Indian Institute of Information Technology Sri City, Chittoor

Bachelor of Technology (B.Tech.)

(Computer Science and 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 more 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. (CSE) Programme

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

SNo	PO ID	Program Outcomes (POs) - CSE Programme
1	PO1	Ability to demonstrate critical thinking and problem-solving approaches for meeting industry, research, societal advancements.
2	PO2	Ability to develop end to end software applications through emerging Software Engineering practices and methodologies
3	PO3	Ability to continuously learn theories and concepts and adapt to the evolving industry and research environment
4	PO4	Ability to solve a given challenge through design and analysis of algorithms and implement the same by means of an efficient and effective computer program
5	PO5	Ability to demonstrate the knowledge and skills learnt in the thematic 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 each of the specialization and full-stack development track courses:

SNo	PSO#	Common PSOs - For All Specializations and FSD Track
1	PSO-01	Ability to recognise problems/opportunities and to use emerging technological choices in the chosen area for developing state-of-the-art solutions
2	PSO-02	Ability to understand the additional domain specific requirements and build efficient solutions, with those requirements in context.
3	PSO-03	Ability to be aware of technical solutions that are following legal, and ethical aspects aligning with social responsibilities both at designing and developmental phases

In addition to the common PSOs for the Specialisations and FSD track that are common to all specializations irrespective of their technical merits and demerits.

The following are the PSOs for AIML specialization:

SNo	PSO#	PSOs - Artificial Intelligence and Machine Learning (AIML)
1	PSO-AIML-01	Ability to identify problems /opportunities where AIML can be applied and to identify the right AIML techniques in such contexts
2	PSO-AIML-02	Ability to perform the data engineering, designing, developing and testing the AIML solutions

The following are the PSOs for Cyber security specialization:

SNo	PSO#	PSOs - Cyber Security (CS)
1	PSO-CS-01	Ability to investigate and interpret forensically security incidents to ensure restoration of services and build effective defense mechanisms.
2	PSO-CS-02	Ability to apply advanced/intelligent tools and techniques to analyse, identify and manage security threats and vulnerabilities.

The following are the PSOs for Data Science specialization:

SNo	PSO#	PSOs - Data Science (DS)
1	PSO-DS-01	Ability to recognize the opportunities where data driven solutions including design experiment, data preparation, carrying out data analysis and visualization techniques to gain insights, can be applied
2	PSO-DS-02	Ability to perform suitable Statistical/Machine Learning modeling for solving real world problem and to support decision analytics systems

The following are the PSOs for Full-Stack Developer Track:

SNo	PSO#	PSOs for Full Stack Development Track
1	PSO-FSD-01	Ability to learn and demonstrate the understanding of state-of-the-art full stack development tools, libraries and services.
2	PSO-FSD-02	Ability to leverage and build, deploy, and support, end-to-end applications using Full Stack Development tools through a demonstrable project.

Curriculum and Syllabi of B.Tech. (CSE)

1. Introduction

This section describes the curriculum and Syllabi of the B.Tech. degree in Computer Science and Engineering (CSE) 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 Computer Science and Engineering (CSE). 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	Communication Skills[1] (4 x 2 credits), Science (2 x 2 credits), Humanities (2 x 2 credits), Aptitude / Competitive programming / Soft skills for employability (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 CSE
	8	Honours Project
B.Tech. (Hons)	**152**	For B.Tech. (Honours) Programme (144 + 8 Credits for Honours)
	14	**Specialization Courses:** 3 Specialization Courses in AI & ML/Cyber Security/Data Science 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 AI & ML / Cyber Security / Data Science (144 Credits + 14 credits for specialization)
B.Tech. (Hons.) with Specialization	**166**	B.Tech. (Honours) with specialization in AI & ML / Cyber Security / Data Science (152 Credits + 14 credits for specialization)

[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

3. UG – CSE Curriculum

The following is the curriculum for the students to be admitted to the B.Tech. in Computer Science and 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 Environment	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	ICS103	Computer Architecture	2-1-1-4
SSHAM 4	ISK102	Operational Communication	1-1-0-2
SSHAM 2 &3		Foundations in Human Values and Ethics / Energy and Environment	1-1-0-2/ 2-0-0-2
		Total Credits	**20**

Semester: 3

Type	Code	Course Name	L-T-P-C
Institute Core	IMA103	Real Analysis, Numerical Analysis and Calculus	3-1-0-4

Institute Core	ICS102	Object Oriented Programming	2-1-1-4
Program Core	ICS202	Advanced Data Structures and Algorithms	2-1-1-4
Program Core	ICS203	Operating Systems	3-1-0-4
Program Core	ICS204	Database Management Systems	2-1-1-4
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	ICS301	Fundamentals of Full Stack Development	2-1-1-4
Program Core	ICS400	Theory of Computation	3-1-0-4
Program Core	ICS341	Artificial Intelligence	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	ICS302	Framework Driven Front-End Development	2-1-1-4
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
Program Elective		Program Elective - 4	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	**20 / 24**

Semester: 6

Type	Code	Course Name	L-T-P-C
Program Core	ICS303	Webservices and Backend Development	2-1-1-4
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	**22**

Semester: 7 (includes an optional Semester Long Project)

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**

[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 taking up the Semester Long Project (SLP) in, these 8 credits will go to Semester Long Project. Otherwise aforementioned courses would be taken by the students to meet the graduation requirements.

4. List of Program Electives

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

a) Agent Based Modelling & Simulations (2-1-0-3)
b) Cloud Computing (2-1-0-3)
c) Compiler Design (2-0-1-3)
d) Computer Graphics and Multimedia (2-1-0-3)
e) Computer Vision (2-1-0-3)
f) Data Mining (2-1-0-3)
g) Distributed Computing (2-1-0-3)
h) High-Performance Computing (2-1-0-3)
i) Information Retrieval (2-1-0-3)
j) Introduction to Cyber Security (2-1-0-3)
k) Machine Learning (2-0-1-3)
l) Natural Language Processing (2-1-0-3)
m) Principles of Cyber Physical System Computation (2-0-1-3)
n) Soft Computing and evolutionary AI (2-1-0-3)

The following is the list of CSE Institute Electives to be offered to all BTech students:

a) Applied Stochastic Models (2-1-0-3)
b) Brain Computer Interaction (2-1-0-3)
c) Cryptography (2-1-0-3)
d) Digital Image Processing (2-0-1-3)
e) Introduction to Data Analytics (2-0-1-3)

5. Full-Stack Development Track

Full Stack Development (FSD) track focuses on producing graduates with industry-ready skills in software development. This industry-focused FSD track consists of three courses delivered in a sequence such that the students learn and demonstrate the latest technologies, tools and libraries used in their job situations. These courses together make them learn all three components- Front end, back end and API/Services and be able to develop end to end applications involving all the components effectively. The track simultaneously focuses on making the student undertake a live project that helps them to implement those technology components learned across three courses. The choices of technologies, tools and libraries shall be based on the current industry needs and profile of the batch of students.

There are three courses offered under this Full-Stack Development track:

a) Fundamentals of Full Stack Development (2-1-1-4)
b) Framework Driven Front-End Development (2-1-1-4) and
c) Webservices and Backend Development (2-1-1-4)

6. Specialization Tracks

a) Artificial Intelligence and Machine Learning

This specialization offers students with deep knowledge of both fundamentals of AIML based computing and the potential applications. The courses are taught by the experts in AIML from both academia and industry. This specialization provides hands-on knowledge of state-of-the-art AIML tools for real-world problem-solving. The semester-long industry projects in the AIML area provides the real experience to students. At the end of this program, the student will be capable of undertaking challenging careers in industry as well as academic / research organisations pertaining to the AIML.

The following list courses are offered under AIML specialization:

i) Machine Learning (2-x-x-3) – The First Level Elective
ii) Deep Learning (2-x-x-3)
iii) Reinforcement Learning (2-x-x-3)
iv) Soft Computing & Evolutionary AI (2-x-x-3)
v) Industry application of AL & ML (1-0-0-1)
vi) Project Work (0-0-4-4)

b) Cyber Security

Security in cyberspace is a crucial aspect, especially in the modern world where most of our communications and interactions happen over the Internet. Cyber security endeavours to counter the wide range of challenges that compromise the effectiveness and reliability of various aspects of cyberspace. Considering the exponential growth of digital devices and the number of users, there is an urgent requirement to develop more robust and potentially secure security frameworks. Thus, there is a need for professionally trained individuals able to understand, analyse, and offer the suitable solutions against respective cyber security challenges. In the present scenario, the cyber industry has only a handful of skilled cyber security professionals in comparison to the estimated futuristic growth in this field. Being an institution of national importance that focuses on information technology, IIIT Sri City is offering a programme focused exclusively on the security aspects of cyberspace. This will help to fulfil the requirement of cyber security professionals in the country, and contribute towards the effective growth of the country.

