit the curriculum to produce industry-ready graduates with required knowledge and competences to take up emerging job roles. In addition, with a view to develop graduates with holistic development, a number of topics are required to be included in the formal curriculum. There is a need to strengthen the academic programme by improving the teaching-learning processes with a student-centered approach. Further, it is realized that the curriculum both in its structure and delivery aspects has to be linked to the desired graduate outcomes. It was also envisaged that the curriculum needs to develop creativity and innovation among students, who are likely to choose entrepreneurship as one of the active career choices.

About Outcome Based Curriculum of B.Tech. Programmes

Given this background, The Board of Governors (BoG) advised the institute to take up implementation of Outcome-based Education (OBE). Accordingly, the institute has taken up efforts to implement OBE and familiarizing the faculty to the importance and implementation aspects of OBE. The institute has started the process of preparing the OBE curriculum. The efforts were initiated in March 2021 with a series of workshops connected by the faculty of IIT Madras and NIT Trichy. A series of workshops/sessions were also attended by the faculty to understand the context, approach, methodologies of implementing OBE. The industry inputs were taken at the subject and programme levels.

The new Curriculum document has the following features:

a) **Programme Outcomes (POs):**
Program outcomes are specific focused statements that describe what students are expected to be able to do at the end of their graduation. These outcomes are expected to align closely with various attributes, a graduate is expected to demonstrate at the end of the programme.

b) **Programme Specific Outcomes (PSOs):**
Programme Specific Outcomes are defined for a specific discipline stating what the students should be able to do at the time of graduation with reference to that specific discipline.

c) **Course Outcomes (COs):**
Course Learning Outcomes are measurable statements that clearly describe significant and necessary learning that learners have gained and can demonstrate the same at the end of a course or a programme. These outcomes identify what learners will be able to exhibit at the end of a course or program. This would also ensure skillset and dispositions that constitute the integrated learning necessary for a graduate to gain during a course or a program.

d) **Systematic Mapping of COs with POs:**
In this curriculum design, we have followed an approach to ensure that each of the topics defined in the syllabus is properly delivered. This is measured by the respective unit wise outcome and there is specific number of outcomes for each of the courses. Each of the unit wise COs are mapped to POs (and PSOs as applicable) on a 5-points scale (as shown below) stating the relevance of that CO to a specific PO:

5	Highly Relevant (Very High)
4	Relevant (High)
3	Moderately Relevant (Medium)
2	Slightly Relevant (Low)
1	Not Relevant (Very Low or None)

Here 5 means that CO is highly relevant to achieve that specific PO and 1 means CO is not necessary to achieve that specific PO. In this way, we have mapped all identified COs with all 8 POs and PSOs (as applicable) and the map is shown at the end of each course description.

e) **Structured syllabus:**
The course content for each of the courses in our curriculum is organized in a structured way with the following components:

i) **Course Objectives:** This describes the overall course objectives of the course and what students are going to focus on in that course

ii) **Syllabus:** In this curriculum revision, we have reoriented the syllabus into 6 units and in each unit, we have organized topics and specific topics that would be covered in the given duration of credit hours. Each course is ensured to cover the content from basics to advanced topics in that specific subject with possible mappings to various practical aspects of application development, wherever possible.

iii) **Text and Reference Books:** It has been taken care of to ensure 1-2 books of high standards are considered as the primary textbook for each course. A few reference books and resources leading to the state-of-the-art research papers are also suggested to get depth of the topics that are supposed to be covered in the specific course.

iv) **Course Outcomes:** Our focus is to ensure that each unit of the syllabus is delivered in such a way that the defined Course outcomes are achieved.

Programme Outcomes (POs) for B.Tech. (ECE) Programme

The following Program Outcomes are derived for the B.Tech. in Electronics and Communication Engineering Programme offered by IIIT Sri City:

SNo	POID	Program Outcomes (POs) - ECE Programmes
1	PO1	Ability to apply fundamental knowledge across both traditional and emerging trends
2	PO2	Ability to demonstrate different skill-sets such as core technical, programming and use hardware tools to address real industry/societal problems
3	PO3	Ability to build end-to-end engineering solutions from analysis, design and implementation to solve industry-specific problems.
4	PO4	Ability to exhibit analytical and critical thinking for meeting industry and research advancements
5	PO5	Ability to demonstrate the knowledge and skills learnt in the horizontal and vertical areas to solve the challenging problems
6	PO6	Ability to work in diverse teams and contribute towards attainment of overall outcome/impact of the tasks/projects
7	PO7	To be aware of ethics, values and socially responsible behaviour and practice the same in all possible situations
8	PO8	Ability to communicate clearly and precisely with individuals and groups for achieving timely and quality outcomes

There are 8 POs and out of which the first 5 POs are specific to building and enhancing the technical expertise of the students during the course of the specific programme and the last 3 POs are general POs that are essential to follow good practices adhering social, cultural and ethical values for the rest of their lives.

Programme Specific Outcomes (PSOs)

The following Program Specific Outcomes are arrived for specialization courses:

SNo	PSO#	Common PSOs - For All Specializations
1	PSO-01	Ability to illustrate fundamental and application knowledge in Electronics, Signal processing, Communication, VLSI and related areas
2	PSO-02	Ability to demonstrate skill-sets and hands-on experience in emerging areas of IoT, Autonomous Systems, Machine learning, Robotics and related areas
3	PSO-03	Ability to express system-level understanding and demonstration of the ideas and solutions in interdisciplinary areas.
4	PSO-04	Ability to innovate and contribute to deep-tech companies, research organizations or start-ups.

The above table covers the PSOs that are common to all specializations irrespective of their technical merits and demerits.

The following are the PSOs for Cyber Physical Systems specialization:

SNo	PSOID	PSO's for Specialization – Cyber Physical Systems
1	PSO-CPS-01	Ability to demonstrate capabilities in the CPS technologies of IoT, Digital Twins and related areas
2	PSO-CPS-02	Ability to take-up product design and development jobs in Industry 4.0, possess implementation skills of industry grade problems and be potential job creators

The following are the PSOs for Next Generation Wireless Communication specialization:

SNo	PSOID	PSO's for Specialization – Next Generation Wireless Communication
1	PSO-NGW-01	Ability to model wireless architectures and protocols using simulation/ analytical skills for different applications of LTE and 5G wireless technologies
2	PSO-NGW-02	Ability to incorporate emerging techniques such as small cells, virtualization, etc. for 5G channel modelling and network resource allocation.

Curriculum and Syllabi of B.Tech. (ECE)

1. Introduction

This document describes the curriculum and Syllabi of the B.Tech. degree in Electronics and Communication Engineering (ECE) offered by IIIT Sri City. The degree requirements are detailed in terms of minimum total credits to be earned, and the minimum credits to be earned in specific areas. These requirements are to make the programs flexible, in which the students can choose courses depending on their interests, as long as they satisfy the minimum requirement.

2. Credit Requirements

It is proposed that a student must successfully complete 144 credits for graduation of B.Tech. in Electronics and Communication Engineering (ECE). The courses across 144 credits are proposed to be split as follows:

Category	Credits	Remarks
Institute Core	40	Common Core courses across both the streams
Program Core	36	Core courses for the program
Program Elective	27	Elective courses for the particular program
Institute Elective	9	Any technical course offered by the Institute
SSHAM	24	Includes Communication Skills[1] (4 x 2 credits), Skills, Science (2 x 2 credits), Humanities (2 x 2 credits), Aptitude courses (2 x 2 credits) and Management (2 x 2 credits)
BTP	8	Bachelor's Thesis Project (BTP) across 2 semesters
B.Tech.	**144**	This fulfils the graduation requirements for the B.Tech. Programme in ECE
	8	Honours Project
B.Tech. (Hons)	**152**	For B.Tech. (Honours) Programme (144 + 8 Credits for Honours)
	14	**Specialization Courses:** 3 Specialization Courses in Cyber Physical Systems / 5G Wireless requires 3 x 3 courses + 4 x 1 Industry Project + 1 x 1 Seminar (= 14 Credits)
B.Tech. with a Specialization	**158**	For B.Tech. with specialization in Cyber Physical Systems / 5G Wireless (144 Credits + 14 credits for specialization)
B.Tech. (Hons.) with Specialization	**166**	B.Tech. (Honours) with specialization in Cyber Physical Systems / 5G Wireless (152 Credits + 14 credits for specialization)

3. UG Curriculum

[1] One communication skill is optional for those who have good fluency in English and other 3 Communication Skills courses are compulsory. Those who are not taking up the first course in the communication skills category, may take one more course in Aptitude / Competitive Programming / Soft skills for employability category to complete 24 credits in total in SSHAM category in order to meet the graduation requirements

The following is the curriculum for the students to be admitted to the B.Tech. in Electronics and Communication Engineering degree programme.

Semester: 1

Type	Code	Course Name	L-T-P-C
Institute Core	ICS101	Computer Programming	2-1-1-4
Institute Core	IMA101	Discrete Structures and Matrix Algebra	3-1-0-4
Institute Core	IEC101	Overview of Computers Workshop	2-1-1-4
Institute Core	IEC102	Digital Logic Design	2-1-1-4
SSHAM 1	ISK101	Essential English (bridge course)	1-1-0-2
SSHAM 2 & 3		Foundations in Human Values and Ethics / Energy and Environments	1-1-0-2/ 2-0-0-2
		Total Credits	**20**

Semester: 2

Type	Code	Course Name	L-T-P-C
Institute Core	IMA102	Probability and Statistics	3-1-0-4
Institute Core	ICS201	Data Structures and Algorithms	2-1-1-4
Institute Core	IEC204	Signals and Systems	2-1-1-4
Program Core	IEC103	Basic Electronics Circuits	2-1-1-4
SSHAM 4	ISK102	Operational Communication	1-1-0-2
SSHAM 2 & 3		Foundations in Human Values and Ethics / Energy and Environments	1-1-0-2/ 2-0-0-2
		Total Credits	**20**

Semester: 3

Type	Code	Course Name	L-T-P-C
Institute Core	IMA200	Real Analysis, Numerical Analysis and Calculus	3-1-0-4
Institute Core	ICS102	Object Oriented Programming	2-1-1-4
Program Core	IEC330	Control Systems	3-1-0-4

Program Core	IEC111	Circuit and Network Analysis	3-1-0-4
Program Core	IEC201	Embedded Systems	3-0-1-4
SSHAM 5	ISK201	Professional Communication	1-1-0-2
		Total Credits	**22**

Semester: 4

Type	Code	Course Name	L-T-P-C
Institute Core	IEC255	Computer and Communication Networks	3-1-0-4
Program Core	IEC400	Fundamentals of Communication	3-0-1-4
Program Core	IEC202	Analog Circuits	2-1-1-4
Program Core	IEC301	Electromagnetics and Transmission Lines	3-1-0-4
SSHAM 6	ISK202	Advanced Communication Skills	1-1-0-2
SSHAM 7		SSHAM 7	x-x-0-2
		Total Credits	**20**

Semester: 5

Type	Code	Course Name	L-T-P-C
Program Core		Digital Signal Processing	3-1-0-4
Program Core	IEC342	Introduction to VLSI	3-1-0-4
Program Elective		Program Elective – 1	2-x-x-3
Program Elective		Program Elective – 2	2-x-x-3
Program Elective		Program Elective – 3	2-x-x-3
SSHAM 8		SSHAM 8	x-x-0-2
SSHAM 9		SSHAM 9	x-x-0-2
HONOURS		Honours – 1	0-0-4-4
		Total Credits	**21 / 25**

Semester: 6

Type	Code	Course Name	L-T-P-C

Program Elective		Program Elective – 4	2-x-x-3
Program Elective		Program Elective – 5	2-x-x-3
Program Elective		Program Elective – 6	2-x-x-3
Program Elective		Program Elective – 7	2-x-x-3
Institute Elective		Institute Elective – 1	2-x-x-3
SSHAM 10		SSHAM 10	x-x-0-2
BTP / HONOURS		BTP - 1 / Honours - 2	0-0-4-4
		Total Credits	**21**

Semester: 7

Type	Code	Course Name	L-T-P-C
Program Elective		Program Elective – 8	2-x-x-3
Institute Elective		Institute Elective – 2	2-x-x-3
SSHAM 11		SSHAM 11	x-x-0-2
BTP / HONOURS		BTP - 2 / Honours - 3	0-0-4-4
		Total Credits[2]	**8 / 12**

Semester: 8 (includes an optional Semester Long Project)

Type	Code	Course Name	L-T-P-C
Program Elective		Program Elective – 9	2-x-x-3
Institute Elective		Institute Elective – 3	2-x-x-3
SSHAM 12		SSHAM 12	x-x-0-2
HONOURS		Honours – 4	0-0-4-4
		Total Credits[3]	**12 / 8**

4. List of Elective Courses (ECE)

[2] In case of a student taking up the Semester Long Project (SLP) in 7th or 8th Semesters, these 8 credits will go to Semester Long Project. Otherwise aforementioned courses would be taken by the students to meet the graduation requirements.

[3] In case of a student going to take up the Semester Long Project (SLP), these 8 credits will go to Semester Long Project. Otherwise, aforementioned courses would be taken by the students to meet the graduation requirements.

The list of ECE Program Elective courses to be offered to UG students is given below:

i) Advanced VLSI (2-0-1-3)
ii) Automotive Electronics (2-1-0-3)
iii) Digital System Design (2-1-0-3)
iv) Electronic Packaging (2-1-0-3)
v) Measurement and Instrumentation (2-1-0-3)
vi) Microprocessors and Microcontrollers (2-0-1-3)
vii) Microsensors and Actuators (2-1-0-3)
viii) Microwave Engineering and Radar Systems (2-1-0-3)
ix) Model-based Signal Analysis (2-1-0-3)
x) Opto Nano Electronics (2-1-0-3)
xi) Pattern Recognition (2-0-1-3)
xii) Wireless Communication (2-1-0-3)

The following is the list of ECE Institute Electives to be offered to UG students

i) Introduction to Cyber Physical System (2-1-0-3)
ii) Introduction to Robotics (2-0-1-3)
iii) Wireless Networks (2-1-0-3)

5. Specialization Tracks

a) **Cyber Physical Systems**

CPS is an amalgamation of physical processes, wireless networking and extensive computing. The physical processes are monitored with varied sensors and then communicated through networking to create an automated feedback-based embedded control system. The automated/ smart systems are modelled from the data points through technological abstractions of IoT, intelligent systems, machine learning and pattern recognition. Over the last 3-5 years, there has been an exponential growth in the number of companies pursuing this area and offering technological opportunities. It is an interdisciplinary program that would train and prepare students for the next wave of required technological skill-sets.

The following are the elective courses to be taken under this specialization:

i) Internet of Things (3 Credits: 2-1-0-3)
ii) Intelligent and Autonomous Systems (3 Credits: 2-1-0-3)
iii) Digital Twins: Concepts and Applications (3 Credits: 2-1-0-3)
iv) Seminar Course (1 Credit: 1-0-0-1)
v) Project Work (4 Credits: 0-0-4-4)

b) **Next Generation Wireless Communication**

5G wireless communication technology is designed to deliver higher multi-Gbps peak data speeds, ultra-low latency, more reliability, increased network capacity, and a more uniform user experience. 5G would be based on LTE and would be an amalgamation of several independently developed technologies such as Massive MIMO, UWB, NOMA, etc; with an evolved packet core and cloud-based radio access network. For successful deployment of 5G wireless systems, it is essential to comprehend and design each technology, while providing an intelligent integration of the same.

The following are the elective courses to be taken under this specialization:

i) Wireless Communication (3 Credits: 2-1-0-3)
ii) Advanced Wireless Communication (3 Credits: 2-1-0-3)
iii) 5G Technologies and Applications (3 Credits: 2-1-0-3)
iv) Seminar Course (1 Credit: 1-0-0-1)
v) Project Work (4 Credits: 0-0-4-4)

6. SSHAM (Skill, Science, Aptitude, Humanities and Management) Course:

i) Essential English (Bridge Course) (1-1-0-2)
ii) Operational Communication (1-1-0-2)
iii) Professional Communication (1-1-0-2)
iv) Advanced Communication Skills (1-1-0-2)
v) Foundations in Human Values and Ethics (1-1-0-2)
vi) Energy and Environment (2-0-0-2)
vii) Bioinformatics (2-0-0-2)
viii) Skills for Employability (1-1-0-2)
ix) Quantitative and Reasoning Aptitude (1-1-0-2)
x) Personal Growth Programme (1-1-0-2)
xi) Macro-economics and Personal Finance (2-0-0-2)
xii) IT Project Management (2-0-0-2)
xiii) Innovation and Entrepreneurship (2-0-0-2)
xiv) Climate Change and its Implications (2-0-0-2)
xv) ICT for Development (2-0-0-2)

Institute Core Courses

of the B.Tech. (ECE) Programme

Computer Programming

Institute Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of this course is to create a strong fundamental quest for programming among students using the basic problem-solving skills. This course will also provide the students the ability to apply logical thinking by means of learning by doing the basic programming in C, This course involves a lab component that would give the students hands-on experience in solving problems using C language.

2. **Syllabus:**

   Unit – 1 [7 Hours]: Introduction to Computers and Programming: History of Computers, Overview of C, Procedural Programming, Programming Languages, Compilers, Linkers and Loaders, Binary Representation

   Unit – 2 [8 Hours]: Variables, Data Types and Arrays: Variables, Constants, Operators in C, Data types in C, Managing I/O in C, Arrays, bitwise operators

   Unit – 3 [10 Hours]: Control Structures, Multi-dimensional Arrays and Strings: Decision making and Branching: Conditions-if-else constructs, switch case, Ternary conditional statements, Decision making and looping: for loop, while loop, do-while, nested loops, break, continue, Programs on arrays, Multidimensional Arrays, Character Arrays, and Strings Operations

   Unit – 4 [8 Hours]: User Defined Functions: Defining Functions in C, Call by Value, functions with arrays, Scope of variable names. Recursive functions, Tail recursion. Analysing recursion, Tree of recursion, linear recursion, Recursion and Stack

   Unit – 5 [9 Hours]: Composite Data Structures: Pointer Concepts, Structures, Array of Structures, Unions, Enums and Functions with Call by Reference, Dynamic Memory allocation: malloc, realloc and calloc

   Unit – 6 [6 Hours]: File Handling: File Management in C, Input/Output streams, File Opening Modes, Command Line Arguments

3. **Course Outcomes:**

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

   i) To understand basics of computing including various number systems and basic commands for creating, compiling and running a sample C program in unix / linux

   ii) To understand various data types, variables, operators and an array of values in C language

iii) To develop skill set for solving problems using control loops / decision structures, multi-dimensional arrays and strings

iv) To understand the specifics of a solution in terms of user defined functions and recursive functions including tail recursions and analysis of recursive solutions

v) To understand pointers, composite data structures, and apply call by reference and dynamic memory allocation routines for developing small applications in C

vi) Able to handle various file operations in C and use them for writing efficient programs

4. Text Books:

a) Brian W. Kernighan, Dennis Ritchie, The C Programming Language, Second Edition 1988, Prentice-Hall, USA, ISBN 0-13-110370-9

b) Donald E. Knuth, The Art of Computer Programming, Volume {I - IV:}, 1973, Addison-Wesley, USA

5. Reference Books:

a) Richard Reese, Understanding and Using C Pointers, First Edition, May 2013, O'Reilly Media Inc., CA, USA

b) Yashavant Kanetkar, Let Us C, 15th edition, 2016, BPB Publications, New Delhi, India

c) E. Balaguruswamy, Programming in ANSI C, 7th edition, 2016, McGraw-Hill Education, India

d) Yashavant Kanetkar, Understanding Pointers in C, 2003, BPB Publications, New Delhi, India

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	3	1	2	3	1	2
CO2	2	3	4	2	3	2	2	2
CO3	4	4	3	4	3	3	2	3
CO4	3	5	4	5	4	3	3	4
CO5	4	4	5	4	5	3	2	3
CO6	3	3	2	3	2	2	1	1

Discrete Structure and Matrix Algebra

Institute Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**
   The objective of the course is to enable students to develop logical thinking, ability to reason, ability to use mathematically correct terminology and its application to computer science. The course enables students to understand underlying concepts of matrix algebra and gain further skills in the relevant techniques to apply them appropriately.

2. **Syllabus:**
   Unit – 1 [10 Hours]: Mathematical Logic - Propositions, Predicates and Quantifiers, Logical Statements, Equivalence of Statements, Converse, Contrapositive and InverseStatements, Tautology and Contradiction, Mathematical Inference, VariousProof Strategies, Disprove, Normal Forms

   Unit – 2 [8 Hours]: Sets, Induction and Recursion: Basic set operations, Functions, Cardinality, Countable and uncountable sets, Sequence & summations. Induction and Recusion: Principle of Induction, Strong induction, Recursive algorithms, recursive definition of sets, structural induction

   Unit – 3 [7 Hours]: Counting techniques: Sum and Product Rule, Inclusion and ExclusionPrinciples, Pigeonhole Principle, Generalized Pigeonhole Principle, Permutation,Combination, Recurrence Relation, Solving Homogeneous and Non Homogeneous Recurrence Relations, Binomial Coefficients and Identities

   Unit – 4 [7 Hours]: Relations: Relations, Equivalence and Partial order relations, partition and equivalence classes, Closure of relation, Representation and operation on relations, Posets,totally ordered sets, well-ordered sets, least and maximum elements, least upper bound, greatest lower bound, Lattice

   Unit – 5 [9 Hours]: Solving Linear Equations, Vector Spaces and Subspaces: Solving Ax = b, Elimination with matrices, Multiplication and inverse matrices, Factorization into A = LU, Transposes and Permutations. Spaces of Vectors, Column space, Null-space, Row Space, Left null space, Independence, basis, and dimension, Rank and Row reduced form, Invertible matrices

   Unit – 6 [7 Hours]: Orthogonality and Eigen Values and Eigen vectors: Orthogonal vectors and spaces, Projections, Orthogonal bases and Gram-Schmidt. Diagonalization, Spectral Decomposition, Symmetric Matrices, Positive Definiteness, Singular Value Decomposition

3. Course Outcomes:

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

i) To build valid logical arguments and to apply them in proving or disproving mathematical statements.

ii) To learn and perform set operations that is used for various applications in probability and to apply recursion in solving appropriate algorithmic problems.

iii) To learn counting strategies in solving appropriate counting problems.

iv) To understand and diagramatically represent characteristics of relations useful for subsequent courses such as understanding databases.

v) To solve linear system and learn further matrix computations applicable to machine learning and suitable advanced courses.

4. Text Books:

a) Keneth H. Rosen, Discrete Mathematics and applications, 7th edition, 2012, TataMcGraw Hill, ISBN: 978-0-07-338309-5

b) Gilbert Strang, Introduction to Linear Algebra, 3rd edition, 2003, Wellesley Cambridge Press, ISBN: 0-9614088-9-8

5. Reference Books:

a) C.L. Liu, Elements of Discrete Mathematics, 2nd edition, 1985, McGraw-Hill Book, ISBN: 0-07-038133-X

b) L. Lovász, J. Pelikán, K. Vesztergombi, Discrete Mathematics: Elementary and Beyond, 2003, Springer, ISBN: 0-387-95584-4, 0-387-95585-2

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	1	4	3	1	1	1	1
CO2	4	1	4	3	1	1	1	1
CO3	4	1	4	3	1	1	1	1
CO4	4	1	4	1	1	1	1	1
CO5	4	1	4	4	1	1	1	1
CO6	4	1	4	4	1	1	1	1

Overview of Computers Workshop

Institute Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of this course is to provide an overview of different components involved in a computer, including Desktop, Laptop and Mobile. The course will provide a demonstration of different basic commands and technologies involved in the computer world.