The following list courses are offered under Cyber Security specialization:

i) Introduction to Cyber Security (2-x-x-3) – The First Level Elective
ii) Network and Data Security (2-x-x-3)
iii) Threat Intelligence (2-x-x-3)
iv) Software Security (2-x-x-3)
v) Cyber security Regulations (1-0-0-1)

vi) Project Work (0-0-4-4)

c) Data Science

There is an increasing demand for Data Scientists in every corner of the world because almost all types of the industries are inclined to make data driven decisions. Data Science jobs have consistently been in high demand since the last 5 years. This trend signifies that around the world as well as in India, there is a high demand for data scientist professionals who are well versed in various aspects of data science. Whereas it can be easily perceived, being a relatively new field, the supply of the Data science skilled resources is still quite low. Not only in quantity, the quality of the jobs is also very lucrative, whether in terms of remuneration or sophistication. Healthcare, aviation, manufacturing, automobile, IT services, ecommerce, Pharma, financial institutions, infrastructure, entertainment, FMCG are examples of few sectors where data science has become an essential component of their businesses. A few industrial research laboratories and academic institutes across the globe have already shown their efforts on research and development in this area.

The following list courses are offered under Data Science specialization:

i) Introduction to Data Analytics (2-x-x-3)
ii) Advanced Data Analytics (2-x-x-3)
iii) Big Data Analytics (2-x-x-3)
iv) Python for Data Science (2-x-x-3)
v) Industry Applications of Data Science (1-0-0-1)
vi) Project Work (0-0-4-4)

7. 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. (CSE) 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, 2nd 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, 1st 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 Structures 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 implement its application to computer science. The course enables students to interpret underlying concepts of matrix algebra and gain further skills in the relevant techniques to use 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 - Basic Set Operations, Functions, Cardinality, Countable and Uncountable Sets, Sequence & Summations; Induction - Principle of Induction, Strong Induction; Recursion - Recursive Algorithms, Recursive Definition of Sets, Structural Induction;

   Unit – 3 [7 Hours]: Counting techniques - Sum and Product Rule, Inclusion and Exclusion Principles, 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 Solving Ax = b, Elimination with Matrices, Multiplication and Inverse Matrices, Factorization into A = LU, Transposes and Permutations; Vector Spaces and Subspaces - 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 – Orthogonal Vectors and Spaces, Projections, Orthogonal Bases and Gram-Schmidt; Eigen Values and Eigen vectors - 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 use them in proving or disproving mathematical statements.

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

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

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

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

4. Text Books:

a) Keneth H. Rosen, Discrete Mathematics and applications, TataMcGraw Hill, 7th Edition, 2012, 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) Chung L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book, 2nd Edition, 1985, ISBN: 0-07-038133-X

b) László Lovász, József Pelikán, Katalin Vesztergombi, Discrete Mathematics: Elementary and Beyond, Springer, 2003, 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

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. **Revised 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 (Unit wise):**

   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; 1st Edition, 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
c) Mark G. Sobell, A Practical Guide to Ubuntu, (4th Edition)
d) Mark G. Sobell, A Practical Guide to Ubuntu Linux, Prentice Hall; 4th Edition (23 December 2014)
e) AT&T Unix System V Users Manual
f) Andrew S. Tanenbaum, Computer Networks, Pearson Education India, 2013 (5th Edition)
g) 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; 2nd 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 [7 Hours]: Probability Theory-Sample Space, Events, Axioms of Probability, Other Definitions, Probability Rules, Conditional Probabilities, Bayes' Theorem, Independence of Events;

   Unit – 2 [12 Hours]: Random Variable and Distribution -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 [11 Hours]: Jointly Distributed Random Variable-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]: Limit Theorems and Inequalities-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 [6 Hours]: Statistical Inference-I-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 [7 Hours]: Statistical Inference-II-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 learn 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, 2nd Edition, Wiley, ISBN:9788126519262
b) S. Ross, A first Course in Probability, 8th Edition, Pearson, ISBN: 9780136033134
c) D.C. Montgomery, G.C. Runger, Applied Statistics and Probability for Engineers, 7th Edition, Wiley , ISBN:9781119456261
d) Michael J. Evans and Jefrey S. Rosenthal, Probability and Statistics, 2nd Edition, ISBN: 9781429224628

5. Reference Books:

a) Anderson, T.W., (1958) Introduction to Multivariate Statistical Analysis, Wiley: New York, ISBN:9788126524488
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 implement different tree data structure and operations.

iv) To comprehend 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) Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Pearson Education India, 2nd Edition, 2002, ISBN: 978-0201498400

b) Seymour Lipschutz, Data Structures with C, MC Graw Hill India, 1st Edition, 2010, ISBN: 978-0070701984

c) Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Data Structures using C and C++, Pearson, 2006, ISBN: 978-8131703281

5. Reference Books:

a) Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Fundamentals of Data Structures in C, Silicon Pr; 2nd Edition, 2007, ISBN: 978-0929306407

b) Robert L. Kruse, Clovis L. Tondo, Bruce P. Leung, Data Structures and Program Design in C, Prentice Hall, Subsequent edition, 1996, ISBN: 978-0132883665

c) Thomas H. Cormen, Introduction to Algorithms, MIT Press, 3rd Edition, 2009, ISBN: 978-0262033848

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

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

1. **Revised 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

2. **Course Outcomes (Unit wise):**

   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

3. 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)

4. 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)

5. 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 the students to provide the basic concepts of sequences and series, to use various methods for solving numerical problems and to analyse the characteristics of functions of single and several variables

2. **Syllabus:**

   Unit – 1 [8 Hours]: Sequences - 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; Solutions of non-linear equations - bisection, Newton-Raphson and regula-falsi methods;

   Unit – 3 [6 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 centre 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, forty second 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) Paul Deitel and Harvey Deitel, Java how to Program, 9th Edition, Prentice Hall Press, Upper Saddle River, NJ, USA, 2011.

b) David J. Eck, Programming: Introduction to Programming Using JAVA, CreateSpace, Paramount, CA, 2009

c) Robert Endre Tarjan, Data Structures and Network Algorithms, Society for Industrial and Applied Mathematics Philadelphia, PA, USA, 1983, ISBN:0-89871-187-8

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. This 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 link layer concepts using simulation skill and propose modifications for the performance improvements

4. Text Books:

a) Computer Networking: A Top-Down Approach, James F. Kurose and Keith W. Ross, 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 , 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	4	2	5	2	4	1	1	2
CO2	4	3	4	5	4	2	1	1
CO3	3	2	4	3	5	3	2	2
CO4	3	3	3	5	3	3	2	3

Program Core Courses

of the B.Tech. (CSE) Programme

Advanced Data Structures and Algorithms

Program Core

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

1. **Course Objectives:**

   The objective of this course is to deepen the knowledge of the data structures and algorithms along with complexity analysis, proof of correctness and implementation.

2. **Syllabus:**

   Unit – 1 [9 Hours]: Basic Data Structures and Algorithms - Overview of stacks, queues, searching and sorting, divide and conquer, asymptotic analysis, recurrence relations, randomized quick sort, linear time sorting, binary search tree, height balanced tree, AVL tree;

   Unit – 2 [10 Hours]: Advanced Tree Data Structures - 2-4 Tree, searching, insertion, deletion, Red Black Tree, searching, insertion, deletion, B+ Tree, Tries; Hashing - Hashing, Universal Hashing;

   Unit – 3 [8 Hours]: Graph Data Structures - Basics of Graph, Data Structures for Graph; Graph Traversal - Breadth First Search, Depth First Search, Applications of DFS and BFS;

   Unit – 4 [7 Hours]: Minimum Spanning Trees - Kruskal's and Prim's Algorithm;
   Single Source Shortest Paths - Dijkstra and Bellman Ford;

   Unit – 5 [8 Hours]: Dynamic Programming - Fibonacci Number, Floyd Warshall for All Pairs Shortest Paths, Longest Common Subsequences, Knapsack;

   Unit – 6 [6 Hours]: Advanced Topics - Network Flows, Randomized Algorithms, etc.; Computational Complexity - NP-completeness and Polytime reductions;

3. **Course Outcomes:**

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

   i) To analyze the complexity of algorithms and compute the closed form expression for recurrence relations.

   ii) To use the tree based data structures for different algorithms.

   iii) To utilize the depth-first and breadth-first search algorithms for Graph traversal.

   iv) To apply the graph algorithms to solve the minimum spanning tree and shortest path problems.

   v) To use the dynamic programming to solve the challenging problems using the solutions of sub-problems.

vi) To use the randomized algorithms for different applications and analyze the computational complexity.