2. **Syllabus:**

   Unit – 1 [8 Hours]: Basic Computer Organization, Processors and its organization, CPU, Memory, Storage Devices, Interfaces, Number System (Binary)
   Types of Memories - Channel and Bus Architectures, Standard buses - Devices and Controllers - Ports and Connectors - Bootstrap Loaders - Inside of a typical desktop/laptop - Motherboard and Switch settings and Jumpers - Servers

   Unit – 2 [8 Hours]: Layers of Software, BIOS - Operating System - Windows, Linux and Android - File Systems – Windows, Linux and Android - Utilities and Tools - Device Drivers, Programming Tools - Compiler, Linker, Loader - Database Management Systems

   Unit – 3 [12 Hours]: Linux Kernel - Basic Commands in Linux / Windows - Shell Scripts – Bourne/Bash Shell

   Unit – 4 [8 Hours]: Computer Networks Networks and Types of Networks - Protocol Layers Ethernet, TCP/IP, IP Address and significance, Internet and its Protocols (http, https, ftp) - Security related topics

   Unit – 5 [4 Hours]: Mobile Devices - Basics of Mobile based computing, Hardware Components of a mobile device. Internet through Data Communication – 2G, 3G, 4G, 5G - WiFi and Near Field Communication

   Unit – 6 [8 Hours]: Microprocessors (8085/8086) and Microcontrollers, Introduction to Assembly Language and Embedded C

3. **Course Outcomes:**

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

   i) To become familiar with various components of a modern computer and the number systems conversions

   ii) To understanding various components of a computer software system including system software and application software.

   iii) To gain expertise with the usage the commands in Linux/Unix/Windows operating systems and various commands for handling file operations and shell scripting in these operating systems.

iv) To understand the layered architecture and example protocols in Application, Transport and MAC layers

v) To comprehend inside of mobile device and the communication mechanism involved

vi) To develop basic assembly codes using microprocessor, and microcontroller and understand the difference between C and Embedded C

4. Text Books:

a) John Hayes, Computer Architecture and Organization, McGraw Hill Education, 3rd edition (1 July 2017)
b) Ron White, Tim Downs, How Computers Work, BPB Publications; First edition (7 July 2016)
c) Phillip Barry, Overview of Computer Science, University of Minnesota-Twin Cities, 2015

5. Reference Books:

a) David Reed, J. Glenn Brookshear, Introduction to Computer Science: A Balanced Overview, Pearson (January 1, 2011)
b) G. Michael Schneider, and Judith L. Gersting, Invitation to Computer Science, Thompson (5th Edition), 2010 A Practical Guide to Ubuntu, Mark G. Sobell (4th Edition)
c) Mark G. Sobell, A Practical Guide to Ubuntu Linux, Prentice Hall; 4th edition (23 December 2014)
d) AT&T Unix System V Users Manual
e) Andrew S. Tanenbaum, Computer Networks, Pearson Education India, 2013 (5th Edition)
f) Pattnaik and Mall, Fundamentals of Mobile Computing, Prentice-Hall of India Pvt. Ltd, 2015 (2nd Edition)

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	2	2	2	1	1	2
CO2	2	3	3	2	3	2	2	3
CO3	3	4	5	4	3	3	3	3
CO4	2	3	4	3	3	3	2	2
CO5	2	3	3	3	3	2	2	3
CO6	2	2	2	1	2	1	1	2

Digital Logic Design

Institute Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of this course is to make undergraduate students understand the fundamentals of digital circuit design. This would begin with number representation and difference between analog and digital systems. Students will be able to analyze logical operations using combinational and sequential circuits together with verilog implementation.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Number systems-Brief review of Digital systems, Binary numbers, Number base conversions, Representation of Negative Numbers, Complements, Binary arithmetic, Binary Codes for Decimal Numbers.

   Unit – 2 [8 Hours]: Boolean Algebra-Basic Definitions, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Digital Logic Gates and timing concepts.

   Unit – 3 [8 Hours]: Gate level minimization-The Map Method - K-map 4 variable, Product of Sums Simplification, NAND and NOR Implementation, Other Two-Level Implementations. Review of, RTL, DTL, TTL, ECL, CMOS families.

   Unit – 4 [12 Hours]: Design of Combinational Logic Circuits-Analysis Procedure, Design Procedure, Binary Adder-Subtractor, Parallel Adder, Carry look Ahead Adder, Binary Multiplier, Code Converters -Binary to Gray, Gray to Binary, BCD to Excess-3 Code Conversion and vice versa, BCD to 7-segment code converter, Magnitude Comparator-4 bit, Decoders, Encoders, Multiplexers, De-multiplexer, Parity generator and checker.

   Unit – 5 [12 Hours]: Sequential logic circuits-Latches, Flip -Flops-SR, D, JK & T, realization of FFs, synchronous and asynchronous sequential circuits-State table and state diagrams, State reduction, Shift Registers-SISO, SIPO, PISO,PIPO, Design of counters-Modulo-n, Johnson, Ring, Up/Down, Design of Serial Adder, Serial Multiplier, FSM, Mealy and Moore state machines - State minimization – Sequence detection. Programmable devices-PAL and PLA.

   Unit – 6 [4 Hours]: Introduction to Verilog-Verilog Implementation of combinational and sequential circuits

3. **Course Outcomes:**

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

   i) To perform the conversion among different number systems; Familiar with basic logic gates -- AND, OR & NOT, XOR, XNOR to build simple logic circuits.

ii) To understand the basic properties of Boolean algebra and simplify Boolean functions.

iii) To optimize simple logic circuits using Karnaugh maps, understand "don't care"

iv) To design simple and complex combinational logics using basic gates

v) To understand sequential logic components: SR Latch, D Flip-Flop and their usage in practical applications. Able to experimentally implement with typical datapath designs: Register, Adders, Shifters, Comparators; Counters, Multiplier, Arithmetic-Logic Units (ALUs).

vi) To understand hardware description language (HDL) concepts and implement sequential circuit design based HDL and state table using D-FFs.

4. Text Books:

a) Morris Mano, Digital Design, 6th Edition, Pearson. ISBN-10 : 9353062012

5. Reference Books:

a) Verilog HDL by Samir Palnitkar Pearson Education; 2 edition (2003) ISBN-10 : 8177589180

b) John F wakerly, Digital Design: Principles and Practices, Pearson,4th edition. ISBN-10: 8131713660

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	4	3	3	3	2	2	2
CO2	5	4	3	4	3	2	2	2
CO3	5	5	4	5	4	3	3	2
CO4	5	5	5	5	4	5	4	2
CO5	5	5	5	5	4	5	4	2
CO6	5	5	5	5	4	5	4	2

Probability and Statistics

Institute Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**
   The objective of this course is to enable students a) to learn formal treatment of probability theory and its applications, and also basic principles of statistical inference; b) be equipped with the necessary tools for statistical analysis of real time data.

2. **Syllabus:**
   Unit – 1 [8 Hours]: Sample Space, Events, Axioms of Probability, Other Definitions, Probability Rules, Conditional Probabilities, Bayes' Theorem, Independence of Events

   Unit – 2 [10 Hours]: Cumulative Distribution Function, Expectation, Variance, Moments, Skewness, Kurtosis, Quantiles, Median, Discrete Random Variables and Their Distributions, Continuous Random Variables and Their Distributions, Properties of PDF and PMF, Moment Generating Functions, Characteristic function

   Unit – 3 [10 Hours]: Conditional Distributions: Discrete and Continuous case, Joint and Marginal Distribution, Covariance and Correlation, Bivariate and Multivariate Normal Distribution,Functions of random variables and random vectors, distributions of sums of random variables.

   Unit – 4 [5 Hours]: The Central Limit Theorem, Law of Large Numbers, Boole's Inequality, Bonferroni's Inequality, Chebyshev's and Markov's Inequality, Cauchy-Schwartz inequality, Jensen's Inequality

   Unit – 5 [7 Hours]: Distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions. Estimation, Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation.

   Unit – 6 [8 Hours]: Confidence intervals, Test of Hypothesis, Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test. Z-test, t-test, Chi-square test, F-test. Computation, Simulation and Visualization using R or matlab

3. **Course Outcomes:**

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

   i) To understand probability theory and variables concepts and apply them to engineering applications

   ii) To identify distributions and characteristics of data for implementing any model

   iii) To examine the relationship between different variables

iv) To identify the bounds on probability of an uncertain distribution

v) To analyze and interpret sample data and make inferences about the population parameters

4. Text Books:

a) V K Rohatgi & A K M E Saleh, An Introduction to Probability and Statistics, second edition, Wiley
b) S. Ross, A first Course in Probability, eighth edition, Pearson
c) D.C. Montgomery, G.C. Runger, Applied Statistics and Probability for Engineers, Seventh edition, Wiley
d) Michael J. Evans and Jefrey S. Rosenthal, Probability and Statistics, Second Edition

5. Reference Books:

a) Anderson, T.W., (1958) Introduction to Multivariate Statistical Analysis, Wiley: New York
b) A.M. Gun, M.K. Gupta & B. Dasgupta, An Outline of Statistical Theory, Volume One, World Press

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	4	2	3	1	1	1
CO2	5	1	4	2	3	1	1	1
CO3	5	1	4	2	3	1	1	1
CO4	5	1	4	2	3	1	1	1
CO5	5	1	4	2	3	1	1	1
CO6	5	1	4	2	3	1	1	1

Data Structures and Algorithms

Institute Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**
   This course aims to provide a broad understanding of data structures and algorithms for solving the problems efficiently with critical thinking along with the analysis of computational complexity.

2. **Syllabus:**
   Unit – 1 [8 Hours]: Mathematics of Computing - Algorithm Analysis, Algorithmic Thinking, Problem Solving Approaches, Recurrence Relations; Primitive Data Structures – Arrays, Storage structures, Matrices, Sparse matrices;

   Unit – 2 [8 Hours]: Composite Data Structures - Linked list, Doubly linked lists, Circularly linked lists, Complexity Analysis of Data Structures; Dynamic storage management - Garbage collection and compaction;

   Unit – 3 [9 Hours]: Stacks and Queues - Create, Read, Update, Delete, Stack and Queue using Linked List, Circular Queue; Specific Tasks - Prefix, postfix, infix notation and conversions, Complexity Analysis of Queues and Stacks; Strings - Data Structures with Strings;

   Unit – 4 [5 Hours]: Linear Search – Applications, Analysis, Running Time;
   Binary Search – Applications, Analysis, Running Time;
   Hashing – Basic Hashing Techniques;

   Unit – 5 [9 Hours]: Binary Trees - Construction, Insertion, Update, and Deletion Operations; Traversal - Inorder, Preorder, and Postorder;
   Binary Search Tree - Construction, Insertion, Update, and Deletion Operations;
   Heap – Properties, Construction, Binary Heaps;

   Unit – 6 [9 Hours]: Sorting - Overview and Needs, Comparison based Sorting; Basic sorting techniques - Selection sort, Insertion sort, Bubble sort; Divide and Conquer based sorting techniques: Merge Sort, Quick sort, Heap sort; Sorting Analysis - Choosing Suitable Sorting Algorithms, Algorithmic Analysis of Different Sorting Techniques;

3. **Course Outcomes:**

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

   i) To analyze the algorithmic complexity and demonstrate the algorithmic thinking for problem solving.

   ii) To analyze and implement the basic data structures with primitive operations.

iii) To get the understanding of tree based data structures and the implementation of different tree operations.

iv) To understand and implement various searching and sorting techniques along with choosing the appropriate technique for any given problem.

v) To design programming solutions by identifying the efficient data structures and algorithms for solving problems.

4. Text Books:

a) Weiss, Mark Allen. Data Structures and Algorithm Analysis in C. Second Edition. Pearson Education India. (DSAC)
b) Seymour Lipschutz, Data Structures with C, Schaum's Outline Series
c) Langsam Yedidyah, Augenstein J Moshe, Tenenbaum M, Data Structures using C and C++, PHI.

5. Reference Books:

a) Horowitz, Sahni, Freed, Fundamentals of Data Structures in C, Silicon Press.
b) Kruse R., Data Structures and Program Design in C, Pearson Education India.
c) Cormen et al. Introduction to Algorithm 3rd Edition. MIT Press, 2017

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	4	3	5	4	1	3	4
CO2	5	5	3	5	4	1	3	4
CO3	5	5	3	5	4	1	3	4
CO4	5	5	3	5	4	1	3	4
CO5	5	5	3	5	4	1	3	4
CO6	5	5	3	5	4	1	3	4

Signals and Systems

Institute Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of this course is to provide the fundamental concept of signal representation, analysis, different types of systems and their characteristics, mathematical transforms and use of computer tools/programming to solve problems

2. **Syllabus:**

   Unit – 1 [12 Hours]: Introduction; Classification of signals - Continuous time and discrete time, Even and odd, Periodic and non-periodic, Deterministic and Random, Energy and Power; Basic operations on signals - Scaling, Shifting, Reflection, Precedence rule for time shifting and time scaling; Elementary signals - Exponential, Sinusoidal, Step, Pulse, Impulse, Ramp, Relationship between sinusoidal and complex exponential signals, Exponentially damped sinusoid signals; Properties of systems - Stability, Memory, Causality, Invertibility, Time invariance

   Unit – 2 [8 Hours]: Convolution sum; Interconnection of LTI systems; Impulse response; Step response; Relationship between impulse response and system properties; Properties of LTI systems - Stability, Memory, Causality, Invertibility, Time invariance

   Unit – 3 [8 Hours]: Periodic signal Fourier Series - Properties of Fourier Representations, Parseval's relationships and applications

   Unit – 4 [8 Hours]: Aperiodic signal Fourier transform - Properties, Parseval's relation, Duality property and its applications; Hilbert transform - Pre-envelope; Phase and Group delay

   Unit – 5 [6 Hours]: Laplace transform - Eigen function property, Laplace transform representation, Convergence, S-plan, Unilateral Laplace transform, ROC, Properties

   Unit – 6 [6 Hours]: Sampling theory - Sampling continuous time signals, Aliasing, Reconstruction - Ideal, Practical

3. **Course Outcomes:**

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

   i) To understand and classify the mathematical representation of the continuous and discrete-time signals and systems

   ii) To apply the concept of convolution to evaluate the output of the LTI systems

   iii) To analyze both periodic and aperiodic signals and system's output in the frequency domain

iv) To analyze the continuous-time signals and systems with the Laplace-transform

v) To apply he sampling theorem and signal reconstruction in signal transmission/ receiving

4. Text Books:

a) Alan V.Oppenheim, Alan S.Willsky with S. Hamid nawab, Signal and System, Pearson Education India, 2nd edition (1 January 2015)

b) John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Pearson Education India; 4th edition (1 January 2007)

5. Reference Books:

a) Luis Chaparro, Signals and Systems using MATLAB, Academic Press, 2nd Edition (2 April 2014)

b) Vinay K. Ingle , John G. Proakis, Digital Signal Processing Using MATLAB: A Problem Solving Companion, Cl-Engineering, 4th Edition (1 January 2016)

c) Hahn, Essential MATLAB for Engineers and Scientists, Elsevier, 5th Edition (10 January 2013)

d) Simon Haykin, Barry Van Veen, Signals and Systems, Wiley, 2nd Edition (1 January 2007)

e) H Hsu, R Ranjan, Signals & System, McGraw Hill Education; 2nd Edition (1 July 2017)

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	3	1	1	1	1	1	2
CO2	5	3	3	3	3	1	1	2
CO3	5	2	3	2	1	2	1	2
CO4	5	3	3	3	3	2	1	2
CO5	5	2	3	2	2	1	1	2

Real Analysis, Numerical Analysis and Calculus

Institute Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**

   The objective of the course is to enable students a) to understand basic concepts of sequences and series; b) to use various methods for solving numerical problems; and c) to analyse the characteristics of functions of single and several variables.

2. **Syllabus:**

   Unit – 1 [9 Hours]: Sequence: LUB Axiom, Sequences of real numbers and their limits, convergent sequence, sub sequence, Sandwich theorem, monotonic sequence;
   Series: Convergence of series, comparison test, Ratio test, Root test, Absolute and conditional convergence, Power series, Sequence and Series of Functions.

   Unit – 2 [9 Hours]: Numerical Analysis: Finite Differences, Newton's forward and backward interpolation formulae, central difference interpolation formulae. Trapezoidal and Simpsons 1/3rd rules for numerical integration. Solution non-linear equations - bisection, Newton-Raphson and regula-falsi methods

   Unit – 3 [5 Hours]: Improper Integrals: Introduction, Integration of unbounded functions with finite limits of integration, Gamma and Beta functions and their properties, Evaluation of improper integrals using gamma and beta functions.

   Unit – 4 [9 Hours]: Functions of Single and Several Variables: Concavity and convexity of a curve, points of inflexion, asymptotes and curvature, Functions of several variables- Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, Jacobian, Maxima and Minima of functions of two variables, Lagrange's method of undetermined multipliers.

   Unit – 5 [6 Hours]: Multiple Integrals: Double and triple integrals, Change of order of integration, Change of variables in double integrals, Applications: Finding areas, volumes and center of gravity (Evaluation using beta and gamma functions)

   Unit – 6 [10 Hours]: Vector Calculus: Scalar and vector point functions, Gradient, divergence, curl and their related properties, Solenoidal and irrotational vector point functions, Laplacian operator, Line integral, work done, surface integrals, volume integral, Vector integral theorems, Green's theorem in a plane, Stoke's theorem, Gauss divergence theorem and related problems.

3. **Course Outcomes:**

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

   i) To apply comparison tests to study the convergence of sequences and series

ii) To use numerical techniques to solve practical interpolation problems, integrate complicated functions and solve non-linear equations.

iii) To evaluate improper integrals for solving practical problems.

iv) To find optimum values of high dimension functions by using the knowledge of differentiation.

v) To solve complex engineering problems related to multiple integrals

vi) To integrate vector functions and use them to study electromagnetic and gravitational fields.

4. Text Books:

a) B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, New Delhi, Khanna Publishers.
b) S.C. Malik & S. Arora. Mathematical Analysis, fifth edition, New Age International
c) M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical Methods : For Scientific And Engineering Computation, sixth edition, New Age International

5. Reference Books:

a) K. Ervin, Advanced Engineering Mathematics, tenth edition, New Jersy, John Wiley & Sons
b) E.A. Coddington & N. Levinson, Theory of Ordinary Differential Equations, UK edition, Krieger

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	4	1	4	2	1	1
CO2	5	1	4	1	4	2	1	1
CO3	5	1	4	1	4	2	1	1
CO4	5	1	4	1	4	2	1	1
CO5	5	1	4	1	4	2	1	1
CO6	5	1	4	1	4	2	1	1

Object Oriented Programming

Institute Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of this course is to enable the students to design and analyze applications using Object Oriented concepts. This course is offered to the learners who are familiar with at least one programming language (preferably C) and the basic data structures. This course involves a lab session in which students will learn to code the solutions for the challenging problems using object oriented concepts.

2. **Syllabus:**

   Unit – 1 [7 Hours]: Introduction: Basics of OOP, Structure of Java Programs - Programming Environments, Program Control, Basics of Computation - Control Flow and Branching - Defining Classes, Objects and Methods - Benefits of Object-Oriented Programming Methodologies

   Unit – 2 [10 Hours]: Constructors and Overloading Concepts: Default and Parameterized Constructors - Method Overloading - Packages, Access Specifiers, Composition - Accessor / Mutator(getter/setter) Methods - Keywords, Finals

   Unit – 3 [7 Hours]: Access Control Modifiers: Nested Classes - Interfaces and Inner Classes - Abstract Classes

   Unit – 4 [10 Hours]: Object Oriented Concepts: Inheritance - Polymorphism - Error Handling - Exception Handling, Different Streams - File I/O, and Networking

   Unit – 5 [7 Hours]: Collections: Collections and Iterators - Dynamic Data Structures and Generics - Recursion

   Unit – 6 [7 Hours]: Multithreading and Database Connectivity: Threads, Multi-threading Applications - Java Database Connectivity with MySQL

3. **Course Outcomes:**

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

   i) To understand the basics of Object Oriented concepts and programming constructs in terms of classes, objects, methods and their relationships

   ii) To design classes and create instances using different overloading concepts in object oriented programming

   iii) To develop applications using class hierarchies and implement interfaces and inner classes with data encapsulation approaches

iv) To learn and apply object oriented concepts including inheritance, polymorphism and exception handling including error handling

v) To identify and use various collections libraries available in Object Oriented frameworks for developing scalable applications

vi) To apply multithreading concepts and database connectors with backend database systems including MySQL based database systems

4. Text Books:

a) Robert Endre Tarjan, Data Structures and network algorithms, Society for Industrial and Applied Mathematics Philadelphia, PA, USA, 1983, ISBN:0-89871-187-8
b) Paul Deitel and Harvey Deitel. 2011. Java how to Program (9th ed.). Prentice Hall Press, Upper Saddle River, NJ, USA
c) David J. Eck. 2009. Programming: Introduction to Programming Using JAVA. CreateSpace, Paramount, CA
d) Any decent material that clearly illustrates OOP Concepts
e) State-of-the-art approaches: Research Papers / Seminar Papers / Case Studies

5. Reference Books:

a) Szyperski, C., Gruntz, D.,, Murer, S., Component Software: Beyond Object-Oriented Programming, ACM Press and Addison-Wesley, 2002
b) Donald E. Knuth, The Art of Computer Programming, Vol. 1: Fundamental Algorithms, Addition - Wesley, 3rd Edition, 1998, ISBN-13: 978-0201896831
c) George T. Heineman, Gary Pollice, and Stanley Selkow, Algorithms in a Nutshell, O'Reilly Media, USA, 2009, ISBN: 978-0-596-51624-6

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	4	1	3	3	1	2
CO2	3	3	4	2	4	3	2	3
CO3	4	4	4	3	5	3	3	3
CO4	4	5	5	4	5	4	3	4
CO5	2	3	3	3	4	3	4	3
CO6	3	4	4	4	3	3	2	2

Computer and Communication Networks

Institute Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**

   The objective of this course is to impart knowledge of layered network architecture design and its services. Course will familiarise the students with understanding of standard protocols and its implementations

2. **Syllabus:**

   Unit – 1 [6 Hours]: Guided transmission media: twisted pair, coaxial cable, fibre optic cable; Multiplexing: FDM and TDM: Packet switching and circuit switching: Internet protocol stack: ISO OSI reference model, Delay, loss and throughput in packet switched networks.

   Unit – 2 [10 Hours]: The web and HTTP; FTP; Electronic mail: SMTP; Domain name systems; Peer-to-peer networks.

   Unit – 3 [10 Hours]: Transport layer services; Multiplexing and demultiplexing; Principles of reliable data transfer: Go-Back-N and Sliding window, TCP, UDP, Congestion control.

   Unit – 4 [6 Hours]: Network Layer: Services of network layer, Virtual circuit and datagram networks, Internet protocol

   Unit – 5 [6 Hours]: Link-state routing and distance vector routing. Hierarchical routing, Routing in the internet, broadcast and multicast routing. Duration:

   Unit – 6 [10 Hours]: Link layer services, Error detection and correction; Multiple access protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CD, Ethernet; WiFi. Next generation wireless networks, Intro to self optimization networks (SON).

3. **Course Outcomes:**

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

   i) To analyse new physical layer designs by demonstrating the understanding of the fundamentals in transmission media and layered network architecture.

   ii) To analyse and evaluate the network application by adopting applications layer protocols and transport layer services and propose modifications for performance improvement of industrial applications

   iii) To design and evaluate the topological and routing strategies for latest network architecture designs.

   iv) To demonstrate the understanding of the link layer concepts using simulation skill and propose modifications for the performance improvements

4. Text Books:

a) James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, 6th Edition, Addison Wesley, ISBN-13: 978-0-13-285620-1

b) Theodore S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition pearson 2002, ISBN:9788131731864.