4. Text Books:

a) Thomas H. Cormen, Introduction to Algorithms, MIT Press, 3rd Edition, 2009, ISBN: 978-0262033848

b) Mark A. Weiss, Data Structures and Algorithm Analysis, Pearson, 2nd Edition, 1996, ISBN: 978-0201498400

c) Jon Kleinberg, Eva Tardos, Algorithm Design, Pearson, 1st Edition, 2005, ISBN: 978-0321295354

5. Reference Books:

a) Silvano Martello, Paolo Toth, Knapsack Problems: Algorithms and Computer Implementations, Wiley–Blackwell, Revised edition, 1990, ISBN: 978-0471924203

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	5	5	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

Computer Architecture

Program Core

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

1. **Course Objectives:**

   The objective of the course is to provide the fundamentals of computer internal organisation (such as the CPU, memory unit, and input/output), multi-core, and parallel processing architectures, as well as low-level programming languages used to communicate directly with computer hardware.

2. **Revised Syllabus:**

   Unit – 1 [6 Hours]: Tour of Systems - Information as bits; Program transformation; Working of a Compiler; Processors reading instructions; Caches; Storage Devices; Technologies for Building Processors and Memory; Performance; The Power Wall.

   Unit – 2 [7 Hours]: Data Representation - Information Storage; Integer Representation; Integer Arithmetic; Floating Point.

   Unit – 3 [12 Hours]: Machine Language - Data Formats; Accessing Information; Arithmetic and Logic Information; Control; Procedures; Array allocation; Heterogeneous Data Structures.

   Unit – 4 [7 Hours]: Code Optimization - Capabilities and Limitation of Compilers; Program Performance; Eliminating Loop Inefficiencies; Reducing Procedural Calls; Eliminating unneeded memory references; Understanding Modern processors; Loop unrolling; Enhancing parallelism; Memory Performance; Performance improvement techniques; Identifying and eliminating bottlenecks.

   Unit – 5 [12 Hours]: Processor Architecture - Building a Datapath, A Simple Implementation Scheme, Overview of Pipelining, Pipelined Datapath Storage techniques; Locality; Memory Hierarchy; Cache Memories; Writing Cache-friendly code; Impact of caches on program performance; Compiler drivers; Static Linking; Object files; Relocatable Object files; Symbol and symbol tables; Symbol resolution; Relocation; Executable Object files; Loading executable object files; Dynamic linking with shared libraries; Position independent code; Tools for manipulating object files.

   Unit – 6 [4 Hours]: Parallel Processing Architecture - Introduction; The Difficulty of Creating Parallel Processing Programs; SISD, MIMD, SIMD, SPMD, and Vector; Hardware Multithreading; Multicore and Other Shared Memory Multiprocessors.

3. **Course Outcomes (Unit wise):**

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

   i) Ability to identify the various hardware and software components in a computer system through the life cycle of program execution.

ii) Ability to write reliable programs with a strong knowledge of computer arithmetic including the properties of number representation.
iii) Ability to write better programs with thorough understanding of how programs are represented on a machine namely the assembly language program.
iv) Ability to speed up a program by simple transformations of C code using techniques to improve code performance with efficient machine code generated from compilers
v) Ability to exploit architecture of parallel systems and spatial and temporal locality to improve performance of the application

4. Text Books:

a) Davie Richard O'Hallaron, and Randal Bryant, Computer Systems: A Programmer's Perspective, 3rd Edition, Pearson, USA, ISBN:978-0134092669, 2015.
b) David A Patterson and John L Hennessy. Computer Organization and Design – The Hardware/Software Interface. RISC, 5thEdition, Elsevier, ISBN:9780128122761, 2018.
c) Hamacher, Vranesic, Zaky, Computer Organization, 5th Edition, Tata McGraw Hill, 2011, ISBN:9780072320862.

5. Reference Books:

a) William Stallings, Computer Organization and Architecture - Designing for Performance, 10th Edition, Pearson Ed. 2016 ISBN: 978-0134997193.
b) David M. Harris and Sarah L. Harris, Digital Design and Computer Architecture. 2nd Edition, Elsevier, 2013, ISBN 9780123944245.

Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

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

Operating Systems

Program Core

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

1. **Course Objectives:**

   The objective of the course is to create understanding of the role of operating system in a computer from the programmer's perspective. To enlighten programmers with the impact of the operating system on the performance and correctness of their application programs.

2. **Revised Syllabus:**

   Unit – 1 [4 hours] : Introduction - Architecture, Goals & Structures of O.S, Basic functions; Interaction of O.S. & hardware architecture - System calls, Batch, multiprogramming; Multitasking, time sharing, parallel, distributed & real-time O.S.

   Unit – 2 [12 hours]: Process Management - Process Concept, Process states, Process control, Threads; Types of scheduling - Pre-emptive, Non pre-emptive; Scheduling algorithms - FCFS, SJF, RR, Priority; Thread Scheduling, Real Time Scheduling; System calls - ps, fork, join, exec family, wait; Exceptions - Exceptions Handling, Classes of Exceptions, Exceptions in Linux/IA32 System; Signals-Signals terminology, Sending Signals, Receiving Signals, Signal Handling Issues, Portable Signal Handling, Explicitly Blocking and Unblocking Signals, Synchronous flows to avoid Nasty Concurrency Bugs.

   Unit – 3 [10 Hours]: Concurrent Programming - Processes, I/O Multiplexing, Threads, Shared Variables in Threaded Program; Synchronizing Threads with Semaphores, Using Threads for Parallelism, Other Concurrency Issues.

   Unit – 4 [10 Hours]: Memory Management - Physical and Virtual Addressing, Address Spaces, VM as a tool for Caching, VM as a tool for Memory Management, VM as a tool for Memory Protection, Address Translation, Case Study (Intel Core i7/Linux Memory System), Memory Mapping, Dynamic Memory Allocation, Garbage Collection, Common Memory-Related Bugs in C Program.

   Unit – 5 [8 Hours]: System-Level I/O - Unix/Linux I/O, Opening and Closing Files, Reading and Writing Files, Robust Reading and Reading with the RIO Package, Reading file Metadata, Sharing files, I/O Redirection, Standard I/O, Secondary Memory, Disk Scheduling.

   Unit – 6 [4 Hours]: OS Security - Model, Potential attacks, Design Principles.

3. **Course Outcomes (Unit wise):**

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

   i) Ability to create and work with processes, and define process handling and use of system calls by operating systems.

ii) Ability to analyze and ensure the correctness requirements of programs running concurrently.

iii) Ability to design different memory partitioning techniques and describe virtual memory concepts.

iv) Ability to develop different interfaces to file systems and input-output systems.

v) Ability to demonstrate techniques to thwart operating system security attacks.

4. Text Books:

a) Abraham Silberschatz, Greg Gagne, Peter B. Galvin, Operating System Concepts, Wiley, 10th Edition, 2018, ISBN: 978-1119320913

b) Davie Richard O'Hallaron, and Randal Bryant, Computer Systems: A Programmer's Perspective, Pearson, USA, 3rd Edition, 2015, ISBN: 978-0134092669

5. Reference Books:

a) Andrew Tanenbaum, Modern Operating Systems, Pearson Education India, 4th Edition, 2016, ISBN : 978-9332575776

b) William Stallings, Operating Systems: Internals and Design Principles, Pearson, 8th Edition, ISBN: 9780133805918

Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

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

Database Management Systems

Program Core

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

1. **Course Objectives:**

   The objective of the course is to introduce the core principles and techniques required in the design and implementation of database systems. This course provides with theoretical knowledge and practical skills on how to organize, maintain and retrieve information efficiently and effectively from a DBMS.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Database System Concepts - Data Models, Schemas, Instances

   Unit – 2 [8 Hours]: Database system architecture - Three-Level Architecture and Data Independence, Database Languages and Interfaces, Centralized and Client/Server Architectures for DBMS

   Unit – 3 [8 Hours]: Data Modeling - Entity-Relationship Diagram, Relational Model, Integrity constraints and data manipulation operations, Relational Algebra and Relational Calculus

   Unit – 4 [10 Hours]: SQL (Structured Query Language) - Data Definition and Data Types, Constraints, Queries, Insert, Delete, and Update Statements, Views, Stored Procedures and Functions, Database Triggers, SQL Injection

   Unit – 5 [10 Hours]: Normalization for Relational Databases - Functional Dependencies, Normalization; Query Processing, Query Optimization algorithms.

   Unit – 6 [8 Hours]: Transaction Processing - Transaction Processing, Concurrency Control Techniques; Database Recovery Techniques; Object and Object-Relational Databases; Database Security and Authorization.

3. **Course Outcomes:**

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

   i) To demonstrate the basic concept of DBMS, components of DBMS and its functions.

   ii) To model an application's data requirements using ER diagrams and design database schemas based on the conceptual model

   iii) To convert the ER-model to relational tables, populate relational database and formulate SQL queries on data with correlated subqueries.

   iv) To design and develop a database with key concepts and query optimization techniques.

v) To comprehend and demonstrate the concept of transactions and their properties, the anomalies and the recovery techniques used to recover from crashes.