5. Reference Books:

a) Andrew Tanenbaum, and Davis Wetherall, Computer Networks, 5th Edition, Pearson ISBN: 978-8131770221

b) Bobbi Sanberg, Networking the complete reference, 3rd Edition, Mc Graw Hills, ISBN: 978-0-07-182765-2

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	5	2	3	1	1	2
CO2	4	3	3	3	4	2	1	1
CO3	3	2	4	3	5	2	1	1
CO4	3	3	3	5	3	1	1	2
CO5	5	2	5	4	4	1	2	1
CO6	4	2	3	4	5	1	1	1

Program Core Courses

of the B.Tech. (ECE) Programme

Basic Electronic Circuits

Program Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of this course is to provide clear understanding of basic concepts in analyzing the electronic circuits. Student is expected to become familiar with crucial components of electronic systems and their applications and to verify the theoretical concepts learnt in this course. This is a lab based course in which theoretical concepts could be practiced with lab exercises.

2. **Syllabus:**

   Unit – 1 [6 Hours]: SI units, Time, frequency, wavelength, Charge, Current, Voltage, Power, Voltage and current sources, Review of basic concepts, physical and mathematical representations of Ohm's law, Kirchoff's laws, passive elements - Resistor, Inductor and Capacitor, series and parallel resistive networks, Voltage and Current division.

   Unit – 2 [6 Hours]: D-C power supply - Diode characteristics, half-wave and full wave rectifiers, shunt capacitor filter, voltage regulator, regulated D-C power supply.

   Unit – 3 [9 Hours]: Transistor - BJT, modes of operation, CE configuration input/output characteristics; Amplifier - Amplifier parameters, operational amplifier (OP-AMP), the VCVS model of an op-amp, Op-amp configurations - inverting and non-inverting, Difference amplifier, instrumentation amplifier, Op-Amp as: adder, subtractor, integrator etc.

   Unit – 4 [9 Hours]: Filter - Concepts of low-pass, high-pass and band-pass filters, ideal (brick-wall) filter response, frequency response of simple RC filters, active RC filters using Op-amp.

   Unit – 5 [9 Hours]: Op-amp based Comparator - inverting and non-inverting comparators, Applications: zero crossing detector, window detector, Schmitt trigger, square wave generator (Astable multivibrator), Monostable multivibrator, sine wave generator. 555 timers: functional diagram, monostable operation.

   Unit – 6 [9 Hours]: Analog-Digital conversion: Digital to Analog Converter (DAC) using binary resistor scheme, R-2R ladder DAC, Analog to Digital converter (ADC) - Parallel comparator, ADC using counter and DAC, ADC using successive approximation.

3. **Course Outcomes:**

   At the end of the course, Students should be:

   i) Able to understand the basics of electric circuit theory .

   ii) Able to analyze diode circuits for rectification and to extend to design mobile charging circuits.

iii) Able to understand the fundamental principles of operation of BJT, and to understand the application as a switch and amplifier for public address systems and extend the analysis to high gain Op-Amp circuits.

iv) Able to gain basic knowledge of various filters and to design filters to remove noise.

v) Able to extend op-amp to design wave generator circuits.

vi) Able to extend op-amp circuit for analog to digital conversion and vice versa.

4. Text Books:

a) Sudhakar and Shyammohan, Circuits and Networks analysis and synthesis, Publisher : McGraw Hill Education; 5th Edition (1 July 2017), ISBN-10 : 9789339219604

b) Wiliam Hayt, Jr et. al. Engineering circuit analysis, Publisher : McGraw Hill Education; 8th Edition (4 August 2013), ISBN-13 : 978-1259098635

c) Sedra and Smith, Microelectronic circuits theory and applications, Publisher : Oxford University Press (1 June 2017), ISBN-13 : 978-0199476299

5. Reference Books:

a) D A Neamen, Electronic Circuits analysis and design by Publisher : Irwin Professional Publishing (1996) ISBN-13 : 978-0256119190

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	1	1	3	4	1	1
CO2	3	3	5	5	5	4	1	1
CO3	3	3	5	5	3	3	1	1
CO4	5	5	3	3	5	5	2	3
CO5	5	5	3	5	5	4	2	2
CO6	3	5	3	3	5	5	2	2

Control Systems

Program Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**
   The objective of this course is to learn block diagram representation of systems and signal flow graphs; and gain knowledge on how to design a system or component or process through concepts of block diagram reduction, time domain analysis solutions to time invariant systems and different aspects of stability analysis in frequency & time domains. The course would provide a basic yet hands-on experience in developing simple control systems for various applications.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Introduction to Control System: What is a Control System? Blocks in Control System and importance - Gain/ Loss computation for different blocks

   Unit – 2 [6 Hours]: Time Response Analysis: Importance of Time Response, Transient Response, Steady state response, Techniques to compute and compare

   Unit – 3 [10 Hours]: Stability Analysis in S/Z-domain - Continuous and Discrete signals and Systems - Laplace Transform and Inverse Laplace Transform - Z-Transform and Region of Interest (RoI) - Importance and modelling for analysis - Root Locus

   Unit – 4 [6 Hours]: Frequency Response Analysis - Introduction and importance -Nyquist Stability - Bode Plot for Stability

   Unit – 5 [8 Hours]: State space analysis of systems: PI, PD and PID Controllers - Stability vs Performance - Usefulness in Measurement and Instrumentation

   Unit – 6 [12 Hours]: Applications: Industrial environment – Robotics - Project to demonstrate an open-loop and closed-loop feedback system

3. **Course Outcomes:**

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

   i) Ability to comprehend the control and other components involved in any logical system

   ii) Ability to perform yime based analysis of different components/ blocks of the system

   iii) Ability to compute the Gain, Loss, overall Transfer Function and Stability of the system

   iv) Ability to carry out different analysis such as Stability, Controllability, Observability, etc.

v) Ability to develop modules of a complex system, involving PI, PD and PID controllers for industry.

vi) Ability to design an overall control system meeting the given objectives

4. Text Books:

a) I.J. Nagrath and M. Gopal, Control Systems Engineering, New Age International (P) Limited, Publishers.

5. Reference Books:

a) B.C. Kuo, Automatic Control Systems, John Wiley and son's, 9th Edition, India
b) K. Ogata, Modern Control Engineering, by Prentice Hall, India

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	3	3	5	3	1	2	3
CO2	5	3	1	3	3	1	2	3
CO3	5	3	3	3	3	1	2	3
CO4	5	3	3	5	5	1	2	4
CO5	5	5	5	5	5	3	3	4
CO6	5	5	5	5	5	3	3	5

Circuits and Network Analysis

Program Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**

   The objective of teaching this course is to give the under graduate students a good understanding of the fundamentals of electrical circuits. At the end of the course the student would develop an in depth knowledge of circuit elements (active and passive), their characteristics and their functioning when connected together.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction-Introduction to systems, Linear Systems, Electrical Systems/Circuits, Charge, Current, Voltage, Power, Voltage and current sources, Physical and mathematical representations Ohm's law, KCL, KVL, Loops and nodes, Series and parallel connections, Voltage and current division.

   Unit – 2 [12 Hours]: Circuit analysis-Nodal analysis, Mesh analysis, super mesh and super node, principles of linearity, superposition, Superposition theorem, Thevenin and Norton theorems and and their equivalent circuits, Maximum power transfer theorem, Source transformations, Delta-Wye conversion.

   Unit – 3 [16 Hours]: Time domain analysis-Capacitor, Inductor and their combinations, Principle of duality, RL and RC Circuits – Transient response (source free response), Introducing forcing functions – step and rectangular pulse, Complete response – Natural and Forced response, Natural response of an RLC circuit, cases of damping, complete response - forced and natural response.

   Unit – 4 [8 Hours]: AC analysis-Sinusoidal and Complex force functions and their characteristics, Forced response to sinusoidal functions, Phasor, Impedance, Admittance, Phasor diagrams.

   Unit – 5 [4 Hours]: Two port networks-Characterization of a four-terminal network based on its terminal voltages and currents, Two-port parameters – Impedance and Admittance, Relation between Z and Y parameters.

   Unit – 6 [4 Hours]: Special topic-Concepts of Magnetic flux, reluctance, MMF, B and H. Magnetic circuits (series and parallel).

3. **Course Outcomes:**

   At the end of the course, Students should be:

   i) Able to design and analyze electrical circuits consisting of mainly passive elements (R, L and C).

   ii) Apply the concepts of KCL and KVL, and solve complex circuits consisting of multiple nodes, branches and loops

iii) Understand the theoretical concepts and current voltage relationship of passive elements. Compare and verify the same using laboratory and simulation experiments.

iv) Able to analyze the response of circuit elements with respect to the variation in time or frequency domain.

v) Gain familiarity with differences between DC and AC electrical circuits.

vi) Able to understand the difference and draw an analogy between electrical and magnetic circuits.

4. Text Books:

a) Sudhakar and Shyammohan, Circuits and Networks: Analysis and Synthesis, McGraw Hill Education, 5th Edition (1 July 2017), ISBN-10 : 9789339219604

5. Reference Books:

a) Wiliam Hayt, Jr et. al., Engineering circuit analysis by Publisher : McGraw Hill Education; 8th Edition (4 August 2013), ISBN-13 : 978-1259098635

b) KS Suresh Kumar, Electric circuits and networks by, Pearson Education; 1st Edition (1 January 2008). ISBN-10: 9788131713907

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	4	3	3	2	1	2
CO2	5	4	5	3	5	2	1	2
CO3	5	5	5	5	5	3	1	3
CO4	5	5	5	5	5	2	1	2
CO5	5	5	3	4	4	2	1	2
CO6	4	3	3	4	4	2	1	2

Embedded Systems

Program Core

L-T-P-C: 3-0-1-4

1. **Course Objectives:**

   Objective of this course is to introduce students to the fundamentals and advanced topics of the embedded systems and to make them familiar with design and programming of such systems. In this course, Students will learn the Standard architecture and protocols. Course also Introduce them to recent advancements like Networked Embedded Systems and their challenges.

2. **Syllabus:**

   Unit – 1 [8 Hours]: Introduction to Embedded Systems - CPUs vs. MCUs vs. Embedded Systems, Basic understanding: Definitions, Characteristics, Embedded Hardware and Software Architecture, Peripheral devices, Processor and Memory Selection: Different Types of Processor Technologies.

   Unit – 2 [8 Hours]: Microcontrollers - Submodules, Interfacing and Example ARM architecture; Interfacing - Understanding ADC, GPIO, Timers, BUS, I/O addressing, Direct memory access; Communication protocol concepts - Basic Serial Communication Protocols I2C, SPI, CAN;

   Unit – 3 [8 Hours]: Cortex-M3 Architecture - Example ARM architecture: Cortex M3, NVIC; Unique features - Memory MAP, MPU, Register bank, Stack Implementation, Multi-level BUS; Interrupts - Different types of Interrupts, Interrupt Servicing Mechanism, Interrupt Latency; Modes - Debug and Low power modes;

   Unit – 4 [8 Hours]: Introduction to Real Time Operating Systems - Basics of Operating Systems, Differences between General Purpose and Real-Time Operating Systems; Kernel - RTOS Kernel Structure, Issues in multitasking task assignment; Process - Inter Process Communication and Synchronization, Interrupt routines in RTOS Environment;

   Unit – 5 [8 Hours]: Real Time Task Scheduling - RTOS: Processes, Threads, Context switching; Deadlock - Intro to Deadlock, Deadlock avoidance; Example RTOS - Commercial Real-Time Operating Systems and their architectures;

   Unit – 6 [8 Hours]: Networked Embedded Systems - Distributed Embedded Architectures, Networks for Embedded Systems, Internet-Enabled System, Design Examples and Test cases of IoT: Hardware and software modules

3. **Course Outcomes:**

   At the end of the course, Students should have the ability:

   i) To understand and derive the design work flow of an existing or a new embedded system

ii) To Interface sensors, actuators, ADC, Serial, analog & digital ports of a basic embedded board like Arduino .

iii) To develop applications with embedded boards, database and user interface/app

iv) To integrate the standard protocols like CAN, USB, Bluetooth and Wi-Fi. in the system implementation

v) To apply standard RTOS concepts and fine tune RTOS for applications in Industry/research related problems

vi) To demonstrate innovation in design & development of new embedded systems latest technologies like IoT, CPS and Industrial Automation

4. Text Books:

a) Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Second edition, Morgan Kaufmann Publisher 2008, ISBN 978-0-12-374397-8
b) Jonathan W. Valvano, Introduction to Embedded Systems, Createspace Independent Publishing Platform; 1st edition2016, ISBN-10: 1537105728

5. Reference Books:

a) David E-Simon,"An Embedded Software Primer", Pearson Education.
b) Raj Kamal, "Embedded Systems", Tata McGraw Hill, 2003.
c) Vahid Frank, "Embedded system Design: A Unified Hardware/ software Introduction".
d) Mazidi Muhammad Ali and Naimi sarmad, "The avr Micro controller and embedded systems".
e) http://www.mbed.org
f) Materials @ARM Community: ARM University Program.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	2	1	1	1	1	1	1
CO2	3	3	3	2	1	1	2	1
CO3	3	3	4	3	2	3	2	3
CO4	3	3	2	2	2	2	1	2
CO5	4	4	2	2	2	2	1	2
CO6	4	5	5	5	4	4	3	4

Fundamentals of Communication

Program Core

L-T-P-C: 3-0-1-4

1. **Course Objectives:**

   The objectives of this course are to introduce fundamentals of analog and digital communication systems and detail into the techniques of transmitting and receiving information signals using analog and Digital modulation techniques. This is a lab-based course wherein the different theoretical concepts would be practiced through Lab experiments.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Communication system and Noise: Introduction to Transmitter, Receiver, Channel, Introduction to Noise, Types of Noise, Measurement of Noise, Noise in devices, cascaded effect of Noise

   Unit – 2 [4 Hours]: Radio Transmitter and Receiver: Basic blocks in Transmitter and Receiver - Frequency of operation - Range of frequencies and effect on communication

   Unit – 3 [12 Hours]: Analog modulation techniques: Amplitude modulation (Transmitter), Concept of modulation Index, Maths behind the AM technology, Frequency (Modulation) Transmitter) and Demodulation (Receiver), Maths behind the FM technology

   Unit – 4 [8 Hours]: Demodulation techniques (Receiver): Receiver types and details, Superheterodyne receiver and workflow, Maths behind the receiver Control: AFC, AGC concepts

   Unit – 5 [14 Hours]: Introduction to Digital Modulation: Why Digital Modulation
   Pulse Modulation techniques (PAM, PWM, PPM), Sampling and Quantization, PCM, Quantization error, DPCM, DM, ADM

   Unit – 6 [6 Hours]: Multiplexing and Multiple access techniques: Multiplexing - TDM, FDM, Multiple Access (TDMA, FDMA, CDMA), Why CDMA is different than TDMA and FDMA? Applications to different wireless and communication

3. **Course Outcomes:**

   At the end of the course, Students should have the ability:

   i) To comprehend and express the different components in a communication system, detailing into noise

   ii) To understand different blocks involved in transmitter, receiver, frequency of operation, and importance of design of a wireless system

   iii) To have good understanding and hands-on experience of Analog communication, especially, AM, FM and PM

iv) To clearly articulate how the signal is demodulated and decoded at the receiver of the communication system

v) To clearly articulate advantages of Digital modulation over analog modulation and be able to Implement Digital Modulation techniques over Matlab or any software in the 10 Lab sessions

vi) To relate the concepts to real world implementation of 2G and 3G system; and explain how these components are used in today's wireless system

4. Text Books:

a) Kennedy, Davis, Electronic Communication Systems, 4th Edition, TMH, India

5. Reference Books:

a) T. Rappaport , Wireless Communication, 4th Edition, Pearson Publishers, 2016

b) A. Goldsmith, Wireless Communication, Cambridge University Press, 2012

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	2	2	2	1	1	4
CO2	4	3	3	3	2	1	1	4
CO3	5	5	3	4	4	1	1	3
CO4	5	5	4	4	4	2	3	5
CO5	4	5	3	5	3	2	2	4
CO6	3	5	3	5	3	2	2	5

Analog Circuits

Program Core

L-T-P-C: 2-1-1-4

1. **Course Objectives:**
   The main objective of the course is to introduce students to the design and analysis of small signal-based amplifier circuits with BJT and MOSFETs.

2. **Syllabus:**
   Unit – 1 [9 Hours]: Semiconductor Materials and Properties, The p-n Junction, The ideal diode, Terminal characteristics of junction diodes, Modeling diode forward characteristics - Exponential model, PWL, CVD, Ideal model, Reverse breakdown region – Zener diode, Rectifier circuits, Limiting and clamping circuits, Physical operation of diodes, Special diodes

   Unit – 2 [6 Hours]: Device structure and physical operation, current – voltage characteristics, the BJT as an amplifier and a switch, DC Analysis of BJT Circuits, Biasing BJT Amplifier Circuits- voltage divider, fixed bias, swamping circuits

   Unit – 3 [9 Hours]: Small Signal operations and models, transconductance, input resistances, voltage gain, hybrid- model, T-model, Small Signal equivalent circuit, Early effect, Single stage BJT amplifiers CE, CB, CC, Comparison, Darlington amplifier, Voltage follower, frequency response, No Load, Load, Load with source resistance gain comparison

   Unit – 4 [9 Hours]: Device structure and physical operation, current – voltage characteristics, the MOSFET as an amplifier and a switch, DC Analysis of MOSFET Circuits, Biasing MOSFET Amplifier Circuits

   Unit – 5 [9 Hours]: Small Signal operations and models, transconductance (gm), T equivalent circuit model, Body effect, Single stage MOS amplifiers Amplifier Configuration, Common Source, Source Follower, Common Gate Configuration, Summary and Comparison of the three Basic Amplifier Configurations, Summary and comparison

   Unit – 6 [6 Hours]: Multi-stage amplifier circuits, Power Amplifiers: Class A, B, AB, C and D amplifiers

3. **Course Outcomes:**

   At the end of the course, Students should have the ability:

   vii)To understand the physical and electrical conducting properties of semiconductors.

   viii) To analyze the working of diode circuits

   ix) To comprehend the working and design and BJT and MOSFET amplifiers.

x) To design amplifier circuits using BJTs and MOSFETs and analyze the frequency responses of amplifier circuits

xi) To design amplifieAble to build power amplifier circuitsr circuits using BJTs and MOSFETs and analyze the frequency responses of amplifier circuits

xii)To analyze, troubleshoot power amplifier circuits.

4. Text Books:

a) Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits, Theory and Applications, 7th edition, Oxford press.

b) D. A. Neamen, Electronic Circuit Analysis and Design, latest edition, Tata McGraw-Hill, New Delhi, 2007.

5. Reference Books:

a) Integrated Electronics, Jacob Millman, Christos C Halkias, McGraw Hill Education

b) Electronic Devices and Circuits theory– Robert L. Boylestad, Louis Nashelsky, 11th Edition, 2009, Pearson.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	1	1	3	4	1	1
CO2	3	3	5	5	5	4	1	1
CO3	3	5	5	5	3	3	1	1
CO4	5	5	3	3	5	5	2	3
CO5	5	5	3	5	5	4	2	2
CO6	3	5	5	5	3	5	2	2

Electromagnetics and Transmission Lines

Program Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**
   The objective of this course is to provide basic understanding about the static and time varying fields thereby studying the concepts of wave propagation in different types of material media.

2. **Syllabus:**
   Unit – 1 [8 Hours]: Basics of Vector algebra, Coordinate transformation, Vector calculus – Differential parameters; Line surface and volume integrals; Del operator – Gradient of a scalar, Divergence of a vector and divergence theorem, Curl of a vector and Stoke's Theorem.

   Unit – 2 [8 Hours]: Coulomb's Law, Electric field and Electric Flux density, Gauss's Law and its applications, boundary conditions, Poission's and Laplace's equations. Ampere's law and its applications, Magnetic fields, Magnetic Flux density. Magnetic boundary conditions.

   Unit – 3 [8 Hours]: Faraday's law, Displacement current, Maxwell's equations – final form, time-harmonic fields.

   Unit – 4 [8 Hours]: Traveling waves vs Standing waves, wave propagation in lossy dielectrics/ in lossless dielectrics/ in free space/ in good conductors, Wave polarization, Power and the Poynting vector, Reflection of a plane wave at normal incidence.

   Unit – 5 [8 Hours]: transmission line parameters, Transmission line equations (Lossy, lossless and distortionless), input impedance, Standing wave ratio, power, Smith Chart, Applications of Transmission lines.

   Unit – 6 [8 Hours]: Antennas, Antenna parameters, Antenna types, Arrays, FRIIS Transmission Model and Basics of Radar: Range equation.

3. **Course Outcomes:**

   At the end of the course, Students should have the ability:

   xiii) To recognize and classify the Electric and Magnetic fields for both static and time varying cases.

   xiv) To demonstrate the conceptual understanding of the behavior of fields at the interface/boundaries.

   xv)To evaluate wave propagation characteristics in various types of material media.

xvi) To analyse the waves (propagating and standing) in the bounded and unbounded media.

xvii) Ability to apply the fundamental concepts in the application areas like antennas and Radar.

4. Text Books:

a) M. N. O. Sadiku, and S V Kulkarni, Principles of electromagnetics, sixth edition, Oxford University Press, 2016.

b) J. D. Kraus, and D. A. Fleisch, Electromagnetics with Applications, fifth edition, McGraw Hill Education, Indian Edition, 2010, (thirteenth reprint 2018).

5. Reference Books:

a) W.H.Hayt, Engineering Electromagnetics, (7/e), McGraw Hill, 2006.

b) E.C. Jordan & G. Balmain, Electromagnetic Waves and Radiating Systems, PHI, 1995.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	3	2	3	4	2	2	2
CO2	5	4	3	3	4	2	2	2
CO3	5	4	2	3	3	2	2	2
CO4	5	4	2	4	4	2	2	2
CO5	5	3	2	3	4	3	1	3

Digital Signal Processing

Program Core

L-T-P-C: 3-1-0-4

1. **Course Objectives:**

   The objective of this course is to give an improved understanding of digital signal processing principles, tools and algorithms and to enable students to apply the DSP skills to solve a practical signal analysis problem.

2. **Syllabus:**

   Unit – 1 [8 Hours]: The Z- Transform - Direct transform, inverse transform, Properties, Rational Transforms - poles & zeros, pole location and time domain behavior, system function, Inversion of z-transform - contour integration, power series expansion, partial fraction expansion, Analysis of LTI systems - System responses, transient and steady state, Causality and Stability

   Unit – 2 [6 Hours]: Frequency Domain Characteristics of LTI Systems - Response to complex exponential and sinusoids, steady-state and transient analysis, steady state response to periodic signals, Frequency Response of LTI Systems - Frequency response of a system with rational transfer function, Correlation functions and spectra - input & output correlation functions, correlation functions and power spectra

   Unit – 3 [8 Hours]: Discrete Fourier Transform - Frequency domain sampling, Definition, Linear transformation, Properties - periodicity, linearity, symmetry, multiplication and circular convolution, Linear filtering methods - use of DFT, long data sequences

   Unit – 4 [8 Hours]: Efficient computation of DFT - Direct computation, Divide and conquer, radix-2 FFT FFT Applications - Efficient computation of DFT of two real sequences, 2N point real sequence, Quantization Effects - Errors in FFT

   Unit – 5 [9 Hours]: Design of FIR filters: FIR Structures - Direct form, cascade form, Frequency sampling, FIR Design methods - General considerations, symmetric and asymmetric FIR filters, linear phase FIR filters frequency sampling methods, equiripple method

   Unit – 6 [9 Hours]: Design of IIR Filters: Structures - direct forms, signal flow graphs, cascade forms, IIR Design methods - approximation of derivatives, impulse invariance method, Bilinear transformation, frequency transformations in digital domain

3. **Course Outcomes:**

   At the end of the course, Students should have the following abilities:

   xviii) A student should be able to Apply the z-transform for analysis of discrete signals and systems

xix) A student should be able to perform frequency domain analysis of linear systems

xx) A student should be able to apply the knowledge of discrete Fourier transform and its properties

xxi) A student should be able to demonstrate understanding of the Fast Fourier Transform and implement the algorithm for various applications

xxii) A student should be able to design, implement and analyze FIR and IIR digital filters for discrete time signals

4. Text Books:

a) Proakis and Manolakis , Digital Signal Processing, 4th Edition, Pearson (Prentice Hall)
b) Alan Oppenheim, Ronald Schafer and John, Buck, Discrete Time Signal Processing, 2nd ed., Prentice Hall, 1999.