4. Text Books:

a) Abraham Silberschatz, Henry Korth, and S. Sudarshan, Database System Concepts, McGraw-Hill Education, 6th Edition, 2010, ISBN: 978-0073523323

5. Reference Books:

a) Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, 6th Edition, 2010, ISBN: 978-0136086208.

b) Christopher J. Date, A. Kannan and S. Swamynathan, An Introduction to Database Systems, Pearson Education, 8th Edition, 2006, ISBN: 978-8177585568.

c) Jeffrey D.Ullman, Principles of Database Systems, Galgotia Publications, 2nd Edition, 1999.

d) Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw Hill Education, 3rd Edition, 2014, ISBN: 978-0072465631.

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	3	1
CO2	4	3	4	3	5	1	3	4
CO3	2	3	4	3	5	1	3	4
CO4	3	3	4	3	5	1	3	4
CO5	3	3	4	3	5	1	3	3

Theory of Computation

Program Core

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

1. **Course Objectives:**

   The objective of this course is a) to introduce basic concepts of the formal language theory and its applicability to decision problems; b) To make students to appreciate the theoretical concept called "undecidability"; c) To introduce how the difficulty of a solution can be measured by using the time complexity theory and thus make the student to appreciate and understand the NP-Completeness property of a class of problems.

2. **Syllabus:**

   Unit – 1 [8 Hours]: Introduction - Alphabets, Strings and Languages, Automata and Grammars; Deterministic finite Automata (DFA) - Formal Definition, Simplified notation, State transition graph, Transition table, Language of DFA; Nondeterministic finite Automata (NFA) - NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Distinguishing one string from other

   Unit – 2 [8 Hours]: Regular Expression (RE) - Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions; Relation with FA - Regular expression to FA, DFA to Regular expression; Non Regular Languages - Pumping Lemma for regular Languages, Application of Pumping Lemma; Properties - Closure properties of Regular Languages, Decision properties of Regular Languages, Applications and Limitation of FA

   Unit – 3 [8 Hours]: Context Free Grammar (CFG) - Definition, Examples, Derivation, Derivation trees; Ambiguity in Grammar - Inherent ambiguity, Ambiguous to Unambiguous CFG; Normal forms for CFGs - Useless symbols, Simplification of CFGs, CNF and GNF; Context Free Languages (CFL) - Closure properties of CFLs, Decision Properties of CFLs, Emptiness, Finiteness and Membership, Pumping lemma for CFLs

   Unit – 4 [8 Hours]: Push Down Automata (PDA) - Description and definition, Instantaneous Description, Language of PDA; Variations of PDA - Acceptance by Final state, Acceptance by empty stack, Deterministic PDA; Equivalence of PDA and CFG - CFG to PDA and PDA to CFG

   Unit – 5 [8 Hours]: Turing machines (TM) - Basic model, definition and representation, Instantaneous Description; Variants of Turing Machine - TM as Computer of Integer functions, Universal TM; Church's Thesis; Language acceptance by TM - Recursive and recursively enumerable languages;

   Unit – 6 [8 Hours]: Decidability - Halting problem, Introduction to Undecidability, Undecidable problems about TMs; Complexity - Time Complexity, Problem classes - P, NP, NP-Hard, NP-Complete.

3. Course Outcomes:

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

i) To design finite automata that solves the given problem
ii) To represent regular languages through finite automaton and regular expression.
iii) To generate the context free language from the given contex free grammar.
iv) To implement the Push Down Automata to recognize a given context free language along with the applicability of the theory in Compilers.
v) To learn the importance of Turing Machines and how it is related to the computable functions.
vi) To equip with theoretical understanding on how to show that some problems are not computable like the Halting problem. Student understands the NP-Compleness property of a class of problems.

4. Text Books:

a) John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages and Computation, Pearson Education, 3rd edition, 2014, ISBN: 978-0321455369
b) Michael Sipser, Introduction to the Theory of Computation, Cengage Learning, 3rd Edition, 2014, ISBN: 978-8131525296

5. Reference Books:

a) John C. Martin, Introduction to Languages and the Theory of Computation, McGraw-Hill Education, 4th edition, 2010, ISBN: 978-0073191461
b) Bernard M. Moret, The Theory of Computation, Pearson Education, 2002, ISBN: 978-8131708705

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

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

Artificial Intelligence

Program Core

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

1. **Course Objectives:**

   The objective of this course is to teach students to Identify, apply and solve problems using the AI tools, algorithms and techniques. Additionally, the course will expose students to real world problems from various domains and the contemporary AI tools that are used for solving those problems.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction- Definition and history of AI, Introduction to Intelligent agents

   Unit – 2 [8 Hours]: Problem solving by Searching - Uninformed search algorithms, Informed (Heuristic) search algorithms

   Unit – 3 [10 Hours]: Beyond Classical Search- Local Search algorithms, Adversarial Search, Constraint Satisfaction Problems

   Unit – 4 [8 Hours]: Logical Agents & Propositional Logic- Introduction to logical agents, Propositional logic, Propoitional inference mechanisms

   Unit – 5 [10 Hours]: First Order Logic & Inference- First Order Logic, Resolution - theorem proving, Rete algorithm for Forward chaining

   Unit – 6 [8 Hours]: Planning- Planning via searching, Classical planning algorithms, GraphPlan algorithm

3. **Course Outcomes:**

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

   i) To explain Artificial Intelligence and describe the fields and sub fields of Artificial Intelligence.

   ii) To employ suitable tree and graph search algorithms in the process of building an intelligent agent.

   iii) To build intelligent agents which is capable of operating in adversarial multi-agent (game-playing) environment and to also represent various problems as constraint-satisfaction problems, so that they can be solved using Constraint Satisfaction or SAT/SMT solvers.

   iv) To represent a problem in logic and utilize inference algorithms to power knowledge based intelligent agents

v) To build intelligent agents which can make effective use of automated planning algorithms for their planning needs.

4. Text Books:

a) Norvig, P., and Russell, S. J. (2016). Artificial Intelligence: A Modern Approach. United Kingdom: Pearson., ISBN-13: 978-0136042594

5. Reference Books:

a) Brachman, R. J., Levesque, H. J., and Reiter, R. (Eds.), (1992), Knowledge Representation, MIT Press, ISBN-13: 978-1558609327

b) Forbus, K. D., and De Kleer, J. (1993). Building problem solvers (Vol. 1). MIT press, ISBN-10: 0262061570

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

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

Full-Stack Development Track Courses

of the B.Tech. (CSE) Programme

Fundamentals of Full Stack Development
(Course 1/3 under Full-Stack Development Track)

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

1. **Course Objectives:**
   The objective of this course is to teach the fundamentals of a web application and to introduce the basic frameworks and tools, using which the students can develop robust end-to-end web applications.

2. **Revised Syllabus:**
   Unit – 1 [6 Hours]: Introduction, What is a web application? History, What is a webserver, browser, HTTP/HTML/CSS

   Unit – 2 [8 Hours]: JavaScript and Browser, Browser internals: Rendering engine, JavaScript engine, etc; JavaScript introduction

   Unit – 3 [8 Hours]: JavaScript and Node, Introduction to Node, Tooling & Setup, JavaScript in Node

   Unit – 4 [6 Hours]: Introduction to MVC Frameworks: MVC pattern, Building MVC application with express

   Unit – 5 [6 Hours]: Introduction to Database. In-memory databases, RDMS and NoSQL Databases, Database integration (SQL): example: MariaDB/MySQL/PostgreSQL, Database integration (NoSQL) example: MongoDB

   Unit – 6 [14 Hours]: Project 1 (The industry members will be part of the panel evaluating projects.)

3. **Course Outcomes (Unit wise):**

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

   i) To describe how a web application works including the inner working of the related components/applications.

   ii) To demonstrate and design simple interactive webpage using Node.js

   iii) To demonstrate basics of integrating databases to the server side applications (backend)

   iv) To build and demonstrate an end to end web application

4. Text Books:

a) Herron, David. Node.js Web Development – 5th Edition: Server-side Web Development Made Easy with Node 14 Using Practical Examples. United Kingdom, Packt Publishing, 2020, ISBN: 9781838987572

5. Reference Books:

a) Crockford, Douglas. JavaScript: The Good Parts. United States, O'Reilly Media, 2008, ISBN: 9780596554873

b) Brown, Ethan. Web Development with Node and Express: Leveraging the JavaScript Stack. United States, O'Reilly Media, 2014, ISBN: 9781491902295

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	1	2	5	2	1	1	2	3
CO2	4	4	4	5	2	5	2	5
CO3	4	5	3	3	2	4	1	4
CO4	4	5	2	5	2	5	2	5

b) Mapping of COs - PSOs

	PSO-01	PSO-02	PSO-03	PSO-FSD-01	PSO-FSD-02
CO1	2	1	1	5	4
CO2	2	2	1	5	4
CO3	4	3	1	5	4
CO4	4	4	3	4	5

Framework Driven Front-End Development
(Course 2/3 under Full-Stack Development Track)

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

1. **Course Objectives:**
   The objective of the course is to teach students learn a full front-end reactive component based framework (example: React/Angular/Vue); and to equip then with the understanding of the inner working of the front-end frameworks.

2. **Revised Syllabus:**
   Unit – 1 [4 Hours]: Introduction: Introduction to Dynamic HTML/DOM, Introduction to AJAX

   Unit – 2 [6 Hours]: Javascript advanced, Browser Internals - event loop, web apis, etc Introduction to SPA

   Unit – 3 [8 Hours]: Introduction to Advanced Front End Frameworks: Front-end JavaScript Frameworks and Libraries Overview, Introduction to React, React APP Overview

   Unit – 4 [8 Hours]: Advanced Front-End Components, Introduction to JSX,
   React Components States and Pros, React Components and Life Cycles,
   React Router, React Virtual DOM

   Unit – 5 [8 Hours]: Advanced Front-End State Management, Introduction to Redux, Redux Forms, Redux Actions, Advanced Topics

   Unit – 6 [14 Hours]: Project (The industry members will be part of the panel evaluating projects.)

3. **Course Outcomes (Unit wise):**

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

   i) To describe how a browser works, including request/response handling, rendering. etc.

   ii) To explain inner working of a Javascript engine and how this can be used to build Single Page Web ApplicationsTo demonstrate the understanding of how a browser works, including request/response handling, rendering. etc.

   iii) To design, build and utilize front-end frameworks for web application development.

   iv) To use state management solutions effectively to build robust front end applications.

   v) To implement a functional front-end web application using advanced front end frameworks

4. Text Books:

a) Porcello, Eve, and Banks, Alex. Learning React: Modern Patterns for Developing React Apps. United States, O'Reilly Media, 2020, ISBN: 9781492051671

5. Reference Books:

a) Hoque, Shama, Full-Stack React Projects: Learn MERN Stack Development by Building Modern Web Apps Using MongoDB, Express, React, and Node.js, 2nd Edition. United Kingdom, Packt Publishing, 2020, ISBN: 9781839213113

b) Crockford, Douglas, JavaScript: The Good Parts, O'Reilly Media, 2008, USA, ISBN: 9780596554873

Mapping of Course Outcomes to Programme Outcomes / Program Specific Outcomes

c) Mapping of COs – POs

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

d) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-FSD-01	PSO-FSD-02
CO1	2	2	1	5	4
CO2	2	2	1	5	4
CO3	4	4	1	5	4
CO4	3	3	1	5	4
CO5	4	4	3	4	5

Webservices & Backend Development
(Course 3/3 under Full-Stack Development Track)

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

1. **Course Objectives:**
   The objective of this course is to teach how to build Restful web services to support Front-end web applications (SPA) and Mobile clients and also to teach exposing and securing web services for supporting Business-to-Business (B2B) use cases.

2. **Revised Syllabus:**
   Unit – 1 [6 Hours]: Introduction - Webservices & APIs Fundamental Concepts, Flavors of Webservices: SOAP, REST, GRAPHQL;

   Unit – 2 [8 Hours]: RESTful services - Introduction to REST, Building & Testing RESTful services;

   Unit – 3 [7 Hours]: Database: Tools & Optimizations- Schema Design and Domain Models, Object Relational Mapping Tools, Indexing & Query Optimizations;

   Unit – 4 [7 Hours]: Middleware & Security- Handling Multipart form-data and file uploads, Logging and profiling, Authentication & Authorization, Securing Webservices/APIs - JWT Tokens;

   Unit – 5 [4 Hours]: Service Documentation- Webservices Documentation (Open API Swagger);

   Unit – 6 [16 Hours]: Project

3. **Course Outcomes (Unit wise):**
   At the end of the course, students should have the ability:

   i) To describe how webservices/APIs work, including various communication and other protocols.

   ii) To employ state of the art tools and techniques to design and build RESTful services and secure them through industry standard practices.

   iii) To analyze domain to design database schema and implement the same using appropriate tools and techniques.

   iv) To configure and use necessary middlewares for handling file uploads, logging, etc.

   v) To document webservices as per industry standards and to perform unit & integration tests of the entire application

vi) To develop the backend capabilities of an existing web application by exposing and consuming webservices/APIs, along with addressing performance and security concerns.

4. Text Books:

a) Bojinov, Valentin. RESTful Web API Design with Node.js. United Kingdom, Packt Publishing, 2016, ISBN: 9781786463203

5. Reference Books:

a) Crockford, Douglas. JavaScript: The Good Parts. United States, O'Reilly Media, 2008, ISBN: 9780596554873

b) Richardson, Leonard, and Ruby, Sam. RESTful Web Services. United States, O'Reilly Media, 2008, ISBN: 9780596554606

7

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	1	2	5	2	1	1	2	3
CO2	1	5	4	5	2	5	3	5
CO3	4	3	3	3	1	5	1	4
CO4	2	3	4	5	1	3	2	4
CO5	1	1	1	1	1	5	1	5
CO6	1	5	4	5	2	5	3	5

b) Mapping of COs - PSOs

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

Program Elective Courses

of the B.Tech. (CSE) Programme

Agent Based Modeling & Simulations

Program Elective

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

1. **Course Objectives:**

   The objective of this course is to teach students to use Agent Based modeling platforms to model, simulate and perform experiments in various domains, to find solutions to problems.

2. **Syllabus:**

   Unit – 1 [5 Hours]: Introduction- What is Agent Based Modeling, Industrial and Scientific Applications of agent-based modeling, When and Why to use ABM and its limitations

   Unit – 2 [4 Hours]: Systems, Complex Systems and Emergence - Systems, Complex Systems, Emergence

   Unit – 3 [9 Hours]: Creating Agent Based Models- Introduction to ABMS through NetLogo, Agents & Environment, Domain analysis and designing ABMs, Case studies/Examples of ABM in various domains

   Unit – 4 [9 Hours]: Analyzing Agent Based Models-Designing Simulation Experiments, Behaviour Space and Analysis, Graphs & Visual Analysis Interfaces

   Unit – 5 [3 Hours]: Verification, Validation & Replication-ODD protocol for documenting ABMS, Verification and Testing, Validation and Calibration, Replication and Sensitivity Analysis

   Unit – 6 [6 Hours]: Other Modeling Techniques- System Dynamics, Discrete Event Simulation, Cellular Automaton, Hybrid modeling techniques, Advanced topics

3. **Course Outcomes:**

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

   i) To define Agent Based Modeling and explain its applicability to problems in various industrial and scientific domains.

   ii) To describe complex systems and emergence., also to explain ways to investigate emergent phenomenon.

   iii) To analyze a domain, design and implement an Agent Based Model, run experiments and use the results of the simulations to answer intresting questions and for making predictions.

   iv) To use standard best practices for building ABM: including documentation protocols, verification and validation.

v) To describe and use other modeling techniques in tandem with Agent Based Modeling.

4. Text Books:

a) Wilensky, U., & Rand, W. (2015), An Introduction to Agent-Based Modeling: modeling natural, social, and engineered complex systems with NetLogo. Mit Press. ISBN-13: 978-0262731898

5. Reference Books:

a) Railsback, S. F., & Grimm, V. (2019), Agent-based and individual-based modeling: A Practical Introduction, 2nd Edition. Princeton university press, ISBN: 9780691190822

b) Gilbert, N. (2019). Agent-Based Models. United States: SAGE Publications., ISBN: 9781506355610

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

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

Cloud Computing

Program Elective

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

1. **Course Objectives:**

   This course is meant to provide students with the knowledge of cloud computing and its underlying technologies. This course will provide students with the necessary skills to use cloud computing technologies for developing applications.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Evolution of Computing - Grid and Utility Computing, Distributed Computing, The vision of Cloud Computing ,Characteristics and Benefits ; Enabling Technologies of Cloud Computing - Virtualization, Web 2.0, Service Oriented Architecture

   Unit – 2 [4 Hours]: Cloud Computing Architecture - Introduction, Cloud Service Models, Cloud Deployment Models, Open Challenges

   Unit – 3 [8 Hours]: Virtualization - Characteristics of virtualized environments, Taxonomy of virtualization techniques , Virtualization and cloud computing , Pros and cons of virtualization, Technology examples, Containers and Applications

   Unit – 4 [6 Hours]: Cloud Platforms - Amazon Web Services, Google Cloud Platform, Microsoft Azure, Aneka, OpenStack, Cloud Automation using CHEF/Ansible

   Unit – 5 [6 Hours]: Introduction to Bigdata - Bigdata Concepts, Terminology, NoSQL ; Distributed File Systems-Hadoop File System, Google File System, Introduction to MapReduce and Applications

   Unit – 6 [6 Hours]: Cloud Security - Security Issues in Cloud Computing, Hypervisor and VM Security, Data Security in Cloud Environment, Identity and Access Management in Cloud

3. **Course Outcomes:**

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

   i) To describe different cloud computing models and underlying technologies

   ii) To develop real world applications using cloud computing platforms and containerization technologies

   iii) To implement solutions to complex problems using distributed computing technologies

   iv) To identify and analyze security issues in cloud computing

4. Text Books:

a) Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing – A Practical Approach, Tata McGraw Hill, First Edition, 2009, ISBN: 9780070683518

b) George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, First Edition, 2009, ISBN: 978-0596156367