5. Reference Books:

a) V. Ingle and J. Proakis, DSP using Matlab
b) B. Hahn, D. Valentine, Essential Matlab for Engineers and Scientists

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	3	3	3	2	1	2	1
CO2	5	3	3	3	2	1	2	1
CO3	5	2	2	2	2	1	3	1
CO4	4	5	4	3	4	4	4	4
CO5	4	5	4	3	4	4	4	4

Introduction to VLSI

Program Core
L-T-P-C: 3-1-0-4

1. **Course Objectives:**
   The main objective is to use analytical methods and circuit analysis to analyze VLSI circuits and implement in FPGA boards.

2. **Syllabus:**
   Unit – 1 [9 Hours]: Historical perspective, Introduction to IC technology – Types of ICs – Design methodology – Design domains: Gajski-Kuhn's Y-Charts – VLSI design flow – VLSI design styles: Full-custom design, Semi-custom design, FPGA based – Hierarchical abstraction – Design flow verification – CAD tools for VLSI – Introduction to technology nodes.

   Unit – 2 [9 Hours]: Fabrication principles, Basic cleaning, Oxidation, Deposition, Diffusion, Ion-implantation, Etching, Metallization, Diode fabrication, NMOS, PMOS, CMOS: well technology, twin tub technology

   Unit – 3 [6 Hours]: MOS capacitor, MOSFET - n-Channel MOSFET & p-Channel MOSFET – MOSFET threshold voltage – MO2SFET VI characteristics – MOSFET scaling: Constant field scaling & constant voltage scaling – Small geometry effects – MOSFET capacitances – MOSFET modeling

   Unit – 4 [9 Hours]: Voltage transfer characteristics of inverter, Resistive load inverter – Enhancement type NMOS load inverter – Depletion type NMOS load inverter – CMOS inverter – VTC of CMOS inverter – Standard cell library – Schematic design – Layout design – Stick diagram – Design rules check – Measuring propagation delay – Measuring rise and fall time – Ring oscillator – Dynamic power consumption – Power delay product – Energy delay product – Power and energy management – Reliability and noise characterization – Interconnect delay modelling: RC, Elmore, Transmission line

   Unit – 5 [9 Hours]: Digital logic design, CMOS design methodology – Design of CMOS inverter – Design of two input NAND gate and NOR gate – Classification of CMOS digital logic circuit

   Unit – 6 [6 Hours]: MOSFET small signal model, MOSFET as switch – Small signal analysis of single stage amplifiers – Current mirror – CMOS amplifier – Cascode amplifier – Current amplifier.

3. **Course Outcomes:**

   At the end of the course, Students should be:

   xxiii) Able to understand the VLSI design principles.

   xxiv) Able to correlate basic fabrication principles with VLSI design.

xxv) Able to understand and replicate the fundamentals of MOS based devices.

xxvi) Able to analyze complex CMOS circuits and layout based on design rules.

xxvii) Able to design VLSI circuits using stick diagram and lambda rules.

xxviii) Able to extend the principles of analog design to VLSI circuits.

4. Text Books:

a) Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, McGraw-Hill Education; 3rd edition (2002), ISBN-13 : 978-0072460537

b) Neil Weste and David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Pearson; 4th edition (2015)

5. Reference Books:

a) Samir Palnitkar, Verilog HDL, Pearson education, Second Edition, 2003.

b) System Verilog 3.1a –Language Reference Manual (Accellera Extensions to Verilog 2001), 2004

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	1	1	3	4	1	1
CO2	3	3	5	5	5	4	1	1
CO3	3	5	5	5	3	3	1	1
CO4	5	5	3	3	5	5	2	3
CO5	5	5	3	5	5	4	2	2
CO6	5	5	5	3	5	5	2	2

Program Elective Courses

of the B.Tech. (ECE) Programme

Advanced VLSI Design

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of the course is to develop a strong foundation in VLSI domain so that students can implement the Low Power VLSI circuits using EDA tools.

2. **Syllabus:**
   Unit – 1 [2 Hours]: MOSFETs - Operation, Threshold voltage, Currents and capacitances of long-channel and short-channel MOSFETs.

   Unit – 2 [4 Hours]: Inverter – Static and dynamic behavior, propagation delay and noise margins, Vth derivation and regions of operation. Interconnects: Parasitic Physical aspects, delay models.

   Unit – 3 [6 Hours]: Introduction to advanced VLSI tools, VLSI Design flow and verification, VLSI Design Styles, System-on-Chip (SoC) Design Methodology, 3D Packaging, algorithms and system design. Transistor level design, Layout design, Verification methods, Design management tools.

   Unit – 4 [8 Hours]: Custom circuit design: Overview of Digital and analog design
   a) Combinational and sequential logic design using CMOS- (i) Static families- CMOS, Ratioed logic and transmission gates, Pass-transistor logic, logic effort, sizing, stick diagrams. Layout design using VLSI Electric tool. (ii) Dynamic families-Domino,NP-CMOS, Charge leakage, Charge sharing, Design rule constraints.

   Unit – 5 [8 Hours]: Sequential circuit design – Static and dynamic latches,
   Master-slave FFs, Edge triggered logic, CMOS, NORA-CMOS, TSPCL logic. Layout design using VLSI Electric tool.

   Unit – 6 [8 Hours]: Power consumption, power-delay product, Low-power design, Datapath Architectures: Adders, Multipliers, Shifters, Memory – ROM, SRAM & DRAM arrays.

3. **Course Outcomes:**

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

   xxix) Ability to understand the basic MOS concepts in terms of design parameters

   xxx) Ability to use Noise margin margin, propagation delay concept to design the MOS circuits

   xxxi) Ability to understand the designing trade off in order to design low power VLSI circuits

xxxii) Ability to model and analyze the MOS based circuits using EDA tools

xxxiii) Ability to design MOS based Memory circuits for different applications

4. Text Books:

a) S.M. Kang & Y. Leblibici, CMOS Digital Integrated Circuits-Analysis & Design by TMH
b) J.M. Rabey, Digital Integrated Circuits Design by, Pearson Education.

5. Reference Books:

a) NHE Weste & K. Eshraghian, Principles of CMOS VLSI Design: A System Perspective by McGraw Hill Pub
b) B.G. Streetman & S. Baneerjee, Solid State Electronic Devices by, PH India.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	4	4	1	2	1	1	1
CO2	3	3	3	5	2	1	1	1
CO3	3	4	3	2	3	1	1	1
CO4	3	4	2	4	3	2	1	1
CO5	5	3	5	3	2	1	3	1

Automotive Electronics

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The purpose of this course is a) to study the various sensors and actuators, displays used in automobiles; b) to get familiar with navigation aids, and telematics services; and c) to study the Radar and LIDAR technologies used in the automotive sector. To get familiar with EMI/EMC standards and compliances.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Working principle and characteristics of Pressure sensors, Linear and Angle Position Sensors, Flow Sensors, Temperature, Heat, and Humidity Sensors, Speed and Acceleration Sensors, automotive actuators, Cruise Control, ABS, Electronic suspension control and electronic steering control.

   Unit – 2 [4 Hours]: Instrument Panel Displays: The Evolution to Electronic Displays, Types of Display Screen. Cameras, Vision-based Recommendation, Audio-based alerts, Audio-Visual Synchronization.

   Unit – 3 [6 Hours]: Automotive navigation technologies, navigation systems and examples of navigation systems: GPS navigation, Inertial navigation system, global navigation satellite system.

   Unit – 4 [8 Hours]: Vehicle-to-vehicle (V2V) / vehicle-to-infrastructure (V2I) communication, Vehicle fleet management and maintenance, Roadside assistance, Emergency call (eCall), Consumer device integration, Secured onboard communication.

   Unit – 5 [8 Hours]: FMCW RADAR, LiDAR, LiDAR vs. Radar vs. Camera, environmental sensing technologies to enrich vehicle performance, safety, and driver experience.

   Unit – 6 [4 Hours]: The Electromagnetic Environment of an Automobile Electronic System, IEEE Standards Related to EMC, Cabling, Printed Circuit Board EMC Checklist.

3. **Course Outcomes:**

   At the end of the course, students should be:

   i) Able to work with different sensors, and actuators used in the automotive sector.

   ii) Able to demonstrate different types of displays, and audio-visual technologies.

   iii) Able to demonstrate navigation technologies used in vehicles.

   iv) Able to describe the role of telematics in the automotive sector.

   v) Able to analyse the role of radar and Lidar in ADAS, autonomous driving and safety.

vi) Able to understand the different EMC standards for the automotive sector.

4. Text Books:

a) Ribbens, Understanding Automotive Electronics, 8th Edition, Elsevier, Indian Reprint, 2013

5. Reference Books:

a) Ronald. K. Jurgon, Automotive Electronics Handbook, McGraw-Hill, 1999.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

a) Mapping of COs – POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	5	4	3	4	3	2	3
CO2	5	4	3	3	4	2	2	3
CO3	5	4	3	4	3	4	3	3
CO4	4	5	4	3	4	3	2	4
CO5	5	5	4	4	3	4	3	3
CO6	3	3	3	3	4	3	4	3

Digital System Design

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of this course is to provide in depth knowledge of digital logic circuits in the form of state model, fault model and test methods. It gives the skills necessary for the student to design and implement digital design projects.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Minimization and Transformation of Sequential Machines: The Finite State Model – Capabilities and limitations of FSM – State equivalence and machine minimization – Simplification of incompletely specified machines. Fundamental mode model – Flow table – State reduction – Minimal closed covers – Races, Cycles and Hazards.

   Unit – 2 [6 Hours]: Digital Design using PLD: Digital Design Using ROMs, PALs and PLAs , BCD Adder, 32 – bit adder, State graphs for control circuits, Scoreboard and Controller, A shift and add multiplier, Array multiplier, Keypad Scanner, Binary divider

   Unit – 3 [6 Hours]: SM Charts: State machine charts, Derivation of SM Charts, Realization of SM Chart, Implementation of Binary Multiplier, dice game controller

   Unit – 4 [6 Hours]: Fault Modeling & Test Pattern Generation: Logic Fault model – Fault detection & Redundancy- Fault equivalence and fault location –Fault dominance – Single stuck at fault model – Multiple stuck at fault models –Bridging fault model. Fault diagnosis of combinational circuits by conventional methods – Path sensitization techniques, Boolean Difference method – Kohavi algorithm – Test algorithms – D algorithm, PODEM, Random testing, Transition count testing, Signature analysis and test bridging faults.

   Unit – 5 [6 Hours]: Fault Diagnosis in Sequential Circuits: Circuit Test Approach, Transition Check Approach – State identification and fault detection experiment, Machine identification, Design of fault detection experiment

   Unit – 6 [6 Hours]: PLA minimization and testing: PLA minimization-PLA folding, Fault model in PLA, test generation and testable PLA design

3. **Course Outcomes:**

   At the end of the course, students should be:

   i) Capable of designing the basic digital systems and comprehend the limitations of finite state machines

   ii) Able to implement and analyse programmable approach using ROM, PLA and PAL

   iii) Able to model ASM charts for complex digital logic circuits.

   iv) Able to design methodologies for fault models in sequential circuits

v) Capable of implementing different techniques for fault detection

vi) Able to implement PLA design using specific models

4. Text Books:

a) Charles H. Roth, Fundamentals of Logic Design, 7th ed., Cengage Learning, ISBN-10: 1133628478

5. Reference Books:

a) Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, Digital Systems Testing and Testable Design –- John Wiley & Sons Inc. ISBN-10 : 0780310624

b) John F Wakerly, Digital Design: Principles and Practices by, Pearson Education; 4th edition (1 January 2008). ISBN-10: 8131713660

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

b) Mapping of COs – POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	4	3	3	3	2	1	2
CO2	5	4	3	4	3	2	1	2
CO3	5	5	4	5	4	3	1	3
CO4	5	5	5	5	4	4	1	2
CO5	5	5	5	5	3	4	1	2
CO6	4	4	4	4	3	4	1	2

Electronic Packaging

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   This course is designed to provide fundamental aspects of the electronic packaging technologies and processes to develop microsystem packages and electronic products.

2. **Syllabus:**
   Unit – 1 [4 Hours]: Electronics Packaging – An Overview, Miniaturization of technology, Silicon Wafer and their packages, Different levels of Packaging, Role of Microelectronics components, Critical Issues viz., Interface, Testing & evaluation.

   Unit – 2 [8 Hours]: Packaging Technologies like Wafer dicing, Bonding and Sealing. Design aspects and Process Flow, Materials for Packaging, Top down System Approach. Different types of Sealing Technologies like brazing, Electron Beam welding and Laser welding.

   Unit – 3 [9 Hours]: Vacuum Packaging with Moisture Control, 3D Packaging examples. Bio Chips / Lab-on-a chip and microfluidics, Various RF Packaging, Optical Packaging, Packaging for Aerospace applications. Advanced and Special Packaging techniques – Monolithic, Hybrid etc., Transduction and Special packaging requirements for Absolute.

   Unit – 4 [5 Hours]: CAD for Printed Wiring Boards (PWBs) and Design for Manufacturability (DFM). PWB Technologies, Single-chip (SCM) and Multi-chip modules (MCM), flex circuits.

   Unit – 5 [4 Hours]: Recent trends in manufacturing like micro-vias, sequential build-up circuits and high-density interconnect structures. Materials and processes in electronics packaging, joining methods in electronics; lead-free solders.

   Unit – 6 [6 Hours]: Surface mount technology design, fabrication and assembly, embedded passive components; thermal management of PWBs, thermo-mechanical reliability, design for reliability, electrical test and green packaging issues, Assignments in PCB CAD; hands on sessions/Design & Simulation for board manufacturing and assembly.

3. **Course Outcomes:**

   At the end of the course, Students should have the ability to:

   xxxiv) understand and analyze the electronic package using standard packaging technology and electronic assembly flow process.

   xxxv) design package for different applications such as Microfluidics, Bio-Chips, Aerospace and similar domain.

   xxxvi) create package layout according to current state of the art and industry trends in the Electronic Packaging area.

xxxvii) design, simulate and create PCB layout for Integrated Circuits (ICs)/Microsystems applications.

4. Text Books:

a) Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2012.

5. Reference Books:

a) Richard K. Ulrich, Advanced electronic packaging, 2nd ed., Wiley, 2006.
b) R S Khandpur, Printed Circuit Boards, McGraw Hill, 2006.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	4	1	2	1	1	1
CO2	3	4	3	5	2	1	1	1
CO3	4	2	5	1	4	1	1	1
CO4	3	5	4	3	5	4	4	5

Measurement and Instrumentation

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of this course is to provide constructional details and principle of operation of analog and digital measuring instruments; along with the working and applications of various transducers and data acquisition devices.

2. **Syllabus:**
   Unit – 1 [4 Hours]: Measurement of Electrical Quantities, Standards of Measurement & Errors, Voltmeter, Ammeter, Wattmeter, and Energy meter.

   Unit – 2 [7 Hours]: Measurement of low, medium and high resistances, insulation resistance measurement, AC bridges for inductance and capacitance measurement.

   Unit – 3 [7 Hours]: Current and Potential transformers, ratio and phase angle errors. Electronic Measurements: Electronic voltmeter, multimeter, wattmeter & energy meter.

   Unit – 4 [4 Hours]: Time, Frequency and phase angle measurements using CRO Spectrum & Wave analyzer. Digital counter, frequency meter, voltmeter, multimeter, and storage oscilloscope.

   Unit – 5 [7 Hours]: Transducers, classification & selection of transducers, strain gauges, inductive & capacitive transducers, piezoelectric and Hall-effect transducers, thermistor, thermocouple, photo-diodes & photo-transistors, encoder type digital transducers, basic concepts of smart sensors and applications. Data Acquisition Systems.

   Unit – 6 [7 Hours]: Overview of A/D converter, Types and characteristics – Sampling, Errors, Objective, Building blocks of Automation systems, Counters, Modes of operation-Frequency, Period, Time interval measurements, Single and Multichannel Data Acquisition systems. Case Studies: Industrial process measurements like flow, temperature, pressure and level development system

3. **Course Outcomes:**

   At the end of the course, Students should be:

   xxxviii) Able to understand and replicate the fundamentals of measurement principles.

   xxxix) Able to analyse the complexity and to represent measured quantities with proper uncertainty.

   xl) Able to calibrate instruments and design circuits for industrial measurements.

   xli) Able to apply knowledge of data acquisition to perform different measurements

xlii) Able to demonstrate the knowledge and skills in digital measurement in advanced technologies.

xliii) Able to build basic blocks of automation and measure the parameters.

4. Text Books:

a) K. Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai, 2003

b) W. D. Cooper and A. P. Helpric, Modern Electronic Instrumentation & Measurement Techniques, PHI, 1990.

5. Reference Books:

a) J. P. Bentley, Principles of Measurement Systems, Longman Group Ltd. (Pearson Education), 1995

b) M. Tooley, PC Based Instrumentation and Control, Newnes, 1997

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	1	1	3	4	1	1
CO2	3	3	5	5	5	4	1	1
CO3	3	5	5	5	3	3	1	1
CO4	5	5	3	3	5	5	2	3
CO5	5	5	3	5	5	4	2	2
CO6	3	5	5	5	3	5	2	2

Microprocessors and Microcontrollers

Program Elective

L-T-P-C: 2-0-1-3

7. **Course Objectives:**
   The main objective of this course is to the student get familiarized with the basics of working with Microprocessors, Microcontrollers, and assembly language programming.

8. **Syllabus:**
   Unit – 1 [4 Hours]: Computer number systems, codes: Review of decimal, binary, hexadecimal number systems, BCD, Gray codes.

   Unit – 2 [5 Hours]: 8086 Microprocessor Architecture - Microprocessor evaluation, 8086 Internal architecture, BIU, Register organization, Memory segmentation, Addressing modes, Stack, Flags, Interrupts, Pin diagram.

   Unit – 3 [8 Hours]: 8086 assembly language programming - Instruction set, Assembler directives; Assembly language programming- Simple sequence programs, Conditional/unconditional jumps, Looping, Solving arithmetic expressions, Procedure, String manipulations.

   Unit – 4 [5 Hours]: The 8051 Microcontroller - Overview of 8051 family, Introduction to 8051, Pin and block diagram, Register, RAM allocation, Addressing modes, Flags

   Unit – 5 [8 Hours]: 8051 assembly language programming - Instruction sets, Assembler directives, Stack, I/O Port programming

   Unit – 6 [6 Hours]: Real-world interfacing - 8051 Interfacing a stepper motor, Keyboard, Digital to analog converter (DAC)

9. **Course Outcomes:**

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

   i) Ability to understand different number systems and their conversion

   ii) Ability to understand the architecture of the microprocessor 8086

   iii) Ability to develop and code in assembly 8086 programming to implement the arithmetic, logical, and string related operations

   iv) Ability to understand the architecture of the microcontroller 8051

   v) Ability to program 8051 microcontroller to implement a logical functionality using I/O interfacing

vi) Ability to understand the basic interfacing of stepper motor, keyboard, digital to analog converters and design a solution using 8051 microcontroller

10. Text Books:

a) Douglas V. Hall and SSS P Rao, Microprocessors and Interfacing, 3rd Edition, Tata McGraw-Hill Education, 2017.
b) Mazidi & Mazidi, 8051 microcontrollers & embedded system, Pearson Education (2006).

11. Reference Books:

a) Soumitra Kumar Mandal, Microprocessors and Microcontrollers: Architecture, Programming and Interfacing using 8085, 8086 and 8051, McGraw Hill Education (1 July 2017)
b) Muhammad Ali Mazidi, Rolin McKinlay, Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson, 2nd edition (22 August 2007)
c) Kenneth Ayala, The 8051 Micro controller, Cenage learning, 3rd edition 2007

12. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

a) Mapping of COs – POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	1	1	1	1	1
CO2	5	5	2	2	3	3	2	3
CO3	5	5	2	2	3	3	2	3
CO4	5	5	2	2	3	3	2	3
CO5	5	5	2	2	3	3	2	3
CO6	3	5	5	3	3	3	2	3

Micro Sensors and Actuators

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   This course is designed to provide fundamental understanding of the design, fabrication, testing and working principles of different types of sensors and actuators, using a wide range of physical sensing principles.

2. **Syllabus:**
   Unit – 1 [4 Hours]: Introduction – MEMS and Microsystems – History of MEMS – Why MEMS? Overview of Microfabrication Multidisciplinary Nature of Microsystems Design – Biomedical Applications of MEMS – Applications of MEMS in Automotive Industry – Applications of MEMS in other related fields, Scaling laws, Inspection and live demonstration of MEMS devices.

   Unit – 2 [8 Hours]: Packaging Technologies like Wafer dicing, Bonding and Sealing. Design aspects and Process Flow, Materials for Packaging, Top down System Approach. Different types of Sealing Technologies like brazing, Electron Beam welding and Laser welding.

   Unit – 3 [6 Hours]: Dry Etching – Wet Etching –Plasma Etching and Reactive ion Etching – Bulk Micromachining – Surface Micromachining – LIGA Process –Demonstration of some bulk and surface micromachining processed devices – Wafer Dicing and Wafer Bonding.

   Unit – 4 [6 Hours]: Introduction – Micro sensors: Acoustic wave sensors – Biomedical sensors and Biosensors – Chemical sensors – Optical sensors – Pressure sensors – Accelerometers – Thermal sensors

   Unit – 5 [6 Hours]: Micro actuators: Actuation using thermal forces – Actuation using shape memory alloy – Actuation using piezoelectric crystals – Actuation using electrostatic forces – Micro actuators: Micro grippers – Micro motors – Micro valves – Micro pumps- Micro accelerometers – Microfluidics.

   Unit – 6 [6 Hours]: Basic concepts of design of MEMS devices and processes - Design for fabrication - Other design considerations - Analysis of MEMS devices - FEM and Multiphysics analysis - Modelling and Simulation tools.

3. **Course Outcomes:**

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

   i) To understand current state of art and challenges of micro sensors and actuators.

   ii) To create a process flow for microsystems design, fabrication and testing.

   iii) To demonstrate novel and significant process approach for microsystem development.

iv) To demonstrate the sensing and actuating principle by developing working models.

4. Text Books:

a) Tai - Rai Hsu, MEMS and Microsystems: Design and Manufacturing, Tata MC Graw Hill, Edition 2002

b) Marc J. Madou, Fundamentals of Microfabrication (Second Edition), , CRC press Taylor and Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL33487-2724, 2002

c) Stephen D.Senturia, Microsystems Design, Springer, 2001

5. Reference Books:

a) Gregory Kovacs, Micro machined Transducers, Tata Mc Graw Hill, 1998

b) Marc Madou, Fundamentals of Microfabrication, CRC Press, 2002

c) Selected papers in Microsensors, MEMS devices, smart materials and micro actuators

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	4	1	2	1	1	1
CO2	2	5	3	5	3	1	1	1
CO3	2	5	3	1	4	1	1	1
CO4	5	4	5	5	4	3	4	1

Microwave Engineering & Radar Systems

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of this curse to provide the fundamental understanding of different types of modes in guided structures, the analysis of basic microwave networks using the Scattering matrix parameters and different types of radar systems.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Maxwell's Equations, Boundary Conditions, Fields in different media, Microwave Network analysis: Introduction to Scattering (S) parameters. Impedance Matching.

   Unit – 2 [9 Hours]: General solutions: TEM, TE and TM waves, Parallel pate and rectangular and circular waveguides, Cut-off frequencies, other types of transmission lines: Stripline, microstrip etc. Wave velocity and dispersion.

   Unit – 3 [9 Hours]: Basic properties of three port and 4 port networks, Power dividers (resistive and Wilkinson) & Couplers (90 deg and 180 deg), Filters design by insertion loss method, Filters implementation.

   Unit – 4 [3 Hours]: Radar Block Diagram and Operation, Radar Applications, Range equation, Minimum detectable signal, Radar Cross Section of Targets, Pulse Repetition Frequency and Range Ambiguities.

   Unit – 5 [6 Hours]: Able to describe the role of radar in different application domains.

   Unit – 6 [3 Hours]: Computational Methods: Finite Difference Method, Moment Method, Asymptotic methods: Geometrical Optics, Geometric Theory of diffraction, Uniform theory of diffraction.

3. **Course Outcomes:**

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

   xliv) Ablility to evaluate the scattering parameters of different microwave networks.

   xlv) Ablility to differentiate the propagating modes in single conductor and multi conductors.

   xlvi) Ability to analyze and design the passive components and their applications in RF circuits.

   xlvii) Ability to demonstrate the presence of electromagnetic signature of objects.

xlviii) Ability to describe the role of radar in different application domains like automotive, aerospace and so on.

xlix) Ability to apply numerical and ray based techniques to solve advanced electromagnetic problems.

4. Text Books:

a) David M. Pozar, Microwave Engineering, 4th Ed., John Wiley & Sons, Inc., 2012.
b) M. Skolnik, Introduction to radar systems, 3rdEd., McGRAW-HILL Book Comp., 2001.

5. Reference Books:

a) Collins: Foundations of Microwave Engineering, IEEE Press, 2nd Edition

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	4	5	3	4	3	2	3
CO2	5	4	3	1	3	2	2	2
CO3	4	5	5	3	5	3	3	4
CO4	5	3	3	2	3	3	3	3
CO5	4	2	1	2	4	2	2	4
CO6	4	3	3	3	4	3	2	2

Model Based Signal Analysis

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of this course is to introduce the students to the problem of "Parameter Estimation" specifically under known signal/data models. The course is going to train the students to do performance analysis of the estimators through Monte-Carlo simulations

2. **Syllabus:**
   Unit – 1 [5 Hours]: Introduction: Mathematical estimation problem, estimator performance, Minimum variance unbiased estimation (MVUE), minimum variance criterion Existence of MVUE, Finding MVUE, Extend to Vector parameters

   Unit – 2 [6 Hours]: Bounds on Signal Estimation: Accuracy considerations, Cramer Rao Bound (CRLB), General CRLB, Transformation of parameters, Extension to Vector parameter case, General Gaussian case, asymptotic CRB

   Unit – 3 [5 Hours]: Linear Models and Sufficient Statistics - Definition, Examples, Sufficient Statistics, finding SS, Using sufficiency for finding MVUE, Best Linear Unbiased Estimator, finding BLUE

   Unit – 4 [10 Hours]: Classical Approaches - Maximum likelihood estimation, example, finding MLE, properties, transformed parameters, Numerical methods, Asymptotic MLE Least Squares - LS Approach, Linear LS, Order recursive LS, Sequential LS, Non-linear LS.

   Unit – 5 [5 Hours]: Bayesian Approach - Introduction, Prior knowledge, Choosing the Prior, Properties of Gaussian pdf, Bayesian linear model, deterministic parameters, Minimum Mean Square Error Estimation

   Unit – 6 [5 Hours]: Spectral Analysis - Basics, Power spectral density, Properties of PSD, Spectral Estimation problem, Periodogram, Correlogram, Rational spectra, Covariance structure, ARMA models, AR models, Yule Walker method

3. **Course Outcomes:**

   At the end of the course,

   l) a student should be able to formulate a statistical parameter estimation problem from a given statistical model

   li) a student should be able to derive the Cramer-rao bound on the performance of the estimator for a given probabilistic model

   lii) a student should be able to identify if the sufficient statistics exists and utilize them for deriving the estimator

liii)a student should be able to derive and implement a time-domain estimator based on any of the existing classical and the Bayesian methods and analyze its performance

liv)a student should be able to derive a spectral estimator and apply the same to extract the spectra from random signals and analyze the performance

4. Text Books:

a) Fundamentals of statistical signal processing I: Estimation Theory, Steven M. Kay, Prentice Hall
b) Spectral Analysis of Signals by Peter Stoica and Randolph Moses, PHI publications.

5. Reference Books:

a) Louis Scharf, Statistical Signal Processing: Detection, Estimation, and Time Series Analysis, Addison Wesley.
b) Box and Tiao, Bayesian Inference in statistical analysis, Wiley
c) James Candy, Model based Signal Processing, Wiley. 704pp, 2005

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	3	2	3	3	1	1	1
CO2	5	2	2	2	2	1	1	1
CO3	5	2	3	2	3	1	1	1
CO4	4	4	3	4	4	3	3	3
CO5	4	4	4	4	4	3	3	3

Opto-Nano Electronics

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**

   The objective of teaching this course is to make undergraduate and graduate students understand on the importance of emerging optoelectronic devices and their applications. The basics of nanostructures are emphasized in this course to make sure the students understand the quantum based optical devices.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Introduction-Wave nature of light: Total internal reflection, refraction, Principle of superposition, Interference, diffraction, Review of semiconductor fundamentals: elemental and compound semiconductors, band structure, Indirect and direct, mass action law, doping and depletion width calculations, Drift and diffusion equations in a p-n junction.

   Unit – 2 [6 Hours]: Optical Process in semiconductors-Recombination process: Radiative, non-radiative, band-to-band, SRH and Auger recombination. Absorption and emission in semiconductors, Defects in semiconductors, Franz-Keldysh and Stark effects, absorption and lifetime calculations.

   Unit – 3 [9 Hours]: LED's-Principle of action, LED materials, power and efficiency calculations, LED driver circuits, spectral response, frequency response and modulation bandwidth, LED structure: Homostructure, Heterostructure, surface emitting and edge emitting LED’s.

   Unit – 4 [3 Hours]: LASER's-Basic principle, concept of spontaneous and stimulated emission, population inversion, optical feedback, threshold conditions, Hetero-junction and distributed feedback lasers.

   Unit – 5 [6 Hours]: Photodiodes and solar cells-PN, PiN, Avalanche and heterojunction photodiodes, Avalanche multiplication factor in APD’s, quantum efficiency and responsivity. Solar Cells: Jsc, Voc, Fill factor and efficiency calculation. Design of single junction solar cells using PC1D software.

   Unit – 6 [6 Hours]: Introduction to Nanoconcepts-Importance of Nanoscale, Nanostructure types, Electronic-Magnetic and Optical properties. Quantum Mechanical Phenomenon: Quantum well, Quantum wires and quantum dots. Carbon Nanostructures: Carbon nanotubes, Fullerenes, Properties and types of CNT
   Fabrication and characterization of nanomaterials; MBE, MOCVD, SEM, TEM, AFM, STM and XRD.

3. **Course Outcomes:**

   At the end of the course, Students should be:

lv) Able to understand the actual physical processes involved in semiconductors for emission of light.

lvi) Apply the concepts of semiconductor physics, and calculate the parameters that are crucial for energy conversion.

lvii) Able Understand the theoretical concepts and current voltage characteristics of optical devices

lviii) Able to analyze the trade off when designing optical devices for high efficiency.

lix) able to design optical devices such as solar cells using specialized software tools.

lx) able to differentiate conceptually between electronics devices (BJT, FET, rectifier diodes, etc.,) and optical devices (LED's, LASER's, APD's and solar cells).

4. Text Books:

a) Pallab Bhattacharya, Semiconductor optoelectronic devices (2nd edition) ISBN: 978-93-325-8741-0, Pearson

5. Reference Books:

a) S.C. Gupta, Optoelectronics devices and systems, Prentice Hall India Learning Private Limited, Second edition, ISBN-10: 8120350650

b) Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw Hill Education, First edition (27 March 2019). ISBN-10: 9353165873

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	3	3	5	2	1	3
CO2	4	4	5	3	5	2	1	4
CO3	5	5	5	5	5	2	1	4
CO4	5	5	5	5	5	2	1	4
CO5	5	5	4	4	4	3	1	5
CO6	5	4	4	4	4	2	1	4

Pattern Recognition

Program Elective

L-T-P-C: 2-0-1-3

1. **Course Objectives:**
   The objective of the course is to introduce the fundamentals required for understanding, tools for practical implementation and metrics for performance analysis of classical pattern recognition algorithms.

2. **Syllabus:**
   Unit – 1 [5 Hours]: Introduction : Review of Probability theory, Probability distributions, Decision theory, evaluation criteria, Supervised and Unsupervised Learning

   Unit – 2 [5 Hours]: Linear Models: Discriminant functions, Generative models, Probabilistic Discriminative Models, Maximum likelihood approach, Likelihood ratio test

   Unit – 3 [10 Hours]: Parametric Classifiers: SVM Theory and Implementation: Theory of SVMs, Binary classification using SVM, Soft-Margin SVM, Kernels in SVMs, Mercer's theorem, M-class Classification, Binarization, One class SVM, GMMs, EM algorithm, K-means clustering

   Unit – 4 [6 Hours]: Feature extraction: Time domain features, Frequency domain features, short time-frequency domain features, Spatial features

   Unit – 5 [5 Hours]: Non parametric classifiers: Decision Trees, K Nearest Neighbor classifier, Random Forests

   Unit – 6 [5 Hours]: Introduction to ANNs for classification: ANN architectures, Feedforward neural networks, Back-propagation algorithm

3. **Course Outcomes:**

   At the end of the course,

   i) A student should be able to Formulate a supervised and unsupervised learning problem

   ii) A student should be able to select and implement a suitable pattern recognition algorithm for simulated data

   iii) A student should be able to design and code suitable feature engineering methods

   iv) A student should be able to implement and evaluate the performance of classification algorithms on real-world datasets

4. **Text Books:**
   a) C. Bishop, Pattern Recognition and Machine Learning

b) Sergios Theodoridis , Pattern Recognition
c) Nello Christianni, An Introduction to Support Vector Machines and Other Kernel-based Learning Methods
d) Isabella Guyon, Feature extraction foundations
e) E. Alpaydin, Introduction to machine learning, MIT press
f) C. Bishop, Neural networks for pattern recognition

5. Reference Books:

a) Duda, Richard O. and Peter E. Hart. Pattern classification. John Wiley & Sons, 2006.
b) Theodoridis, Sergios, et al. Introduction to pattern recognition: a matlab approach. Academic Press, 2010.
c) Bisong, Ekaba. Building machine learning and deep learning models on Google cloud platform. Berkeley: Press, 2019.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	2	3	4	3	1	1	1
CO2	5	3	3	4	3	1	1	1
CO3	5	5	3	3	3	3	3	3
CO4	5	4	4	4	4	1	1	1

Wireless Communication

Program Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**

   The objective of this course is to provide a comprehensive knowledge of cellular communication fundamentals, Techniques, and the recent trends in cellular systems and wireless Communication.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Overview of wireless communication, Examples of Wireless Communication Systems. Trends in Cellular Radio and Personal Communications, Second Generation (2G) Cellular Networks. Third Generation (3G) Wireless Networks, 4G LTE. Wireless Local Area Networks (WLANs). Bluetooth and Personal Area Networks (PANs)

   Unit – 2 [6 Hours]: Introduction. Frequency Reuse. Channel Assignment Strategies. Handoff Strategies. Interference and System Capacity. Trunking and Grade of Service. Improving Coverage & Capacity in Cellular Systems. Intra-cell and Inter-cell Interference, Erlang-B and C Chart. Multiple Access techniques – FDMA, TDMA, CDMA.

   Unit – 3 [6 Hours]: Introduction to Radio Wave Propagation. Free Space Propagation Model. Relating Power to Electric Field. The Three Basic Propagation Mechanisms. Reflection. Ground Reflection (Two-Ray) Model. Diffraction. Scattering. Practical Link Budget Design Using Path Loss Models. Outdoor Propagation Models. Indoor Propagation Models. Signal Penetration into Buildings. Ray Tracing.

   Unit – 4 [6 Hours]: Small-Scale Multipath Propagation. Impulse Response Model of a Multipath Channel. Small-Scale Multipath Measurements. Parameters of Mobile Multipath Channels. Types of Small-Scale Fading.

   Unit – 5 [6 Hours]: Frequency of operation, transmitter and receiver, Uplink/Downlink, TDMA/FDMA implementation, time frame and time slots, voice channel and control channel, Data rate, speech to data encoding.

   Unit – 6 [6 Hours]: Multiple Input Multiple Output (MIMO) Systems: Spatial Multiplexing and Channel Modelling, MIMO channel capacity and beamforming. Orthogonal Frequency Division Multiplexing (OFDM).

3. **Course Outcomes:**

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

   i) Ability to illustrate the evolution of wireless communication technologies and standards.

   ii) Ability to demonstrate the fundmental knowledge and current trends of cellular communication.

iii) Ability to design and develop different radio wave propagation models to analyze signal strength in various scenarios.

iv) Ability to analyse the effects of multipath and fading on wireless link modeling.

v) ability to work on different techniques used in wireless communication.

vi) ability to work with different technologies used in Wireless Communication

4. Text Books:

a) Theodore S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, 2006

b) Goldsmith A, Wireless Communications, Cambridge University Press, 2012.

5. Reference Books:

a) David Tse and P. Viswanath: Fundamentals of Wireless Communication, Cambridge University Press, 2004.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	2	2	4	1	2	2
CO2	4	3	3	3	3	2	2	3
CO3	5	4	5	4	3	4	3	3
CO4	3	4	3	4	4	3	2	4
CO5	4	5	2	3	3	2	2	2
CO6	3	3	3	5	4	3	2	3

Institute Elective Courses

of the B.Tech. (ECE) Programme

Introduction to Cyber Physical Systems

Institute Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of the course is to provide importance on the principles of automation and control in the industrial applications of CPS along with in-depth knowledge of modelling, design, and analysis of CPS, integrating computation, networking, and physical processes. The course would provide exposure to the students to real world problems in this domain and make them give presentations and be up-to-date aware of concepts, challenges and real-world case studies such as industry 4.0, healthcare, and connected vehicles

2. **Syllabus:**
   Unit – 1 [4 Hours]: Introduction to Cyber Physical System: Definition of Cyber Physical System (CPS) - Basic principles of design and validation of CPS - Inter-disciplinary nature of CPS

   Unit – 2 [6 Hours]: Examples and Basic Technologies: Importance of different Basic Technologies, Control, Communication and Computation - Data Analytics - Image/Video Processing, Industry 4.0 and IIoT, Automation and Applications

   Unit – 3 [4 Hours]: CPS - Platform components: CPS HW platforms - Processors, Sensors, Actuators - CPS Network – Bluetooth, Zigbee, RFID, CAN, Automotive Ethernet - CPS Sw stack - RTOS, Scheduling Real Time control tasks

   Unit – 4 [6 Hours]: Introduction to Robotics: Introduction to Robotics for CPS - Robotic Kinematics and Dynamics - Degree of Freedom, Manipulators - Mathematics involved in Robotics - Applications to Cyber Physical System

   Unit – 5 [8 Hours]: Principles of Automated Control Design: Principle and motivation - Controller Design Techniques - Model Predictive Controller (MPC) - Understanding sub-system behaviour - Carry out end-to-end simulation

   Unit – 6 [8 Hours]: CPS Case Studies: Automotive: S/w controller for ABS, ACC, Lane Departure warning, Suspension control, Real-time recommendation; Healthcare: Artificial infusion, Pacemaker; Green Building: Automated lighting, AC Control, etc.

3. **Course Outcomes:**

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

   i) Ability to comprehend and articulate various CPS concepts and technologies

   ii) Ability to understand various technologies and components within Cyber Physical System

iii) Ability to comprehend system level integration with hardware, software and control point of view in industrial IoT setting.

iv) Ability to Carry out analysis of Robotics-based system for industry 4.0 environment and similar manufacturing-based applications

v) Ability to develop small modules for an industry relevant automation problem

vi) Ability to deliver a solution relevant for various Industrial applications in healthcare, Industry 4.0, etc.

4. Text Books:

a) E. A. Lee, and Sanjit Seshia, Introduction to Embedded Systems – A Cyber Physical Systems Approach, MIT Press, 2nd Edition, 2017

5. Reference Books:

a) Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015

b) Raj Rajkumar, Dionisio De Niz, and Mark Klein. Cyber-Physical Systems, Pearson Education, First edition (2017), ISBN-13: 978-9386873569

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	2	2	4	3	1	1	2
CO2	4	3	2	3	3	1	1	3
CO3	5	3	3	3	4	2	2	3
CO4	5	4	3	4	4	3	2	4
CO5	5	4	4	4	5	3	3	5
CO6	5	5	4	5	5	4	3	5

Introduction to Robotics

Institute Elective

L-T-P-C: 2-0-1-3

1. **Course Objectives:**

   The objective of the course is to introduce the fundamentals, frame the problem of robotic movement, design and implement control algorithms for robots in a practical application scenarios

2. **Syllabus:**

   Unit – 1 [5 Hours]: Introduction: Fundamentals - descriptions, positions, orientations, and frames, mappings - changing descriptions from frame to frame, operators - translations, rotations, and transformations, summary of interpretations, transformation arithmetic, transform equations.

   Unit – 2 [7 Hours]: Robot Mechanics: Robot Kinematics - Link description, link-connection description, convention for affixing frames to links, manipulator kinematics, actuator space, joint space, and cartesian space. linear and rotational velocity of rigid bodies, angular velocity, motion of the links of a robot, velocity propagation from link to link, Dynamics - jacobians, acceleration of a rigid body, mass distribution, newton's equation, euler's equation, iterative newton—euler dynamic formulation.

   Unit – 3 [6 Hours]: Robot Control: Introduction - Feedback and closed-loop control, second-order linear systems, control of second-order systems, control-law partitioning, introduction to trajectory generation - trajectory-following control

   Unit – 4 [6 Hours]: Mechatronis - Sensors - vision, motion, laser, radio; Actuators - motors, electrical motors, electromechanical motors, Interfacing

   Unit – 5 [6 Hours]: Robot Programming: Microcontrollers, robot programming - the three levels of robot programming, a sample application, arduino programming, raspberry pi, advanced hardware - Nvidia jetson

   Unit – 6 [6 Hours]: Robotic Applications: Applications Fields - Assistive Robots, Wearable Robots, Industrial Robots, Service Robotics and Medical Robotics

3. **Course Outcomes:**

   At the end of the course,

   i) A student will be able to describe the components of a robot and the mathematical foundations for robots

   ii) A student will be able to formulate and solve the mathematical and geometrical problem of robotic movement

iii) A student will be able to analyze the robotic control problem and develop a suitable solution

iv) A student will be able to identify the required sensors and actuators for a given robotic application

v) A student will be able to demonstrate the programming skills on a laboratory scale robot for a particular application

4. Text Books:

a) John J. Craig, Introduction to Robotics: Mechanics and Control, Addison-Wesley Publishing company, 3rd Edition, 2003
b) Godfrey Onwubolu, Mechatronics: Principles and Applications, Elsevier, 2005

5. Reference Books:

a) Robotics Modelling, planning and Control, Siciliano et al, Springer, 2009.
b) Fundamentals of Robotic Mechanical Systems, Theory, Methods and Algorithms, Jorge Angeles, Springer, 3rd Edition, 2007
c) Introduction to Mechatronic Design, E. Caryyer et al, Pearson, 2010
d) Mechatronics, William Bolton, Pearson, 6th Edition, 2015

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	3	3	3	2	1	1	1
CO2	5	3	3	3	2	1	1	1
CO3	4	4	4	4	3	1	1	1
CO4	4	4	4	3	3	3	1	3
CO5	4	4	4	4	5	4	4	4

Wireless Networks

Institute Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of this course is to provide an introduction to various current and nextgeneration wireless networking technologies, and undertakes a detailed exploration of fundamental architectural and design principles used at all layers. Course will also impart the design methodology of wireless networks and make them understand the challenges in wireless sensor neetworks, multi-hop and cloud networks.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Introduction - Introduction to Wireless Communication, Networks, cellular networks;

   Unit – 2 [6 Hours]: Cellular Networks - Cellular Concepts, Hexagonal cells Cell Reuse, Co-Channel and Adjacent Channel Interference Capacity Calculation, Radio propagation models; Resource allocation and scheduling - TDM/FDM, TDMA, FDMA, CDMA;

   Unit – 3 [6 Hours]: Wireless Networks - Wireless local area networks, Personal Area Networks (PAN), Network resource allocation

   Unit – 4 [6 Hours]: WSN & Multi-hop Networks - Multi-hop routing Protocols, Wireless Sensor Networks

   Unit – 5 [6 Hours]: Advanced Networking - Cloud and Virtualization, Network Function Virtualization;

   Unit – 6 [6 Hours]: Software Defined Networking - Introduction to Software Defined Networking, SDN in next generation networks, SDN hands on - mininet simulations;

3. **Course Outcomes:**

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

   i) Ability to understand the cellular networks and the challenges at various layers

   ii) Ability to design Hexagonal cellular network and apply different Radio propagation aspects

   iii) Ability to apply the standard protocols used at the MAC layer and scheduling mechanisms and propose modifications in the existing protocols

   iv) Ability to analyse the challenges in multi-hop networks and Wireless sensor networks and use the standard protocols in applications

   v) Ability to Understand and adapt to the advance networking, cloud and NFV

vi) Ability to develop Software Defined Networking based solutions for the performance improvement to solve existing challenges in wireless networks

4. Text Books:

a) Wireless Communications & Networking, By T Rapport, ISBN 0-13-042232-0, Princeton Communications

b) Wireless Communications & Networking, By Vijay Garg, The Morgan Kaufmann Series, Year-2007, ISBN-978-0-12-373580-5

5. Reference Books:

a) Andrea Goldsmith, Wireless Communications, Publisher:Cambridge University Press, Online publication date:June 2012, Print publication year:2005, Online ISBN:9780511841224

b) Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson publications, ISBN-13: 978-0-13-212695-3, ISBN-10: 0-13-212695-8

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	2	2	2	1	1	1
CO2	5	3	4	2	2	1	1	1
CO3	5	2	4	3	3	2	1	1
CO4	5	4	4	3	3	3	2	1
CO5	5	4	5	4	3	2	3	1
CO6	5	5	5	4	4	2	3	1

Specialization Elective Courses

B.Tech. (ECE) Programme with Specialization in Cyber Physical Systems

Internet of Things

Specialization Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   Objective of this course is to introduce students to the Internet of Things basics, architectures and standards. Course also provides knowledge of protocols and hands-on sessions with applications of it in IoT. Students are expected to know the advancements and recent topics with overall system level understanding using case studies on real time applications of IoT

2. **Syllabus:**
   Unit – 1 [6 Hours]: Introduction to IoT - Definitions, Generic architecture of IoT, Sensing and Actuation;

   Unit – 2 [6 Hours]: Connectivity - MQTT, CoAP, IEEE 802.15.4, Protocols - ZigBee, 6LowPAN, RFID, HART, WHART, NFC, Blueetooth, Zwave;

   Unit – 3 [6 Hours]: Sub-modules of IoT - Sensor Networks for IoT topologies, Coverage, Mobility, Interoperability of IoT, Evolving technologies part of IoT - UAV, M2M;

   Unit – 4 [6 Hours]: SDN in IoT - Software Defined Networking (SDN), SDN-IoT architecture, applications of SDN in IoT Networking;

   Unit – 5 [6 Hours]: Cloud Computing, Service models for IoT - Basics of Cloud computing, Service models, Openstack, Sensor Clouds, Fog Computing;

   Unit – 6 [6 Hours]: Data Analytics, AI & ML in IoT - Example case studies - Importance of Data analytics, AI and ML in IoT applications; Case-studies: Smart Cities, Smart Transportation, Smart Grids, IIoT, Health Care, Precision Agriculture, Testbed examples;

3. **Course Outcomes:**
   i) To able to categorize the given IoT application subsystems in the standard 5 layer IoT architecture
   ii) To be proficient with industry accepted standard protocols like MQTT, CoAP, WirelessHART etc. and implement them in industrial/research related problems.
   iii) To be able to design a real time monitoring/data acquisition system for an IoT application
   iv) To be able use the latest trends in SDNs and use them to optimize the performance of IoT modules.
   v) To be able to code and integrate the hardware, software and cloud services in implementation of IoT applications.
   vi) To be able to identify a societal problem and demonstrate innovative solutions and prototypes with integration of IoT and AI & ML modules

4. Text Books:

a) Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by (CRC Press), ISBN-10:1498761283

b) Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, (Universities Press), ISBN-10:0996025529

5. Reference Books:

a) Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014.

b) Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, 1st Edition, Apress Publications, 2013

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

a) Mapping of COs – POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	1	1	1	1	1	1
CO2	3	4	3	1	1	2	1	2
CO3	3	4	4	2	3	3	1	3
CO4	3	4	3	3	3	2	1	2
CO5	4	5	5	4	3	4	2	4
CO6	5	5	5	5	5	5	3	4

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-04	PSO-CPS-01	PSO-CPS-02
CO1	4	3	3	3	4	4
CO2	4	5	2	3	4	4
CO3	3	5	4	4	4	4
CO4	3	5	3	3	4	4
CO5	4	5	5	5	5	5
CO6	5	5	5	5	5	5

Intelligent and Autonomous System

Specialization Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of the course is: a) to impart the fundamental knowledge and architectures of Internet of Things; b) to protocols and hands-on sessions with applications of it in IoT; and c) to introduce the advancements and recent topics with case studies on real time applications of IoT.