5. Reference Books:

a) Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, Mastering Cloud Computing, Tata Mcgraw Hill, First Edition, 2013, ISBN: 9781259029950

b) Kai Hwang, Geoffrey C. Fox and Jack G. Dongarra, Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, Morgan Kaufmann, First Edition, 2012, ISBN: 978-0123858801

c) Rittinghouse, John W. and James F. Ransome, Cloud Computing: Implementation, Management and Security, CRC Press, First Edition, 2009, ISBN: 978-1439806807

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

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

Compiler Design

Program Elective

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

1. **Course Objectives:**

   The objective of this course is to enable students a) to learn how a high level language program is translated to a low level language program in a systematic and modular way; b) to learn the tools and techniques involved in building each phase of a compiler.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Various stages/phases – General applications of compiler building techniques. Lexical Analysis – Need – Tokens, patterns, lexemes, Regular expressions, definitions – recognition – Lex tool – finite automata review (DFA, NFA, Minimization, etc) – symbol table. Syntax Analysis – Need – Specification of syntax – CFG

   Unit – 2 [8 Hours]: Parsing, ambiguity – a review of PDAs – Eliminating left recursion – left factoring – Top-down parsing, recursive descent parsing, FIRST, FOLLOW, LL(1) grammars, LL(1) parsing, LL(1) parsing table, Non Recursive predictive parsing.

   Unit – 3 [8 Hours]: Bottom-up parsing, reductions, handles, shift-reduce parsing, conflicts, LR parsers, LR(0), SLR, CLR, LALR parsing techniques – Yacc tool. Syntax-Directed Translation – Syntax directed definitions (SDD) – S-attributed, L-attributed SDD

   Unit – 4 [6 Hours]: DAG order of evaluation – Semantic rules, actions, actions within production – applications. Intermediate-Code Generation – DAGs for expressions – Three-address code, quadruples, triples – Types, type expressions, equivalence, translation of type expressions – type checking – Control flow -- Intermediate code for procedures.

   Unit – 5 [4 Hours]: Code (Machine-independent & dependent) optimization – source optimization – data-flow analysis – redundancy elimination – region based analysis – peephole optimization – optimal code for expressions.

   Unit – 6 [4 Hours]: Code generation – Instruction selection (tree rewriting), register allocation – Static allocation, stack allocation, runtime addresses – Basic blocks, flow graphs – register and address descriptors – an example case study.

3. **Course Outcomes:**

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

   i) To identify various phases of compilation along with their functionality. Student can represent a set of tokens using regular expressions. Student is capable of using automated tools that tokenize the given character stream.

   ii) To demonstrate how a program can be parsed in the two principal ways, namely, the top down and the bottom up parsing.

iii) Ability to design and demonstrate syntax-directed definitions (SDDs) and syntax-directed translations (SDTs) and the ability to use automated tools that does the same.

iv) To implement the code optimization in order to improve the performance of the generated program.

v) To demonstrate how assembly code is generated for a piece of high level code.

4. Text Books:

a) Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Compilers: Principles, Techniques, and Tools, Pearson Addison-Wesley, 2014, ISBN: 9789332518667, 933251866.

b) Keith Cooper, Linda Torczon, Engineering a Compiler, 2nd Edition, Elsevier Science, 2011, ISBN:9780080916613, 0080916619.

5. Reference Books:

a) Priti Shankar, Y.N. Srikant, The Compiler Design Handbook Optimizations and Machine Code Generation, 2nd Edition, CRC Press, 2018, ISBN:9781420043839, 1420043838.

b) Charles N. Fischer, Richard J. LeBlanc Jr., Ron K. Cytron, Crafting A Compiler, 2nd Edition, Pearson Education, 2011, ISBN:9780133001570, 0133001571.

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

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

Computer Graphics and Multimedia

Program Elective

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

1. **Course Objectives:**

   The objective of the course is to introduce principles of computer graphics from the mathematical foundation to graphics visualization. This will cover the stages in rendering digital information to human understandable graphics including object representation, transformation, viewing, and projection.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Computer Graphics Basics - Applications, Random and Raster scan systems; Graphics software and standards - OpenGL introduction; Graphics Primitives - Points, lines, circles and ellipses.

   Unit – 2 [6 Hours]: Area Fill - scan-line polygon filling, inside-outside test, boundary and flood-fill, character generation; Attributes of output primitives - line attributes, area-fill attributes, character attributers; OpenGL primitives - Functions, pipeline, drawing output primitives with OpenGL, event handling and view manipulation.

   Unit – 3 [8 Hours]: 2D Transformations - Basic transformations, matrix representations, homogeneous coordinates, composite transformations, reflection and shearing; Viewing - viewing pipeline and coordinates system, window-to-viewport transformation, point clipping, line clipping, polygon clipping.

   Unit – 4 [5 Hours]: 3D concepts - Parallel and perspective projection, Depth cueing, Visible line and surface identification; 3D representation - Polygon surfaces, tables, equations, meshes, curved lines and surfaces, quadric surfaces, spline representation, cubic spline interpolation methods, Bezier curves and surfaces, B-spline curves and surfaces.

   Unit – 5 [6 Hours]: 3D transformations - Translation, rotation, scaling, reflection, shear, composite transformations; 3D viewing - viewing pipeline and coordinates, parallel and perspective transformation, view volume and general parallel and perspective projection transformations.

   Unit – 6 [5 Hours]: Visible surface detection - back face detection, Depth buffer, A-buffer, Scan-line detection; Illumination models - light sources, basic illumination models, ambient, diffuse and specular relection; Color models - properties of light, chromacity diagram, XYZ, RGB, YIQ, CMY, HSV models.

3. **Course Outcomes:**

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

   i) To explain the basics of display systems and fundamentals of computer graphics.

   ii) To use OpenGL and implement different computer graphics algorithms.

iii) To illustrate the backend of different computer graphics applications such as animation, 3D sketch etc.

iv) To design and view 2D and 3D objects and perform operations like transformation and clipping.

v) To develop algorithms to detect visible surfaces and describe models for illuminations and color.

4. Text Books:

a) Donald D. Hearn, M. Pauline Baker, Warren Carithers, Computer Graphics with OpenGL, Pearson Education India, 4th edition, 2013, ISBN: 978-9332518711

5. Reference Books:

a) Peter Shirley et al., Fundamentals of Computer Graphics, CRC Press, 3rd edition, 2009, ISBN:978-1568814698

b) James D. Foley et al., Computer Graphics: Principles and Practice, Pearson Education India, 3rd edition, 2013, ISBN: 978-0321399526

c) Dave Shreiner, OpenGL Programming Guide: The Official Guide to Learning OpenGL, Addison-Wesley Professional, 8th edition, 2013, ISBN: 978-0321773036

d) Donald D. Hearn, M. Pauline Baker, Computer Graphics C Version, Pearson Education India, 2nd edition, 2002, ISBN: 978-8177587654

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

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

Computer Vision

Program Elective

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

1. **Course Objectives:**

   The objective of this course is to develop the theoretical and algorithmic basis by which useful information about the world can be automatically extracted and analyzed from a single image or a set of images.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Computer Vision - Introduction and Overview, Light, Image Formation; Filtering - Filtering, Edge Detection

   Unit – 2 [6 Hours]: Feature Detection, Description and Matching - Feature Detection, Harris Corner Detection, Invariance and Blob Detection, Feature Descriptors and Matching

   Unit – 3 [5 Hours]: Image Transformations and Alignment - Image Transformations, Image Alignment, RANSAC, Hough Transform, Feature Tracking and Optical Flow

   Unit – 4 [8 Hours]: Perspective and 3D Geometry - Camera Models, Single-view Geometry and Calibration, Image Stitching, Epipolar Geometry, Stereo, Structure from Motion, etc

   Unit – 5 [7 Hours]: Recognition and Learning - Image Recognition, Viola-Jones Face Detection, Bag-of-Words Model, Convolutional Neural Networks, Image Classification, Object Detection, Segmentation

   Unit – 6 [6 Hours]: Advances in Computer Vision and Case Studies - Advanced topics such as Image Generation, Video Processing, Visual Question Answering, etc., Case studies

3. **Course Outcomes:**

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

   i) To exploit the feature detection and description techniques for image matching.

   ii) To comprehend the understanding of image transformation and feature tracing for motion tracking.

   iii) To exploit the 3D to 2D projection for different applications such as image stitching and 3D reconstruction.

   iv) To apply the statistical and learning based features for visual recognition.

   v) To apply the recent trends in computer vision to solve the real world problems.