2. **Syllabus:**
   Unit – 1 [4 Hours]: Autonomous Systems – Introduction - Concept and definitions - Embedded Systems, Computer Networks, M2M (Machine to Machine Communication), Internet of Everything (IoE), Machine Learning, Industrial automation

   Unit – 2 [4 Hours]: Intelligent Systems - Concept of Data, Information, Knowledge and Wisdom - Knowledge discovery process (Image, ML, Data Analytics) - PLC vs Microcontrollers: cost, performance, and power - Selection criteria and tradeoffs - Industrial networks, M2M networks

   Unit – 3 [6 Hours]: Wireless Sensor Networks - Sensor nodes - WSN communication technologies: LoRA, Zigbee and WiFi; Cellular communication and LPWAN technologies

   Unit – 4 [6 Hours]: Design and Development - Reference architectures - Standardization initiatives - Interoperability issues - Industrial Internet Reference - Architecture from Industrial Internet Consortium (IIC) - Networks, communication technologies and protocols - AI/ML in Automation for Industry 4.0 applications: Deep learning models

   Unit – 5 [8 Hours]: Case Studies: Intelligent and Autonomous Systems - Smart factories and cyber physical systems - Autonomous Driving - Predictive maintenance, Anomaly detection etc.

   Unit – 6 [8 Hours]: Algorithms for Prediction and Integral Communication systems -Need for integral Communication model for autonomous systems - Introduction to Kalman Filter - Single and multi-dimensional Kalman filters - OPC UA and hands-on with MATLAB and Prosys server, UA client

3. **Course Outcomes:**

   At the end of the course, Students should have the ability:
   i) Ability to understand the IoT layered architecture and categorize the subsystems in the IoT architecture
   ii) Ability to apply the industry accepted standard protocols like MQTT, CoAP and WirelessHART and use them in the implementation of industrial/research related problems.
   iii) Ability to design a real time monitoring/data acquisition system for an IoT application

iv) Ability to demonstrate the performance improvement using SDNs in IoT modules.

v) Ability to develop end to end IoT application with integration of hardware, software and cloud services.

vi) Ability to demonstrate innovative solutions with prototypes of IoT, AI & ML modules to solve any societal problems.

4. Text Books:

a) A. Gilchris, Industry 4.0: The Industrial Internet of Things, Apress, 1st Edition, 2017, ISBN-13: 978-1484220467

5. Reference Books:

a) Giacomo Veneri, and Antonio Capasso, Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0, Packt Publishing; 1st Edition, 2018, ISBN: 1789537223

b) Dilip Kumar Pratihar, Intelligent Autonomous Systems: Foundations and Applications, Springer-Verlag Berlin Heidelberg, 1st Edition, 2010, ISBN: 978-3-642-11676-6

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

a) Mapping of COs – POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	3	5	3	3	1	1
CO2	4	3	3	3	3	3	1	1
CO3	4	3	3	3	3	3	2	2
CO4	5	5	5	5	5	4	3	3
CO5	5	5	5	5	5	4	3	4
CO6	5	5	5	5	5	4	5	5

b) Mapping of COs - PSOs

	PSO-01	PSO-02	PSO-03	PSO-04	PSO-CPS-01	PSO-CPS-02
CO1	5	3	2	3	2	2
CO2	5	2	3	3	3	2
CO3	5	3	3	3	3	3
CO4	4	4	4	4	5	4
CO5	4	3	4	5	5	5
CO6	4	3	5	5	5	5

Digital Twins - Concepts and Applications

Specialization Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of this course is to give an overall understanding of Industry 4.0 latest technology- Digital Twins. Both theoretical and practical concepts of Digital Twins will be introduced to students with real time case studies. Students are expected to develop a Digital Twin solution using Embedded systems, IoT, control systems concepts to solve an industry case study by the end of this course.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Introduction to Industry 4.0- Industry 4.0 environment, Technologies transforming Industry 4.0, Understanding CPS and IoT;

   Unit – 2 [6 Hours]: Basic Concepts of Digital Twins-Definition and features; Digital Twins in Industry 4.0 - Real time usage of Digital Twins, Existing DT examples;

   Unit – 3 [6 Hours]: Building blocks of Digital Twins-Different planes in DT Data, Model and Service planes of a DT; Industry case study examples-Industry case study-1 & 2 with Data, Model and service plane details;

   Unit – 4 [6 Hours]: Digital Shadow-Introduction of Digital shadow, Example of Digital shadow; Digital Thread - Introduction of Digital shadow, Example of Digital shadow, Relation of Digital Shadow and Thread with DT;

   Unit – 5 [6 Hours]: Types of Digital Twins-Based on Product, process, Based on Functionality, Based on Maturity; Selecting the Digital Twins for an operation-Selecting the DT for an operation, Digital Twins: benefits and Applications;

   Unit – 6 [6 Hours]: Communication aspects of Digital Twin-Integration of heterogeneous subsystems in a DT - Introduction to OPC-UA, Work flow of OPC UA, Implementing an end to end OPC UA framework with MATLAB, Prosys server and UA clients; Digital Twin Use cases-Health care - Manufacturing domain, Predictive Maintenance, Anomaly detection, Automotive sector - Aerospace, Agriculture; Digital Twin opportunities-Role of AI/ML in Digital Twins, Summary and Future of DT: Future Digital Twins;

3. **Course Outcomes:**

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

   i) Ability to understand the Industry 4.0 and the relevance of CPS and IoT in it.

   ii) Ability to design, model and formulate a Digital Twin flow for an industrial problem statement.

   iii) Ability to develop a Digital shadow and threads for an industry subsystem

iv) Ability To develop a DT solution and analyse the performance and challenges

v) Ability to implement OPC UA for an Industry/project implementation

4. Text Books:

a) Mikel Armendia, Mani Ghassempouri, Erdem Ozturk, Flavien Peysson, Twin-Control: A Digital Twin Approach to Improve Machine Tools Lifecycle, Springer International Publishing, 2019, ISBN-10: 3030022021

b) Pieter van Schalkwyk, Digital Twins: The Ultimate Guide, Sep 2019

5. Reference Books:

a) Fei Tao, Meng Zhang, A. Y. C. Nee, Digital Twin: A Complete Guide For The Complete Beginner by Vijay Raghunathan, Santanu Deb Barma. Source: Amazon.in Digital Twin Driven Smart Manufacturing.

b) Fei Tao, Meng Zhang, A. Y. C. Nee, Digital Twin Driven Smart Manufacturing

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

a) Mapping of COs - POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	1	1	1	3	1	1	1
CO2	2	3	5	4	5	4	1	4
CO3	2	4	4	4	5	5	1	4
CO4	2	4	5	3	5	5	2	4
CO6	4	4	5	4	5	5	3	4

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-04	PSO-CPS-01	PSO-CPS-02
CO1	5	3	3	3	3	3
CO2	4	4	4	5	4	4
CO3	4	4	4	5	5	5
CO4	4	5	4	5	5	5
CO6	4	4	4	5	5	5

Specialization Elective Courses

B.Tech. (ECE) Programme with Specialization in Next Generation Wireless Communication

Advanced Wireless Communication

Specialization Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**

   The objective of this course is to go deep into the advanced concepts and modular technologies in the next generation LTE-based wireless communication system (4G and 5G). This course would be deal with Physical layer, link layer module. Further it would provide insights and an extensive analysis on the transmission and reception mechanisms for LTE and LTE-Advanced system.

2. **Syllabus:**

   Unit – 1 [6 Hours]: MIMO and Massive MIMO: Traditional wireless System (1x1), 2 x 2 System, 4 x 4 System, Maths behind TX and RX, Nmax Transmission, Receiving mechanism

   Unit – 2 [6 Hours]: OFDM, Non-Orthogonal multiple access (NOMA): Orthogonality, Mechanisms to achieve the same, Non orthogonal mechanisms, Effect on Multiple Access, Why NOMA

   Unit – 3 [8 Hours]: Multihop Communication: No. of hops, Math relation, Effect on Interference, Power relation, System Capacity

   Unit – 4 [6 Hours]: Ultra Wide Band, Cognitive Radio and Software Defined Radio: Modulation and Demodulation, Spectral Efficiency, Distance, Cognition, Intelligent Radio, Programmable Design

   Unit – 5 [4 Hours]: Self Organizing Networks (SON): Self Configuration, Self Healing and Self Optimization

   Unit – 6 [6 Hours]: TX-RX Chain Prototype: Modular implementation, Advantages, Challenges and Design Aspects

3. **Course Outcomes:**

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

   i) Comprhend the use of MIMO and the mechanism for Massive MIMO

   ii) Students will be able to demonstrate the use and advantages/ disadvantages of OFDM and NOMA system

   iii) Clearly articulate the benefits and Challenges of Multihop Transmission System

   iv) Students will be able to use new and programmable modulation schemes

   v) Students will be able to demonstrate the different aspects in automatically network organization

vi) Students will be able to design and simulate different modules for 1 GBps+ communication mechanism

4. Text Books:

a) H. Nikookar and R. Prasad, Introduction to Ultra Wideband for Wireless Communications, Springer 2009.

b) Emil Björnson, Jakob Hoydis and Luca Sanguinetti, Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency, Foundations and Trends in Signal Processing: Vol. 11: No. 3-4, 2017, http://dx.doi.org/10.1561/2000000093

5. Reference Books:

a) Y. Liu, Z. Qin and Z. Ding, Non Orthogonal Multiple Access for Massive Connectivity, Springer 2020

b) Multihop Cellular Networks, IEEE Communication Magazine, Vol. 45, September 2007

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

a) Mapping of COs – POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	3	5	3	3	1	3
CO2	4	3	4	3	4	3	1	3
CO3	4	3	3	4	3	3	2	3
CO4	5	5	5	5	5	4	3	4
CO5	5	5	5	5	5	4	4	4
CO6	5	5	5	5	5	4	5	4

b) Mapping of COs – PSOs:

	PSO-01	PSO-02	PSO-03	PSO-04	PSO-NGW-01	PSO-NGW-02
CO1	5	3	2	3	3	3
CO2	5	2	3	3	3	3
CO3	5	3	3	3	3	4
CO4	4	4	4	4	5	4
CO5	4	3	4	5	5	5
CO6	4	3	5	5	5	5

5G Technologies and Applications

Specialization Elective

L-T-P-C: 2-1-0-3

1. **Course Objectives:**
   The objective of the course is to give a basic understanding of the 5G concepts and use cases. This course also provides the holistic view and the benefits in applications like IoT. Students are expected to know the latest technologies and challenges in 5G technology

2. **Syllabus:**
   Unit – 1 [6 Hours]: Introduction to 5G - Concepts from 4G and Applications, Historical Trend of Wireless Communications, Evolution of LTE Technology to Beyond 4G, 5G Roadmap, 10 Pillars of 5G, Evolution of Existing RATs, Hyperdense Small Cell Deployment, Developing Millimetre Wave RATs, Redesigning Backhaul Links, Allocation of New Spectrum for 5G, Spectrum Sharing, RAN Virtualisation, 5G Infrastructure PPP, 5G Architecture;

   Unit – 2 [6 Hours]: 5G internet - Internet of Things and Context Awareness, Networking Reconfiguration and Virtualisation Support, Mobility, An Evolutionary Approach from the Current Internet, Quality of Service Control, Network Resource Provisioning, Aggregate Resource Provisioning, Control Information Repository, Service Admission Control Policies, Network Resource Provisioning, Network Configurations;

   Unit – 3 [6 Hours]: Small Cells for 5G Mobile Networks - Small Cells, WiFi and Femtocells as Candidate Small Cell Technologies, Capacity Limits and Achievable Gains with Densification, Gains with Multi Antenna Techniques, Gains with Small Cells, Approach and Methodology, Demand vs Capacity, Small Cell Challenges;

   Unit – 4 [6 Hours]: Cooperation for Next Generation Wireless Networks - Cooperative Diversity and Relaying Strategies, Cooperation and Network Coding, Cooperative ARQ MAC Protocols, PHY Layer Impact on MAC Protocol Analysis, Impact of Fast Fading and Shadowing on Packet Reception for QoS Guarantee, Impact of Shadowing Spatial Correlation;

   Unit – 5 [6 Hours]: Mobile Clouds - Technology and Services for Future Communication Platforms, Mobile Cloud, User Resources, Software Resources, Hardware Resources, Networking Resources, Mobile Cloud Enablers, The Mobile User Domain, Wireless Technologies, Software and Middleware, Network Coding;

   Unit – 6 [6 Hours]: Case Studies and Course Project - Connected Vehicles, HealthCare, Industrial Networking;

3. **Course Outcomes:**
   At the end of the course,
   i) Students will be able to explain the transition from 4G to 5G
   ii) Students will be able to draw the interdependencies of IoT applications on 5G technologies

iii) Students will be able to arrive at the small cell architecture with a clear idea of performance gains
iv) Student will be able to analyse the effect of PHY and MAC layer aspects on Packet recception and QoS
v) Student will be able to estimate the user, software and hardware resources in a cloud environment
vi) Student will be able demonstrate understanding of 5G concepts through an Industry relevant course project

4. Text Books:

a) Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley publications, June 2015, ISBN: 978-1-118-86752-5
b) Afif Osseiran, Ericsson, Jose F. Monserrat, Universitat Politècnica de València, Patrick Marsch, 5G mobile and wireless communications technology, June 2nd 2016, ISBN: 9781107130098

5. Reference Books:

a) Haesik Kim, Design and Optimization for 5G Wireless Communications, John Wiley & Sons Ltd, 15 April 2020, ISBN:9781119494553
b) Saad Asif, 5G Mobile Communications: Concepts and Technologies, 6 September 2018, CRC Press, ISBN-10: 1498751555

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes:

a) Mapping of COs – POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	2	2	1	2	3	2	1
CO2	4	3	2	2	5	3	4	1
CO3	3	4	3	2	3	3	3	2
CO4	3	3	4	3	3	3	4	2
CO5	4	4	4	4	4	3	4	4
CO6	5	5	5	5	5	4	5	2

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-04	PSO-NGW-01	PSO-NGW-02
CO1	4	1	2	3	3	3
CO2	4	5	5	4	3	3
CO3	2	2	2	2	4	4
CO4	2	2	2	2	4	4
CO5	3	4	4	4	5	5
CO6	5	5	5	5	5	5

SSHAM Courses
of the B.Tech. (CSE) Programme

SSHAM (Skill, Science, Humanities, Aptitude, and Management) Course:

i) Essential English for Communication (bridge course)
ii) Operational Communication
iii) Professional Communication
iv) Advanced Communication Skills
v) Foundations in Human Values and Ethics
vi) Energy and Environment
vii) Bioinformatics
viii) Skills for Employability
ix) Quantitative and Reasoning Aptitude
x) Personal Growth Programme
xi) Macro-economics and Personal Finance
xii) IT Project Management
xiii) Innovation and Entrepreneurship
xiv) Climate Change and its Implications
xv) ICTs for Development

Essential English for Communication

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   - To help learners to work on their grammar and vocabulary
   - To enable learners to improve their listening, speaking, reading and writing to enhance their fundamental communication in English

2. **Syllabus:**

   Unit – 1 [4 Hours]: Building confidence, Self-introduction, Writing and speaking about everyday activities,
   Pronunciation and accent

   Unit – 2 [4 Hours]: Tenses, Writing and talking about past events, Describing events

   Unit – 3 [4 Hours]: Building vocabulary, Modal verbs, Listening (global, factual, inferential), Listening and talking about the gist

   Unit – 4 [4 Hours]: Reading skills (Skimming and scanning), Reading and talking about the content

   Unit – 5 [4 Hours]: Writing short paragraphs, Writing short biographies

   Unit – 6 [4 Hours]: Writing a descriptive essay, Writing short argumentative paragraphs, Voicing opinions and arguments

3. **Course Outcomes:**
   a) Learners will be able to introduce themselves and talk about everyday activities confidently
   b) Learners will be able to identify the purposes of using various tenses and effectively employ them in speaking and writing
   c) Learners will be able to compile words, phrases and idioms and use them appropriately in their oral and written communication
   d) Learners will be able to read for specific information and for overall comprehension and will be able to summarise the ideas in oral and written forms
   e) Learners will be able to write short paragraphs on people, places and events
   f) Learners will be able to write descriptive essays and respond to arguments orally and in writing

4. **Text Books:**
   a) Andrew Thompson, Essential English Communication: Student Book, 2016, Think International Communication, Japan.
   b) Michelle Finlay, Everyday English: Getting to Grips with the Basics of the Language, 2015, Michael O'Mara.

5. Reference Books:

a) Herbert Hirsch, Essential Communication Strategies: For Scientists, Engineers, and Technology Professionals, 2nd edition, Wiley-IEEE Press, 2007

b) Sarah Cunningham and Peter Moor, Cutting Edge, 2016, Pearson Education Limited.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

c)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	1	1	2	1	4
CO2	1	1	2	1	2	2	1	5
CO3	1	1	2	1	2	2	1	5
CO4	1	1	2	1	2	2	1	5
CO5	1	1	2	1	2	1	1	5
CO6	1	1	2	1	2	3	1	5

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	1	1	2	1	4
CO2	2	1	1	1	2	2	1	5
CO3	2	1	1	1	2	2	1	5
CO4	2	1	1	1	2	2	1	5
CO5	2	1	1	1	2	1	1	5
CO6	2	1	1	1	2	3	1	5

Operational Communication

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   - To introduce essential skills of communication in English
   - To enable learners use these skills effectively in academic and non-academic contexts

2. **Syllabus:**

   Unit – 1 [4 Hours]: Informal and formal introduction (self-others), Greetings and conversational etiquette, Pronunciation and accent

   Unit – 2 [4 Hours]: Common mistakes made by Indian English speakers, Spotting errors and rectifying them in oral and written communication

   Unit – 3 [4 Hours]: Asking for and giving information, Listening to and giving instructions; Communicative Strategies: Face to face communication – social and personal

   Unit – 4 [4 Hours]: Describing products and processes, Writing reviews, Design a theme based posters and brochures

   Unit – 5 [4 Hours]: Email etiquette, Writing Emails and Letters

   Unit – 6 [4 Hours]: Word Building- phrases, idioms, collocations, Abbreviations
   Note Taking, Note Making, Summarizing, Precise Writing, Notices, Memorandums, Agenda, minutes

3. **Course Outcomes:**
   a) Learners will be able to orally introduce themselves and others in formal and informal contexts
   b) Learners will be able to identify and eliminate common mistakes in writing and speaking
   c) Learners will understand and respond to instructions and will be able to provide clear written and oral instructions and information
   d) Learners will be able to write subjective and objective descriptions
   e) Learners will be able to write effective emails following the etiquettes
   f) Learners will be able to create their digital profile following the netiquette

4. **Text Books:**
   a) Lewis Lansford; Peter Astley, Oxford English for Careers: Engineering 1: Student's Book, 2013, Oxford University Press.
   b) Raman, Meenakshi and Prakash Singh, Business Communication, 2nd ed, 2011, OUP. New Delhi.

5. **Reference Books:**
   a) Emmerson, Paul, Email English, 2013 Macmillan, London.

b) Peter Astley, Lewis Lansford, Oxford English for Careers: Engineering 1 Teacher's Resource Book, 2014, Oxford

5. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	2	1	1	3	1	5
CO2	1	1	2	1	2	3	1	5
CO3	1	1	1	1	2	3	1	5
CO4	1	1	1	1	1	3	1	5
CO5	1	1	3	1	2	3	1	5
CO6	1	1	3	1	2	3	1	5

c)

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	1	1	1	3	1	5
CO2	2	1	1	1	2	3	1	5
CO3	3	1	1	1	2	3	1	5
CO4	3	1	1	1	2	3	1	5
CO5	3	1	1	1	2	3	1	5
CO6	3	1	1	1	2	3	1	5

Professional Communication

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   - To introduce learners to various aspects of interpersonal and social media communication
   - To enable learners use communication skills effectively in academic and non-academic contexts

2. **Syllabus:**

   Unit – 1 [4 Hours]: Preparing a short formal speech, Techniques of narration

   Unit – 2 [4 Hours]: Johari Window, Making Mind Maps

   Unit – 3 [4 Hours]: Learning to introduce new concepts, Writing user manuals, Listening to and interpreting lectures

   Unit – 4 [4 Hours]: Data interpretation- presentations, news reports and analysis; Presenting reports which have graphic information; Reading news articles, columns, magazines, reports, graphics; Oral and written interpretation of graphic information

   Unit – 5 [4 Hours]: Learning netiquette, Blogging/ posting on Social media, Formal and informal social media use, Critical language use on social media platforms, Creating a digital profile, Preparing for online meetings

   Unit – 6 [4 Hours]: Identifying the main and supporting points and following the sequence of ideas in a spoken text, Recognizing indicators to determine the writer's style, tone and point of view, Writing persuasive essays showing awareness of style vis-a vis the purpose of writing and the intended audience, Techniques of negotiation and persuasion in speaking

3. **Course Outcomes:**
   a) Learners will be able to prepare short speeches for formal contexts
   b) Learners will be able to overcome anxieties in communication and will be able to work as a team for brainstorming
   c) Learners will be able to comprehend and interpret lectures and verbal reports
   d) Learners will be able to analyse and orally and in writing interpret infographics
   e) Learners will be able to use various business communication strategies and to use advanced vocabulary
   f) Learners will be able to identify authorial intention in writing and in speech and they will be able to negotiate and persuade in speaking contexts

4. **Text Books:**
   a) David Bonamy, Technical English Level 2 Course Book, 2013, Pearson
   b) Mark Ibbotson, Cambridge English for Engineering, 2008, Cambridge University Press.

5. Reference Books:

a) Mark Ibbotson, Professional English in Use, Cambridge University Press, 2009
b) Sharma, R.C and Mohan, Krishna, Business Correspondence and Report Writing, 2017, McGraw Hill Education. New Delhi.

5. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

c)

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	3	1	1	4	1	5
CO2	1	1	3	1	2	5	1	5
CO3	1	1	3	1	2	3	1	4
CO4	1	1	3	1	2	4	1	4
CO5	1	1	3	1	2	5	1	5
CO6	1	1	3	1	2	5	1	5

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	1	1	4	1	5
CO2	3	1	1	1	2	5	1	5
CO3	3	1	1	1	2	3	1	4
CO4	3	1	1	1	2	4	1	4
CO5	3	1	1	1	2	5	1	5
CO6	3	1	1	1	2	5	1	5

Advanced Communication Skills

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   - To develop learners' lateral thinking ability and to promote interpersonal oral and written communication
   - To enhance their professional communication skills to prepare them for the communicative demands of the industry

2. **Syllabus:**

   Unit – 1 [4 Hours]: Understanding cross cultural communication, Assertive and aggressive communication, Managing emotional steadiness in aggressive communication contexts

   Unit – 2 [4 Hours]: Body language in various contexts, Culture and body language Proximity, Do's and Don'ts

   Unit – 3 [4 Hours]: Critical Thinking and Creative Writing, Introduction to critical Thinking, Benefits, Barriers, Reasoning, Deductive and inductive Arguments, inferential comprehension, Critical thinking and academic writing

   Unit – 4 [4 Hours]: Differentiating arguments and opinions, Exploratory writing and argumentative writing

   Unit – 5 [4 Hours]: Understanding the contexts and needs for the technical reports Reading and analysing sample technical reports, Understanding the components of a technical reports, Writing technical reports

   Unit – 6 [4 Hours]: Basic presentation skills, Choosing the medium, structuring presentation, Clarity, brevity, interaction

3. **Course Outcomes:**

   a) Learners will be able to demonstrate competence in cross cultural communication
   b) Learners will be able to use gestures and other non-verbal communication strategies effectively in formal and informal contexts
   c) Learners will be able to critically analyse and evaluate situations and communicate proficiently
   d) Learners will be able to argue their case following the etiquettes
   e) Learners will be able to write and analyse technical reports
   f) Learners will be able to make short academic presentations with clarity using various medium and persuade in speaking contexts

4. **Text Books:**

   a) Talbot, Marianne and Chris Wood, Critical Reasoning: A Romp Through the Foothills of Logic for Complete Beginners, 2014, OUP, UK.
   b) Gill Hasson, Brilliant Communication Skills: What the Best Communicators Know, Do and Say, 2012, Ft Pr.

5. Reference Books:

a) Dwyer, J., Communication for Business and the Professionals: Strategies and Skills, 2015, Pearson Education, Melbourne.

b) Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler, Crucial Conversations: Tools for Talking When Stakes Are High, 2013, Brilliance Audio.

5. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

c)

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	3	1	1	5	1	5
CO2	1	1	3	1	1	5	1	5
CO3	3	1	4	1	2	5	1	5
CO4	1	1	3	1	3	4	3	5
CO5	3	1	3	1	2	5	1	5
CO6	1	1	3	1	2	5	1	5

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	1	1	5	1	5
CO2	3	1	1	1	1	5	1	5
CO3	4	1	1	3	2	5	1	5
CO4	3	1	1	1	3	4	3	5
CO5	3	1	1	3	2	5	1	5
CO6	3	1	1	1	2	5	1	5

Foundations in Human Values and Ethics

L-T-P-C: 2-0-0-2

1. **Course Objectives:**

To equip students with life skills (as defined by WHO and UNICEF) which are vital to effectively tackle the challenges of 21st century and with soft skills such as interpersonal relations, decision making, time management, team skills, communication and leadership which raises the employability factor and also the skills which will make them more dynamic and entrepreneurial in nature. To equip students with practical tools and techniques that will make them more creative, efficient, confident, clear minded , stress free, joyful and energetic and come out of depression, suicidal tendencies, addictions, anger. aggression, violent tendencies, anxiety and fear. To instil human values, ethics, moral values and integrity.

2. **Syllabus:**

Unit – 1 [4 Hours]: Self-awareness / Mindfulness and Mind Management: The Seven Levels of Existence - Sources of Energy - Prana and the Breath-Energy and the Mind - Focus and Concentration - Sleep and Its Effect on the Body/Mind Complex - Bringing the Mind to the Present - Discipline and the Mind - The Tendencies of the Mind - Dealing with regret in the past and anxiety in the future - Importance of Being 100%-Inevitability of the Present Moment - Focus and Commitment

Unit – 2 [4 Hours]: Coping with Stress and Coping with Emotions / Emotional Intelligence: Sources of Stress - Stress and the Body-Stress and the Mind-Stress and the Emotions - What is Stress? - Physiology and Stress - Overview of Techniques for Stress Reduction - Techniques and their Effect on Physiology and Psychology - The Role of the Breath-Rhythms of the Breath and their Relation to Emotions - Emotions and the Sympathetic and Parasympathetic Nervous System - Techniques to manage emotions by managing the breath

Unit – 3 [4 Hours]: Interpersonal Relationship Skills and Effective Communication Skills: The Modes of Acceptance - Advantages/Disadvantages - The Complementary Nature of Opposite Values - Judgement and Acceptance - Dealing with People's Opinions - Roles in Life - Responsibility - Service – Impacting our Communities and the World - Being sensitive & Sensible - Your state of mind matters - Humor coupled with care & concern - Types of communication - Communication beyond words - Being a good listener.

Unit – 4 [4 Hours]: Health & Nutrition - Lifestyle & Environment: Wellness Guide-Aligning with Nature - Physical & Mental Health - Food: Types of Food and Its Effect on the Body and Mind - Science of Meditation and its Impact on Mental Wellness - Nature of Habits-How to Develop Good Habits/Break Bad Habits - Dealing with Parents, Society and Peer Pressure - Sex and Its Impact on the Body, Mind and Emotions - Drugs and Alcohol and their Effects on the Body, Mind, and Emotions - Life Choices and the Environment - Direct Application: Life Choices and Team Dynamics - Direct Application: Break Your Own Bad Habits

Unit – 5 [2 Hours]: Ethics, Morality and Integrity: Difference between Ethics, Morals and Integrity - Convergence of Sensibility and Sensitivity - Ethics as a Fundamental Necessity

in Society- Case Study - Non-adherence leading to major Economic Crises worldwide- Case Study - Successful Role Models who have integrated Ethics as a way of life-Role of ethical youth as future Leaders in shaping the Nation

Unit – 6 [6 Hours]: Time Management and Goal Setting - Active Learning & Learning Strategies - Decision Making: Types and Characteristics of activities - Typical nature of reaction to various activities - Planning and Discipline – Urgent and Important Time Matrix-Activity to review participants time spent on various activities - The 5 aspects of learning - Lifelong learning-Learning & Mistakes - 3 Levels of knowledge-Role of Intuition - Barriers to Learning - The Art of making Correct Decisions - Long term vs. Short term Planning - Clarity of Mind – Dealing with Confusion - Decision making and Intuition - Goal-setting and Prioritization

3. Course Outcomes:

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

a) To maintain high energy levels, bring the mind to present moment, concentrate with a relaxed and happy state of mind resulting in increased levels of efficiency.
b) To handle the mind, manage the emotions, eliminate stress and maintain healthy body & mind.
c) To maintain equilibrium in adverse situations, deal with people and situations without losing peace of mind, increase the horizons of responsibility with the vision of one world family, making communication more effective with humour and being a good listener.
d) To develop a wellness guide thereby regularizing biological clock, follow an appropriate diet suitable to one's nature, become aware of the various aspects to be healthy, choose life choices so as to contribute positively to the environment, gives an understanding on how to deal with parents and also to handle peer pressure.
e) To play the role of future leaders in shaping the nation and also brings the ability to be both sensible and sensitive.
f) To prioritize the activities, identify time wasters and barriers to learning, manage the time effectively, set the goals, understand any concept through active learning, use intuitive power for an effective decision making.

4. Text Books:

a) Ravi Shankar, Wisdom for the New Millennium, 2006, Jaico Publishing House, ISBN: 978-8179923702
b) Stephen R. Covey , A. Roger Merrill, First Things First – Time Management, 1996, ISBN: 978-0684802039

5. References:

1. http://web.mit.edu/yesplus/www/Home.html
2. https://www.researchgate.net/publication/279753401_Anti-anxiety_efficacy_of_Sudarshan_Kriya_Yoga_in_general_anxiety_disorder_

A_multicomponent_yoga_based_breath_intervention_program_for_patients_suffering_from_generalized_anxiety_disorder_with_or_witho

3. https://www.artofliving.org/wisdom/emotion al-intelligence
4. https://online.hbs.edu/blog/post/leadership-communication
5. https://www.indeed.com/career-advice/career-development/covey-time-management-matrix
6. https://hbr.org/2020/01/time-management-is-about-more-than-life-hacks
7. https://hbr.org/topic/decision-making
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3573542/

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	5	1	5	5	4	5
CO2	5	1	5	1	5	5	4	5
CO3	5	1	4	1	5	5	5	5
CO4	3	1	2	1	2	3	2	3
CO5	2	1	2	1	2	3	5	4
CO6	5	1	5	1	5	5	4	5

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	2	2	5	5	5	4	5
CO2	5	2	2	5	5	5	4	5
CO3	5	2	2	5	5	5	5	5
CO4	2	1	1	2	3	2	2	3
CO5	4	2	2	4	4	4	5	4
CO6	5	2	3	5	5	5	4	5

Energy and Environment

L-T-P-C: 2-0-0-2

1. **Course Objectives:**

   The objective of the course to teach the principal renewable energy systems. The environmental impact of various energy sources and the effects of different types of pollutants will be explored.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Present Energy resources in India and its sustainability: Different type of conventional Power Plant, Energy Demand Scenario in India, Advantage and Disadvantage of conventional Power Plants, Conventional vs Non-conventional power generation.

   Unit – 2 [4 Hours]: Basics of Solar Energy: Solar Thermal Energy; Solar Photovoltaic: Advantages and Disadvantages, Environmental impacts and safety.

   Unit – 3 [4 Hours]: Wind Energy: Power and energy from wind turbines, India's wind energy potential, Types of wind turbines, Offshore Wind energy, Environmental benefits and impacts.
   Unit – 4 [4 Hours]: Biomass Resources: Biomass conversion Technologies, Feedstock pre-processing and treatment methods, Bioenergy program in India, Environmental benefits and impacts; Other energy sources: Geothermal Energy resources, Ocean Thermal Energy Conversion, Tidal Energy.

   Unit – 5 [4 Hours]: Air pollution: Sources, effects, control, air quality standards, air pollution act, air pollution measurement; Water Pollution: Sources and impacts; Soil Pollution: Sources and impacts, disposal of solid waste; Noise pollution.

   Unit – 6 [4 Hours]: Greenhouse gases: effect, acid rain;Pollution aspects of various power plants; Fossil fuels and impacts, Industrial and transport emissions impacts.

3. **Course Outcomes:**
   a) Ability to describe the principal energy sources and the current energy systems in India.
   b) Ability to contrast between different energy systems, their advantages and disadvantages.
   c) Ability to comprehend the impacts of using different energy resources.
   d) Ability to explain environmental pollution sources and methods to avoid them.

4. **Text Books:**
   a) Boyle G, Renewable energy: Power for a sustainable future. Oxford University press, 2004.
   b) B H Khan, Nonconventional Energy Resources, The McGraw –Hill Second edition.

5. Reference Books:

a) G. D. Rai, Nonconventional energy sources, Khanna Publishers, New Delhi, 2006.
b) Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 2003.
c) G Sargsyan, M Bhatia, S G Banerjee, K Raghunathan and R Soni, Unleashing the Potential of Renewable Energy in India, World bank report, Washington D.C, 2011.
d) Godfrey Boyle, Bob Everett and Janet Ramage, Energy Systems and Sustainability: Power for a sustainable future. Oxford University press, 2010.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	3	2	2	1	4	1
CO2	3	1	4	2	2	2	5	2
CO3	3	1	4	3	3	2	5	2
CO4	3	1	4	4	5	2	5	2

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	2	2	1	4	1
CO2	4	2	1	3	2	2	5	2
CO3	4	2	1	3	3	2	5	2
CO4	4	3	1	3	5	2	5	2

Bioinformatics

L-T-P-C: 2-0-0-2

1. **Course Objectives:**

   The objective of the course is to enable students to understanding basic molecular biology principles; various biological data available for prediction and analysis; requirement or development of new computational methods that could analyze biological data with greater accuracy and make predictions.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction to the central dogma- DNA Proteins and RNA - Scope of Bioinformatics- DNA sequence databases- Sequence retrieval from databases- Sequencing – DNA sequencing, Genomic sequencing, cDNA sequencing,
   DNA Sequences and analysis- Submission of sequences to Databases-Accuracy of the deposited sequences- Sequence formats

   Unit – 2 [4 Hours]: Sequencing – DNA sequencing, Genomic sequencing, cDNA sequencing, DNA Sequences and analysis- Submission of sequences to Databases-Accuracy of the deposited sequences- Sequence formats

   Unit – 3 [4 Hours]: Comparing sequences- Alignment of a pair of sequences -Algorithms, Local and global alignment- Multiple Sequence Alignment-Methods Dot matrix or diagram method for comparing sequences, Dynamic programming methods - Multiple sequence alignment [MSA]- Genome sequencing- Uses of MSA- Scoring and Progressive methods –Iterative methods Statistical analysis - Gene Prediction-Replication- fixing DNA errors, introducing mutations, natural selection

   Unit – 4 [4 Hours]: Database search for similar sequences- Scoring matrices, PAM, BLOSUM, FASTA- Gene prediction- DNA to protein code- triplet code to 20 amino acid Code-Predicting the sequence of protein from DNA- Complexity involved in solving the problems from a prokaryotic versus eukaryotic system

   Unit – 5 [4 Hours]: Protein structure classification- Secondary Structure Elements-Dynamic Programming Approaches-Distance matrix and Protein Structure analysis-domain search, 3D structure prediction - Genome complexity and analysis- SNPs and genetic disorders, genome rearrangements, Global gene regulation, Gene order, Prediction of gene function using composite analysis

   Unit – 6 [4 Hours]: Molecular evolution - Clustering and trees- Phylogenetic Analysis-Discovery of Evolutionary relationships using sequence information - Maximum Parsimony method, Distance methods - Maximum Likelihood approach- Sequence alignment based on an evolutionary model- Reliability of phylogenetic predictions.

3. Course Outcomes:

At the end this course, student should be able to

a) Explicitly explain the steps involved in the central dogma
b) Explain the algorithm of sequencing technologies, advantages and disadvantages of classic versus next generation sequencing technologies
c) Compare and interpret closely matched sequences and variations.
d) Decode or interpret the sequences
e) Think Beyond sequence - Understanding the significance of 3D structure
f) Apply the concepts to understand evolution

4. Text Books:

a) David Mount, Bioinformatics: Sequence and Genome Analysis, 2nd edition, 2004, ISBN: 978-0879697129

5. Reference Books:

a) Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, 2004, ISBN: 978-0262101066

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	4	3	3	2	1	1
CO2	4	3	5	5	4	2	1	1
CO3	2	3	5	4	3	2	1	1
CO4	4	3	4	5	4	2	1	1
CO5	4	3	4	5	4	2	1	1
CO6	4	3	4	3	4	5	5	5

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	1	2	2	3	2	1	1
CO2	5	1	4	4	4	2	1	1
CO3	5	1	4	2	3	2	1	1
CO4	4	1	4	4	4	2	1	1
CO5	4	1	4	4	4	2	1	1
CO6	4	2	4	4	4	5	5	5

Skills for Employability

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   The objective of the course is To enhance the employability skills and career skills of learners and to orient the learners towards grooming as professionals.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction to soft skills for employability, Employing soft skills

   Unit – 2 [4 Hours]: Introducing group discussions, Types of group discussions, Techniques of group discussion: verbal / non – verbal, Practicing group discussions

   Unit – 3 [4 Hours]: Features of Resume and CV (SWOT Analysis), Types of Resume and CV (formats), Writing resume, Components of an ePortfolio, creating an ePortfolio

   Unit – 4 [4 Hours]: Writing cover letters, Writing SoPs

   Unit – 5 [4 Hours]: Interview Skills (telephonic, face to face, video conferencing), Dos and Don'ts during interviews, STAR (Situation, Task, Action, Result), Preparing for the interviews (strategies)

   Unit – 6 [4 Hours]: Introduction to presentation skills, Modes of presentation, Planning a presentation, Making presentations

3. **Course Outcomes:**
   a) Learners will be able to acquire and demonstrate soft skills
   b) Learners will be able to generate ideas and politely engage in group discussions
   c) Learners will be able to write an effective resume and CV
   d) Learners will be able to write cover letters and SoPs
   e) Learners will be able to acquire interview skills and demonstrate them in context
   f) Learners will be able to make effective academic presentation individually and in groups

4. **Text Books:**
   a) Kate Baade, Michael Duckworth et al, Business Result: Student's Book, 2008, Oxford University Press.

5. **Reference Books:**
   a) David Bonamy, Technical English, 2013, Pearson Education Limited.
   b) Daniel Kahneman Thinking fast and slow, 2012, Penguin Press.
   c) Ryan Holiday, Ego is the enemy, 2016, Penguin Press.
   d) Daniel Coleman, Emotional Intelligence, 1995, Bantam Books.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	1	3	4	4	2
CO2	3	2	3	1	2	4	2	4
CO3	1	1	2	1	1	1	1	1
CO4	1	1	1	1	1	1	1	1
CO5	3	2	2	2	4	2	2	3
CO6	2	1	1	2	4	2	1	3

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	2	3	3	4	4	2
CO2	1	3	1	4	4	4	2	4
CO3	1	2	1	3	3	1	1	1
CO4	1	2	1	2	1	1	1	1
CO5	2	3	1	3	4	2	2	3
CO6	2	3	1	2	3	2	1	3

Quantitative and Reasoning Aptitude

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   The purpose of this course is to to enhance problem solving ability through analysing the given data and finding the solutions for real world problems and introduce real time problems through aptitude techniques and to make students predict future outcomes with supportive evidence, through inductive reasoning. To make the students learn the short tricks in numbers and other quantitative concepts that help them in campus placements and other competitive exams.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Arithmetic Aptitude: Divisibility , Co Prime Factor pairs, Short cuts to find Squares, cubes, square roots, cube roots - 2 digit & 3 digit numbers, Divisibility, CPFP, Factors, Remainder Concepts, Training zeroes, Unit's digit, last 2 digits, Surds, Indices, Bridging components, Ratios, Proportions, Mixtures.

   Unit – 2 [5 Hours]: Commercial Math & Inductive Reasoning: Percentage expressions, Percentage change, Net percentage change, Profit, Loss, Discounts, Mark ups, Averages, Partnership, Salary based problems, Data handling, Blood relations, Seating Arrangement.

   Unit – 3 [3 Hours]: Time Relativity: Time reference, Distance reference, Componendo & Dividendo concepts, Trains, Boats & Streams, Races, Chain rule, And / Or Concept, Efficiency, Comparisons, Pipes & Cisterns.

   Unit – 4 [3 Hours]: Probability, P & C's, Spatial Aptitude: Probability - Basic Definitions & Concepts, Theorems of Probability and their applications, Expected value, Permutation and Combination - Fundamental principle of counting, And - Or Simplification, Together and never concepts, at least and at most approach to solve problems.

   Unit – 5 [4 Hours]: Geometry & Logarithm: Lines & Angles, Parallel lines, Triangle Properties, Heights & Distances, Triangles, Quadrilaterals, Regular polygons, Circles, Rectangular solids, Prisms and Spheres, Logarithm – Basic problems and smart tricks.

   Unit – 6 [5 Hours]: Logical Connectives: Syllogisms, Venn diagrams, Symbols & notations, Coding Decoding, Letter & Number – Series and Analogy, Data Interpretation & Data Sufficiency, Inequalities, Crypt arithmetic and Flowcharts.

3. **Course Outcomes:**
   a) Ability to understand the smart tricks in calculation, number relativity, and will be able to relate the techniques and solve problems in stipulated time allotted for each question
   b) Ability to identify standard and variable data and apply percentage concepts to calculate commercial values and will be able to apply inductive reasoning to find the rule-set from a given list of observations and use it to predict the future outcomes and will be familiar to choose the solving techniques accordingly.

c) Ability to develop problem solving ability through analysing the given data and finding the solutions for real world problems based out of time, wages, work concepts, travelling distance and speed, trains travel, upstream and downstream concepts.
d) Ability to understand the techniques in arranging and selecting numbers or alphabets with given conditions and to bring out possible outcomes of an event.
e) Ability to identify the fundamental principles and apply the hints to calculate areas, volumes, surface areas and measurements.
f) Ability to analyse and find out the hidden logic behind the given analogy and series, apply that logic to find solutions in terms of number, letters and symbols. Interpret the data and calculate with smart tricks, check the number analytics to fit the alphabets and derive solutions based on given conditions.

4. Text Books:

a) Quantitative Aptitude by Arun Sharma, McGraw Hill.
b) Logical Reasoning, Arun Sharma, McGraw Hill.

5. Reference Books:

a) The Pearson Guide to Quantitative Aptitude for Competitive Examinations by Dinesh Khattar, Pearson
b) Analytical & Logical Reasoning, Peeyush Bhardwaj, Arihant Publications.
c) Quantitative Aptitude Quantum CAT by Sarvesh K Verma, Arihant Publications.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	4	2	3	1	1	1
CO2	4	3	3	2	3	1	1	1
CO3	3	2	4	3	4	1	1	1
CO4	3	2	3	2	3	1	1	1
CO5	3	2	4	2	3	1	1	1
CO6	4	3	5	3	3	2	1	1

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	2	2	3	3	1	1	1
CO2	3	2	2	4	3	1	1	1
CO3	4	3	3	3	4	1	1	1
CO4	3	3	2	3	3	1	1	1
CO5	4	3	2	3	3	1	1	1
CO6	5	3	3	4	3	2	1	1

Personal Growth Programme

L-T-P-C: 1-1-0-2

1. **Course Objectives:**

   To increase awareness about one's own behaviour and its impact on interpersonal effectiveness in the fast-paced dynamic environment. To provide insights into the needs and emotions of people and offer knowledge, skills and techniques to build relationships, collaborate and adapt to demanding situations while pursuing goals. To explore various behavioural concepts and its applications that set an agenda for self-development.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Personal Growth, Scope, Personal Change, Self-esteem, SMART Goals, Intrinsic and Extrinsic motivation, life roles, balancing life roles.