4. Text Books:

a) Richard Szeliski, Computer Vision: Algorithms and Applications, Springer; 1st edition, 2010, ISBN: 978-1848829343

5. Reference Books:

a) Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2000, ISBN: 978-0521623049

b) David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson, 2nd edition, 2011, ISBN: 978-0136085928

c) Simon Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 1st edition, 2012, ISBN: 978-1107011793

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

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

Data Mining

Program Elective

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

1. **Course Objectives:**
   This course provides with techniques that can extract knowledge from large amounts of data. Both predictive and descriptive methods are covered along with evaluation techniques to quantify the prediction or description made.

2. **Syllabus:**
   Unit – 1 [7 Hours]: Introduction to data mining: What is Data Mining?
   Data Preprocessing: Need - Descriptive Data Summarization: Measuring the Central Tendency, Measuring the Dispersion of Data, Graphic Displays of Basic Descriptive Data Summaries; Data Cleaning: Missing values, Clearning Noisy Data; Data - Integration - Transformation - Reduction: Data Cube aggregation, Attribute subset selection; Dimensionality Reduction, Numerosity Reduction;

   Unit – 2 [5 Hours]: Association Rule Mining: Efficient and Scalable Frequent Itemset Mining methods: The Apriori Algorithm, Generating Association Rules from Frequent Itemsets, Improving Efficiency of Apriori, Mining Frequent Itemsets without Candidate Generation; From Association Mining to Correlation Analysis: From Association analysis to Correlation analysis;

   Unit – 3 [6 Hours]: Supervised learning techniques: Overview of Classification and Prediction - Important Issues: Preparing data for Classification and Prediction, Comparing Classification and Prediction Methods; Bayesian Classification: Bayes Theorem, Naïve Bayesian Classification; Classification by Backpropagation: A Multilayer Feed-Forward Neural Network, Backpropagation; Support Vector Machines.

   Unit – 4 [5 Hours]: Classification by Decision Tree Induction: Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Scalability, and Decision Tree Induction; Rule-Based Classification: Using IF-THEN rules for Classification, Rule Extraction from Decision Tree, Rule Induction using a Sequential Covering Algorithm;

   Unit – 5 [6 Hours]: Unsupervised learning techniques: Overview of Cluster Analysis; Types of data in Cluster Analysis: Interval-Scaled Variables, Binary Variables, Categorical, Ordinal, and Ratio-Scaled variables, Variables of Mixed Types; A Categorization of Major Clustering Methods; Partitioning Methods: Classical Partitioning Methods: k-Means and k-Medoids, Partitioning Methods in Large Databases: From k-Medoids to CLARANS; Hierarchical Methods: Agglomerative and Divisive Hierarchical Clustering, Density-Based Methods; Grid-Based Methods;

   Unit – 6 [7 Hours]: Advanced topics: Mining Data Streams: Frequent-Pattern Mining in Data Streams, Classification of Dynamic Data Streams, Clustering Evolving Data Streams; Mining Time-Series Data: Trend Analysis, Similarity Search in Time-Series Analysis; Text Mining: Text Data Analysis and Information Retrieval, Dimensionality Reduction for Text, Text Mining Approaches; Mining the World Wide Web: Mining the Web Page

layout structure, Mining Link Structures, Automatic Classification of Web Documents, Web Usage mining.

3. Course Outcomes:

At the end of the course,

i) Student will be familiar with various data preparation methods including data cleaning, aggregation, discretization and transformation of data.
ii) Student will be able to apply the techniques to discover association rules from the given transactional data and measure the goodness/qualtiy of the discovered rules.
iii) Student will be able to learn and pratice supervised learning techniques related to probabilistic and discriminative methods in data mining.
iv) Student will be able to adapt and implement rule based supervised classification methods, its various learning techniques to solve various problems in data mining.
v) Student will have a broader understanding of needs and applicability of various unsupervised learning techniques that include a variety of clustering approaches applied in the data mining domain.
vi) Student will be able to understand various data streams, time series, unstructured text data, and web related data and apply various techniques used to mine such data.

4. Text Books:

a) Han J, Kamber M, Pei J. Data Mining: Concepts and Techniques, Morgan Kauffman. 3rd edition, 2011, ISBN: 978-0-12-381479-1.
b) Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, Introduction to Data Mining. United Kingdom: Pearson Education, 2019, ISBN: 9780273769224, 0273769227.
c) Hand David, Mannila Heikki, and Smyth Padhraic. Principles of Data Mining, Prentice-Hall Of India Pvt. Limited, 1st edition, 2001, ISBN: 9788120324572, 8120324579.

5. Reference Books:

a) Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman.Mining of Massive Datasets. United Kingdom: Cambridge University Press, 3rd edition, 2020, ISBN: 9781108476348, 1108476341.
b) Margaret H. Dunham. Data Mining: Introductory and Advanced Topics. Sweden: TPB, 2007, ISBN: 9789332526631, 933252663X.
c) Ian H. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pal, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann Publishers; 4th edition, 2016, ISBN-13: 978-0128042915.
d) Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, An Introduction to Information Retrieval, 2009, Cambridge University Press, Cambridge, England, ISBN: 9780521865715, 0521865719.

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	2	3	2	1	2	2
CO2	5	2	2	3	2	1	2	2
CO3	5	2	2	3	2	1	2	2
CO4	5	2	2	3	2	1	2	2
CO5	5	2	2	3	2	1	2	2
CO6	5	3	3	3	3	2	3	3

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-AIML-01	PSO-AIML-02	PSO-DS-01	PSO-DS-02
CO1	2	4	3	4	3	4	4
CO2	3	3	3	5	5	2	5
CO3	3	5	3	5	5	4	5
CO4	3	5	3	5	5	4	5
CO5	3	5	3	5	5	4	5
CO6	3	5	3	5	5	4	5

Distributed Computing

Program Elective

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

1. **Course Objectives:**

   The objective of this course is to enable students to learn design and analysis of distributed approaches for handling computationally challenging problems. In this course, students could develop enough competencies by demonstrating practical and theoretical knowledge on solving complex tasks that require distributed solutions.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Fundamentals: Design issues and challenges - A Model of Distributed Computations - Event, Processes and State-Time Diagrams - Distributed Sorting on a Line Network

   Unit – 2 [6 Hours]: Logical Clocks and Global States: Logical Time - Logical Clocks, and Vector Clocks - Global States - Consistent Global States - Global Snapshot Recording Algorithms - Distributed Shared Memory

   Unit – 3 [7 Hours]: Message Ordering and Group Communication: Causal Ordering, Concurrent Events - Leader Election in rings - Topology abstraction and overlays - Good / Bad Ordering - Group Communication, Multicast Algorithms - Termination Detection

   Unit – 4 [8 Hours]: Distributed Mutual Exclusion Algorithms: Token Based - Permission Based - Quorum Based MutEx algorithms - Deadlock Detection in Distributed Systems - Checkpointing and Rollback Recovery

   Unit – 5 [4 Hours]: Consensus and agreement algorithms: Distributed Consensus Algorithms - Authentication in Distributed Systems

   Unit – 6 [5 Hours]: Self-Stabilization: Fundamental Concepts - Self-Stabilizing Algorithms to construct Minimum Spanning Trees - Self-stabilization as a solution to Fault Tolerance - Limitations of Self-Stabilization - Peer-to-Peer computing

3. **Course Outcomes:**

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

   i) To understand the basic design issues of distributted computing using events, processes and state-time diagrams

   ii) To identify the impact of logical clocks and consistent states of a distributed system

   iii) To perform topology abstraction and perform ordering of messages in a distributed system using message passing approaches

iv) To apply various mutual exclusion algorithms for solving real-world problems and demonstrate skill sets to design distributed algorithms for failure resistant recovery

v) To understand and apply the design of consensus protocols and their roles in a distributed system

vi) To adapt and build self-stabilizing or self-organizing systems to ensure legitimacy of states in a distributed system

4. Text Books:

a) Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 2008, Cambridge, UK, ISBN (e-Book): 978-0-511-39341-9

b) Gerard Tel, Introduction to Distributed Algorithms, Cambridge University Press, June 2012, ISBN (e-book): 9781139168724

5. Reference Books:

a) Nancy A. Lynch, Distributed Algorithms, Morgan Kaufmann, USA, ISBN: 1-55860-348-4, 1996

b) Andrew S. Tanenbum and Maarten Van Steen, Distributed Systems: Principles and Para: Principles and Paradigms, Pearson Education India; Second edition, 2015, ISBN: 978-9332549807

c) George Coulouris, Jean Dollimore and Tim Kindberg, Distributed Systems: Concepts and Design, Pearson Education India; 4th edition, 2008, ISBN: 978-8131718407

d) Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, Second Edition, CRC Press, Taylor & Francis, 2007

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

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

High Performance Computing

Program Elective

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

1. **Course Objectives:**
   The objective of this course is a) to introduce the fundamental and advanced parallel algorithms through the GPU and MPI programming environments; and b) to provide fundamentals on memory hierarchy design and trade-offs in both uni-processor and multiprocessors.