   Unit – 2 [4 Hours] Communication styles, Dimensions of Normal Behaviour, Characteristics, strengths and development needs, identifying my effective and ineffective styles reflection and action planning.

   Unit – 3 [4 Hours]: Ego States, types, interpersonal transactions, strokes, Johari Window, self-disclosure and giving feedback, applications, reflection and action planning

   Unit – 4 [4 Hours]: Emotional Intelligence (EQ) VS Intelligence Quotient, dimensions of EQ, managing emotions, Interpersonal relationships and its dimensions, reflection and action planning.
   Unit – 5 [4 Hours]: Conflict styles, sources of conflict, conflict resolution techniques, building Trust, Elements of Self Trust, Relationship trust, trust building behaviours.

   Unit – 6 [4 Hours]: Managing Time, planning and prioritization, Creating Win-Win situations, problem solving and idea generation technique, blocks to creativity. Action planning

3. **Course Outcomes:**
   a) Ability to understand and realise that personal growth starts from "with-in", identify drivers for personal change, understand SMART goals, balance life roles and identify barriers in achieving goals.
   b) Ability to understand effective and ineffective communication and behavioural styles, its characteristics, strengths and improvement areas to develop self
   c) Ability to understand ego states, its impact on interpersonal relationships, develop knowledge and skills to give feedback and disclose information to others in a group.
   d) Ability to understand the impact of emotions on behaviour and performance, learn empathetic communication and apply transactional analysis technique to building rapport.
   e) Ability to understand conflict styles, identify sources of conflict and to resolve them. Awareness of how lack of self-trust strains relationships and apply critical behaviours that build trust.

f) Ability to analyse how procrastination, lack of planning and prioritization defeat attaining goals. Ability to separate emotions from facts and apply creative thinking in problem solving situations.

4. Text Books:

a) Covey, Stephen M. R., The Speed of Trust. London, 2008, England: Simon & Schuster

b) Covey, S., The seven habits of highly effective people: Restoring the character ethic, 1989, New York: Simon and Schuster

c) Goleman, D., Emotional intelligence: Why it can matter more than IQ, 1995, New York: Bantam Books

5. Reference Books:

a) Edward De Bono, Six Thinking Hats, 2017, Penguin Books

b) Berne, E. (1964). Games people play: The psychology of human relationships., 1964

c) Frankl, V., Man's search for meaning, 2006, Boston: Beacon Press.

d) Anisa Marku, The Art of Setting Smart Goals: Set winning goals and live a life of abundance, success, and achievement. 2019, Google Digital Version

e) William Moulton Marston, Emotions of Normal People, 1979, I Edition, Persona Press

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	2	1	1	3	1	1
CO2	1	1	2	1	1	4	2	4
CO3	1	1	1	1	1	4	3	4
CO4	1	1	1	1	1	4	3	1
CO5	2	1	1	1	1	4	3	1
CO6	4	2	2	1	2	2	1	1

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	1	2	1	3	1	1
CO2	2	1	1	1	1	4	2	4
CO3	1	1	1	1	1	4	3	4
CO4	1	1	1	1	1	4	3	1
CO5	1	1	1	2	1	4	3	1
CO6	2	1	1	4	2	2	1	1

Macro-economics and Personal Finance

L-T-P-C: 2-0-0-2

1. **Course Objectives:**

   This course provides knowledge in the area of fundamental economics and personal finance, the importance of setting personal financial goals and the ways and means of achieving them by incorporating personal level risk analysis into it.

2. **Syllabus:**

   Unit-1 Introduction to Macro Economics [4 Hours]: Nature of macro-economic system; circular flow of income; national income- concepts and measurement; determinants of economic growth; Various Economic Indicators; inter-relationship between inflation rate, exchange rate and interest rate; trade growth relationship. Price Indices: CPI, WPI& GDP.

   Unit-2 Global Economics [4 Hours]: Aspects of balance of payment management; exchange rate management through macro-economic policies; approaches to manage trade and B. O. P. deficits; managing internal and external balance simultaneously; corporate responses to variations in exchange rates and policies. Fixed vs Flexible Exchange Rate Systems, and Semi-floating Exchange Rate System

   Unit-3 Fundamentals of Personal Finance [4 Hours]: Personal Finance Basics and the Time Value of Money; Financial Aspects of Career Planning; Money Management Strategy: Financial Statements and Budgeting; Planning Your Tax Strategy

   Unit-4 Managing Income and Expenditure [4 Hours]: Financial Services: Savings Plans and Payment Accounts; Introduction to Consumer Credit; Choosing a Source of Credit: The Costs of Credit Alternatives

   Unit-5 Insurance [4 Hours]: Insuring your Resources Property and Motor Vehicle Insurance; Health, Disability, and Long-Term Care Insurance; Life Insurance

   Unit-6 Investing in a systematic way [4 Hours]: Investing Fundamentals; Investing in Stocks; Investing in Bonds; Investing in Mutual Funds Investing in Real Estate and Other Investment Alternatives; Starting Early: Retirement Planning

3. **Course Outcomes:**
   a) Ability to understand the basics of Economics, its indicators, and Financial System, Various intermediaries and the product and services.
   b) Ability to understand the concept of BOP, Time value of money, Importance of budgeting, Personal Financial Statement, Insurance, various forms of Credit and the importance of Investment
   c) Ability to develop skill set for the managing money and its equivalent on their own, and also to manage their borrowing and their investments
   d) Ability to understand the importance of timing their purchases, forecasting their cash flows, insurance and investments
   e) Ability to understand basic thumb rules related to spending, saving, borrowing credits, insurance and investments and retirement planning

f) Ability to handle their own financial planning, forecasting, budgeting, investment, credit, insurance and retirement.

4. Text Books:

a) Kapoor Jack, Dlabay Les and Hughs Robert, Personal Finance, 11th edition, Irwin/McGraw-Hill, New Delhi, 2011.
b) Madura Jeff, Personal Finance, 6 th edition, Pearson education, Chennai, 2016.
c) Rudiger Dornbusch, Stanley Fisher and Richard Startz, Macroeconomics, Tata McGraw Hill, New Delhi.
d) Edward Shapiro, Macroeconomic Analysis, Galgotia Publications, New Delhi.

5. Reference Books:

a) Jack R Kapoor, Personal Finance, McGraw Hill Publications, New Delhi.
b) KC Mishra and Steward Doss, Basics of Personal Financial Planning, Cengage Learning.
c) Joehnk, Billingsley and Gitman, Planning Your Personal Finances, Cengage Learning India Private Limited, Delhi.
d) Mark Hirschey and John Nofsinger, Investments Analysis and Behavior, Mc Graw Hill Publications, New Delhi.
e) Eric J. Pentecost, Macroeconomics – An Open Economy Approach, MacMillan, New Delhi.
f) Michael R. Baye and Dennis W. Jansen, Money, Banking and Financial Markets: An Economics approach, AITBS, New Delhi.
g) Dernburg, T.F. and J.D. Dernburg, Macroeconomic Analysis: An Introduction to Comparative Statistics and Dynamics, Addison-Wesley.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	3	2	3	2	1	2
CO2	2	2	4	2	4	1	2	2
CO3	3	2	4	3	5	3	2	3
CO4	3	4	4	4	5	3	3	4
CO5	2	3	4	3	5	3	2	3
CO6	4	3	4	3	5	1	2	1

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	1	3	2	1	2
CO2	4	1	2	2	4	1	2	2
CO3	4	1	3	3	5	3	2	3
CO4	4	2	3	3	5	3	3	4
CO5	4	2	3	2	5	3	2	3
CO6	4	2	3	4	5	1	2	1

IT Project Management

L-T-P-C: 2-0-0-2

1. **Course Objectives:**

   To understand management in IT project context and to familiarize with managing multiple projects in the software project environment. The students will learn the steps and stakeholders involved in a project.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Basics of Project Management: Projects, Importance of project management; Project Scope Management: Planning scope management, Requirement collection, Defining scope, Creating WBS, Validating scope, Control scope, Case Studies.

   Unit – 2 [4 Hours]: Project Schedule Management: Plan schedule management, Defining activities, Sequence activities, Estimating activity durations, Schedule development, Control schedule; Cost Management: Planning cost management, Cost estimation, Budget determination, Control costs, Case Studies.

   Unit – 3 [4 Hours]: Project Quality Management: Planning quality management, Managing quality, Controlling quality, Case Studies

   Unit – 4 [4 Hours]: Project Risk Management: Risk management plan, Risk identification, Qualitative risk analysis, Quantitative risk analysis, Planning risk responses, Implementing risk responses, Risk monitoring, Case Studies.

   Unit – 5 [4 Hours]: Project Procurement Management: Procurement management planning, Conducting procurements, Controlling procurements, Case Studies.

   Unit – 6 [4 Hours]: Agile Project Management: Introduction; Life cycle: Characteristics of project life cycle, mixing agile approaches; Implementing Agile: creating agile environment, Delivering in agile environment, Case Studies.

3. **Course Outcomes:**
   a) Ability to demonstrate the knowledge of key steps in project management and scope and requirement gathering for projects.
   b) Ability to plan schedule for projects, track schedule, analyze project cost and create a project budget.
   c) Ability to plan, manage, and control the quality requirements of a project.
   d) Ability to analyze the risks associated when planning a project and develop plans to mitigate and monitor the identified risks.
   e) Ability to plan the processes necessary to purchase or acquire products, services, or results needed for a project.
   f) Ability to choose and implement an appropriate life cycle for the project.

4. Text Books:

a) Project Management Institute, A guide to the Project Management Body of Knowledge (PMBOK guide), 2017, 6th edition, ISBN: 978-1628251845

5. Reference Books:

a) Software engineering: a practitioner's approach - Pressman, R.S.; Maxim, B.R, McGraw Hill Higher Education, 2015. ISBN: 9780078022128

b) Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi, 2012.

c) MoSCoW Prioritization, Agile Business Consortium, 2019 https://www.agilebusiness.org/page/ProjectFramework_10_MoSCoWPrioritisation

d) Gopalaswamy Ramesh, "Managing Global Software Projects" – McGraw Hill Education (India), Fourteenth Reprint 2013Godfrey Boyle, Bob Everett and Janet Ramage, Energy Systems and Sustainability: Power for a sustainable future. Oxford University press, 2010.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	5	4	3	3	4	1	3
CO2	4	5	4	4	4	4	2	3
CO3	4	5	4	3	4	5	2	4
CO4	5	5	4	4	4	5	2	4
CO5	4	5	4	4	4	5	2	4
CO6	4	5	4	4	4	5	1	4

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	3	3	3	3	4	1	3
CO2	4	3	4	4	4	4	2	3
CO3	4	4	3	4	4	5	2	4
CO4	4	4	4	5	4	5	2	4
CO5	4	4	4	4	4	5	2	4
CO6	4	3	4	4	4	5	1	4

Innovation and Entrepreneurship

L-T-P-C: 2-0-0-2

1. Course Objectives:

The objective of this course is to enable the students to learn, define, critically think and practically apply innovation strategy in the context of entrepreneurship with a bias towards technology product execution. Students will learn and apply various tools, techniques and theories within the disciplines of starting-up, design thinking, building products and understanding product market fit, customer journey mapping, GTM, marketing, finance, policy and operations. The course involves activities to develop the ability of analysing and understanding business situations in which entrepreneurs are built/get formed , act according to situations and to master the knowledge necessary to plan entrepreneurial activities. At the end of the course, be able to plan and partially execute from concept to commercialization of an idea, product, technology, or business proposition.

2. Syllabus:

Unit – 1 [4 Hours]: Innovation Strategy: Defining context of innovation, understanding Design Thinking principles, Various frameworks of design thinking, applying design thinking to a problem, Identifying Customer Needs , creative Solutions or Gaps - Apply theory to business problems , practical applications to identified group issues.

Unit – 2 [3 Hours]: Innovation Assessment: How to assess innovation, process and structure of assessment, Market Assessment of Innovation , Technology assessment of innovation

Unit – 3 [3 Hours]: Introduction to Entrepreneurship: What is entrepreneurship, is it right for me, Pros and Cons of entrepreneurship , short-term and long-term vision, Types of entreprenurship, AMA with an Entrepreneur.

Unit – 4 [6 Hours]: Starting-Up Basics: Identify a business opportunity, evaluating an idea, understanding customer needs for a product or service, decision of going with a product vs. service, evaluating basic tenets of market, sizing the market, types of product or market evaluation, Market Reseach, Consumer Research, competition mapping, Finalizing the idea to market conception

Unit – 5 [4 Hours]: Product Market Fit & Go-To-Market: New Product Development Process, Understanding Product Market Fit , Assessing it for your own product, How to build initial traction, Go to market strategy for different types of businesses, channel strategy, market mix modelling

Unit – 6 [4 Hours]: Execution Bias: Business planning, Angel Funding, Venture Capital funding, Company formation, Basic Accounting knowledge, Legal and Compliances in company formation, Conceptual knowledge of starting up a company, DIPP registration, GST, TDS etc.

3. Course Outcomes:

a) Students will be able to understand innovation as a strategy and practice. They will be able to apply design thinking to solve problems in various facets.

b) Student will be familiar with assessing various types of innovation and understand the dimensions of technology assessment as well as market assessment with a bias towards technology and products

c) Students are able to develop a keen sense of entrepreneurship, what it entails and learn decision making concepts for various types of entrepreneurship

d) From an ideation stage to learning concepts of business to applying them for their own idea to evaluating various alternatives for product, service, market etc. in both theory and practice is what students will learn and apply.

e) Students are able to critically think about very important concepts like product market fit and go to market so as to apply for their own business idea.

f) Build a start-up pitch-deck and probably a technology product based on learnings including operational issues of starting up, basics of financial understanding as well as every requirement for starting a company will be learnt by students.

4. Text Books:

a) Peter F. Drucker Innovation and Entrepreneurship, Harper Business, 2006, ISBN: 978-0060851132

b) Clayton Christensen, David S. Duncan, Karen Dillon, Taddy Hall, Competing Against Luck: The Story of Innovation and Customer Choice, Harper Business, 2016.

5. Reference Books:

a) Kochland: The Secret History of Koch Industries and Corporate Power in America -Christopher Leonard

b) The Lean Startup: How Constant Innovation Creates Radically Successful Businesses -EricRies

c) Shoe Dog: A Memoir by the Creator of NIKE - Phil Knight

d) Zero to One: Notes on Startups, or How to Build the Future - Peter Thiel

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	1	2	3	5	1	1	3
CO2	3	3	1	4	5	1	1	2
CO3	1	4	3	4	4	3	3	2
CO4	5	3	5	5	3	3	1	2
CO5	3	4	2	5	2	2	1	3
CO6	5	5	5	2	5	4	4	2

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	1	4	4	4	1	1	3
CO2	4	2	5	3	3	1	1	2
CO3	3	1	5	1	2	3	3	2
CO4	5	2	5	4	5	3	1	2
CO5	2	2	4	4	4	2	1	3
CO6	4	3	2	3	3	4	4	2

Climate Change and its Implications

L-T-P-C: 2-0-0-2

1. Course Objectives:

- To familiarize with basic concept of climate, possible natural and anthropogenic influences on climate change, and global climate models (GCMs), interpretation of GCM outputs.
- To create a general awareness of the impact of changing climate on our biodiversity, environment, and projected trends.

2. Syllabus:

Unit – 1 [5 Hours]: Introduction to climate and climate change: weather and climate, important meteorological variables, global warming, possible reasons for global warming, greenhouse gases and human contributions, black carbon and global warming, sources of GHGs and black carbon

Unit – 2 [5 Hours]: Evidence of climate change: climate since industrial revolution, climate modelling, models and future projections, representative concentration pathways, their importance.
Hands-on training: Interpretation of global climate model output, QGIS

Unit – 3 [3 Hours]: Projected future trends and impact: Impact of climate change: global & Indian scenario, surface temperature, precipitation, ocean pH, sea-level, Arctic sea-ice extent.
Tutorials: Trend analysis of climate data and its interpretation

Unit – 4 [5 Hours]: Climate change and biodiversity: biodiversity, importance of biodiversity, pressure on biodiversity from human activities, possible impact, vulnerable species and ecosystems, adaptation, and mitigation.

Unit – 5 [3 Hours]: Climate change and agriculture: Indian agriculture, impact of climate change on agriculture and models, agricultural policies in context of climate change, initiatives of Government of India for climate change adaptation.

Unit – 6 [3 Hours]: Climate change and water resources: global and national water budget; outline of impact of climate change on water, climate change-drought & flood, mitigation and adaptation measures.

3. Course Outcomes:

a) Students will understand climate and climate change, anthropogenic influences on global warming, and climate change.
b) Students will be familiar with global and regional climate models, representative concentration pathways, and their importance.
c) Students can analyse the climate model projections using QGIS, future trends in climatic variables.
d) Students can understand biodiversity, its importance, the possible impact of climate change on biodiversity, and adaptation measures.

e) Students can understand the impact of climate change on Indian agriculture and government policies to mitigate the changing climate.
f) Students will get a general awareness about the water resources of India, the impact of climate change on water, and mitigation measures.

4. Text Books:

a) Lawrence M Krauss, The physics of climate change, 2021, Post Hill Press.
b) Cynthia E. Rosenzweig, Daniel Hillel, Handbook of climate change and agroecosystems: Impacts, adaptation, and mitigation, 2010, ISBN-13 -978-1783265633

5. Reference Books:

a) IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp
b) IPCC: Climate change and biodiversity. Technical Paper V, 2002. ISBN:92-9169-104-7
c) Jan C. Van Dam. Impacts of Climate Change and Climate Variability on Hydrological Regimes, 2003, Cambridge University Press.
d) IPCC Report Technical Paper VI, 2008, Climate change and water.
e) ICAR-Policy paper. Climate Change and Indian Agriculture: Impacts, Coping Strategies, Programs and Policy, 2019

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	5	1	2	3	1	3
CO2	5	4	4	5	4	4	3	4
CO3	5	4	4	5	3	4	2	4
CO4	4	5	5	4	5	5	4	4
CO5	3	4	5	4	5	5	4	4
CO6	3	4	5	4	5	4	4	4

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	3	2	3	1	3
CO2	5	1	2	4	3	4	3	4
CO3	5	1	3	4	4	4	2	4
CO4	4	2	3	4	4	5	4	4
CO5	4	1	3	4	5	5	4	4
CO6	3	1	2	3	3	4	4	4

ICTs for Development

L-T-P-C: 2-0-0-2

1. Course Objectives:

The objective of the course is to introduce the idea of channelling the potential of Information and Communication Technology for socio-economic development and to debate the notion of development as a sociological concept, with a particular focus on India, and discuss the impacts of the development process on society as a multi-faceted phenomenon. The course will help formulate the idea of social media, as a component of ICTs, and the role they play in shaping the contours of a digital society.

2. Syllabus:

Unit – 1 [4 Hours]: Introduction to the idea of Development
Studying development is essentially a multidisciplinary exercise rooted in a range of technical and social-science research. By combining a variety of subject areas, the course will engage deeply with some of the complex problems associated with developing economies especially unstable infrastructures, scarce resources and social disadvantages.

Unit – 2 [4 Hours]: Globalization and Development
This unit will specifically look at globalization as a socio-economic disruptor having far-fetched implications for not only wealth generation for a country but also bringing cultural transformations. Several historical trajectories of globalization in specific country contexts.

Unit – 3 [4 Hours]: Technology and Development
This unit will introduce a variety of social environments across resource and economic constraints that are targets for socio-economic development either through a top-down model of deploying ICTs or through a more market driven and organic social processes. These can range from building low-cost technologies to studying user-driven innovations of ICTs to fit contexts of use. We will cover certain domain areas, using relevant theoretical models and practical outcomes, within ICTs and Development, like, education, healthcare, livelihoods, entertainment, and governance.

Unit – 4 [4 Hours]: Introducing Information and communication technologies as harbingers of social change.
Under this topic we will debate and discuss the nature and contours of new channels of information, social networking the rise of social media and online content generation. Questions posed by these digital artifacts evaluate the inherently democratizing, process of owning, using and networking with new media technologies

Unit – 5 [4 Hours]: Case Studies on ICT
With the help of case studies, with a focus on India, we will articulate the implications of new and digital media in everyday life. Focus on the sociology of new media technologies, with a specific aim to anchor them within select theoretical debates and in specific geographic contexts.

Unit – 6 [4 Hours]: Social Media as a Developmental tool

Research had pointed to the rich field of utilization of new media tools for leisure and social networking as well as the unique affordances they spawn in the arena of self-expression and acquiring socio-digital identities. For example, the pre-pay mobile internet made web surfing an affordable and engaging activity even in the down markets and resource poor social ecologies of urban India. The topic will include case-studies from the global North and South centering on social segments in resource-poor and emerging market settings [for example, „Twitter in Political campaigns, Facebook use in the urban slum].

3. Course Outcomes:

a) Students will develop a critical lens to evaluate the processes and impacts and gain a well-rounded and practical perspective on issues of assessment and successes of development projects.
b) Students will be able to identify and apply a developmental lens in a variety of and diverse socio-economic contexts.
c) The course will provide a strong grounding in developing a sociological perspective of digital media and their impact in the evolution of a digital society as a part of parcel of socio-economic development.
d) The course will attempt to unpack is how technology seeks to address the needs and aspirations of people who increasingly consuming technologies and services despite are living in low resourced eco systems.

4. Text Books:

a) J. Timmons Roberts and Amy Bellone Hite, Eds. The Globalization and Development Reader: Perspectives on Development and Global Change, Blackwell: London, 2014

5. Reference Books:

a) Amartya Sen, Development as Freedom, Anchor Books: New York, 1999
b) C K Prahalad, The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits, Revised and Updated 5th Anniversary Edition, Prentice Hall, New Jersey
c) Jeffrey Sachs, The End of Poverty: Economic Possibilities for Our Time, Penguin Books: New York, 2006
d) Friedman, Thomas L. 2006. The World Is Flat: A Brief History of the Twenty-first Century, Farrar, Straus and Giroux
e) Easterly, W. 2002. “The Elusive Quest for Growth: Economists’ Adventures and Misadventures in the Tropics. MIT Press
f) Turkle, S. (1984) The second self. New York: Simon & Schuster.
g) Mizuko Ito, Daisuke Okabe, and Misa Matsuda, eds., 2005, Personal, Portable, Pedestrian: Mobile Phones in Japanese Life (Cambridge, MA: MIT Press
h) Turkle, S. (1995). Life on the screen: Identity in the age of the Internet. New York: Simon & Schuster.
i) Castells, Manuel (2001): Internet Galaxy. Oxford University Press
j) Lessig, Lawrence. 2009.” RE, Revived” i Remix: Making Art and Commerce Thrive in the Hybrid Economy. The Penguin Press, New York
k) Lister et. al. (2008): New Media A Critical Introduction. London and New York, Routledge.
l) Parthasarathy, Balaji and Yuko Aoyama. 2017. Deploying ICTs for development: An evolutionary perspective. Information Technologies & International Development. 13:157-170.
m) Toyama, Kentaro. 2015. “The Law of Amplification. A simple but powerful theory of technology’s social impact.” In Geek Heresy: Rescuing Social Change from the Cult of Technology. Public Affairs.

6. Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

CO-PO Mapping (CSE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	4	1	3	1	1	1	1	3
CO2	1	3	1	1	3	1	1	1
CO3	1	1	1	1	1	1	4	4
CO4	1	1	1	1	1	2	3	1

CO-PO Mapping (ECE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	4	1	1	1	3
CO2	3	1	1	2	1	1	1	1
CO3	3	1	1	1	3	1	4	4
CO4	2	1	1	1	3	2	3	1