2. **Syllabus:**
   Unit – 1 [6 Hours]: Motivating Parallelism, Scope of Parallel ComputingI, Introduction to HPC: Parallel Programming Platforms; Implicit Parallelism: Trends in Microprocessor Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms;

   Unit – 2 [6 Hours]: Measures of Parallel Algorithms;Analytical Modeling of Parallel Programs: Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, the Effect of Granularity on Performance; Parallel Platforms: Models (SIMD, MIMD, SPMD) , Communication (Shared Address Space vs. Message Passing)

   Unit – 3 [6 Hours]: Thread Basics: Why Threads? The POSIX Thread API,Thread Creation and Termination, Synchronization Primitives in Pthreads,Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs

   Unit – 4 [6 Hours]: Tips for Designing Asynchronous Programs,OpenMP: A Standard for Directive Based Parallel Programming.

   Unit – 5 [6 Hours]: The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators.

   Unit – 6 [6 Hours]: The Age of Parallel Processing, Central Processing Units, The Rise of GPU Computing, A brief history of GPUs, Early GPU computing; CUDA: What is CUDA architecture, using the CUDA architecture, Applications of CUDA, Medical Imaging, Computational Fluid Dynamics, Environmental Science; Introduction to CUDA C: A First Program, Hello world, A kernel call, Passing parameters, Querying devices, using device properties; Prallel Programming in CUDA C:CUDA parallel programming, Summing vectors, A fun example

3. **Course Outcomes:**

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

   i) To comprehend the limitations of traditional single-core architectures and understand the requirements and advantages of parallel computing.

ii) To analyze the performance of serial and parallel implementations and understand the tradeoff between different models of parallel computing.

iii) To design and implement the multithreaded versions of standard single threaded algorithms

iv) To work with massively parallel architecures and take advantage of the available parallelism with CUDA programming.

4. Text Books:

a) John Hennessy and David Patterson, Morgan Kaufmann,, Computer Architecture - A Quantitative Approach, 5th Edition, Morgan Kaufmann, ISBN:9780123838735.
b) Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors A Hands-on Approach, 3rd Edition, Morgan Kaufmann, ISBN 978-0128119860.
c) Peter S. Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011, Morgan Kaufmann, ISBN 9780123742605.
d) Michael J Quinn, Parallel Programming in C with MPI and OpenMP, Tata McGraw Hill, 2003, ISBN: 0070582017

5. Reference Books:

a) Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP, MIT Press, 2008. ISBN 9780262533027
b) Peter S. Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011. ISBN 978-0-12-374260-5
c) Gropp, Lusk, Skjellum, Using MPI, Using MPI, MIT Press, 2014,: ISBN 9780262527392 336

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

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

Information Retrieval

Program Elective

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

1. **Course Objectives:**

   The objective of this course is enable the students to learn theoretical aspects of an information retrieval system and practice information extraction, storage, and retrieval from various sources. The course will make the students to master various IR models for building search and retrieval related components in modern applications.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Fundamentals: Introduction - Terms - Vocabulary and Postings Lists - Dictionaries - Boolean and Tolerant Retrieval

   Unit – 2 [6 Hours]: Components of an Information Retrieval System: Information Extraction - Index Construction - Index Compression Techniques

   Unit – 3 [8 Hours]: Scoring, Retrieval and Evaluation: Scoring, Term Weighting and Vector Space Model - Computing Scores in a Complete Search System - Evaluation in Information Retrieval - Relevance Feedback & Query Expansion

   Unit – 4 [6 Hours]: Various Retrieval Models: XML Retrieval - Probabilistic Information Retrieval - Language Models for Information Retrieval

   Unit – 5 [6 Hours]: Diversification in Information Retrieval: Text Classification & Naive Bayes - Vector Space Models - Flat Clustering - Hierarchical clustering

   Unit – 6 [4 Hours]: Advances in Information Retrieval: Recommender Systems - Web Search Basics, Web Crawling and Indexes - Link Analysis - Conversational IR Systems

3. **Course Outcomes:**

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

   i) To understand the basic of an Information Retrieval systems and components of a search system in general

   ii) To learn different information extraction techniques and algorithms for creating inverted indices and finally applying index compression techniques of an IR system.

   iii) To apply various term weighting schemes, similarity estimation for effective information retrieval and several techniques for query understanding and relevance feedback

   iv) To build various information retrieval systems using XML, Probability and Language Models

v) To perform information retrieval modelling, classification and clustering for search results diversification

vi) To develop / adapt the advanced IR concepts for developing various applications including recommender systems and conversational IR systems

4. Text Books:

a) Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, An Introduction to Information Retrieval, Cambridge University Press, Cambridge, England, 2009

b) Ricardo A. Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley Longman Publishing, Boston, MA, USA, 1999.

5. Reference Books:

a) William B. Frakes and Ricardo Baeza-Yates (Eds.), Information Retrieval: Data Structures and Algorithms, Prentice-Hall, Inc., Upper Saddle River, NJ, USA, 1992.

b) State-of-the-art research papers from SIGIR, WWW, KDD, ECIR, and AIRS conferences

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

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

Introduction to Cyber Security

Program Elective

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

1. **Course Objectives:**

   The objective of this course is to introduce students to the basic concepts of cyber security. This course provides an overview of the tools, technologies and mechanisms used in cyber security along with their use cases.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Overview - Cyber security Concepts, Threats, Attacks, and Assets, Security Functional Requirements, Fundamental Security Design Principles, Attack Surfaces and Attack Trees, Security Strategy

   Unit – 2 [6 Hours]: Security Layers - Human factors in cyber security, Perimeter Security, Network Security, EndPoint Security, Application Security

   Unit – 3 [6 Hours]: Network Security - Network Organization, Firewalls, Proxies, DMZ, Internet security protocols and standards, Intrusion detection and prevention

   Unit – 4 [6 Hours]: Cryptography - symmetric and asymmetric encryption, basics of hashing, common use cases ; Access Control - Authentication, Authorization

   Unit – 5 [6 Hours]: Operating System Security - Program Security, non-malicious program errors, viruses, controls against program threats, protection in operating systems, protected objects, methods of protection

   Unit – 6 [6 Hours]: Incident Response - Incident Prioritization, Incident Handling, Disaster Recovery, Incident Response and Handling Process, Incident Management

3. **Course Outcomes:**

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

   i) To explain the basic concepts and layers of cyber security

   ii) To describe the different tools and mechanisms used in cyber security including access control and cryptography

   iii) To identify the appropriate security mechanisms or tools to handle different cyber security requirements

   iv) To apply the suitable incident response strategy to handle cyber security incidents

4. **Text Books:**

   a) William Stallings and Lawrie Brown, Computer Security Principles and Practice, Pearson, Third Edition, 2014, ISBN: 978-0-13-377392-7

5. Reference Books:

a) Matt Bishop, Introduction to Computer Security, Addison-Wesley, First Edition, 2004, ISBN: 978-0321247445

b) Ross Anderson, Security Engineering, Wiley, Second Edition, 2008, ISBN: 978-0470068526

c) Douglas Robert Stinson and Maura Paterson. Cryptography Theory And Practice, CRC Press, Fourth Edition, 2018, ISBN: 978-1138197015

d) William Stallings, Cryptography and Network Security: Principle and Practice, Pearson, Sixth Edition, 2013, ISBN: 978-0133354690

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

a) Mapping COs – POs

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

b) Mapping COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-CS-01	PSO-CS-02
CO1	4	4	3	2	3
CO2	4	4	3	2	3
CO3	3	3	2	1	3
CO4	3	4	3	5	3

Machine Learning

Program Elective

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

1. **Course Objectives:**

   This course provides the statistical inference and underlying mathematical relationships across various machine learning algorithms. This course also provides exposure to design, implement and analyse the different machine learning algorithms for a given problem.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Introduction to machine learning (ML). Various learning paradigms. Introduction to supervised learning and unsupervised learning. Introduction to Classification and Regression. Brief overview on clustering and dimentionlaity reduction. Introduction to parametric and non parametric machine learning models.
   Assessing and Improving machine learning models-
   a. Quality of fit: Error functions
   b. Evaluation Metrics
   c. Train, Test and Validation Datasets
   d. Over fit vs Under fit
   e. Sampling methods: Holdout method, Cross validation, K-fold cross validation, etc.

   Unit – 2 [6 Hours]: Non-parametric techniques – Parzen Windows, K-nearest neighbor classification. Introduction to the Naive-Bayes classifier, Bayesian decision theory, Maximum-likelihood and Bayesian parameter estimation.

   Unit – 3 [6 Hours]: Regression – linear models, extension to nonlinear models. Bias variance trade-off, Regularization (Ridge, Lasso, etc.). Support Vector Machines (SVMs)- Linear SVM and non-linear kernel methods.

   Unit – 4 [6 Hours]: Basic decision tree and Bagging, Random Forests and Boosting.

   Unit – 5 [6 Hours]: Unsupervised Learning: clustering, mixture models and EM. Dimensionality reduction techniques – PCA, SVD.

   Unit – 6 [6 Hours]: Introduction to Neural Network: Linear discriminants – Perceptron. Multi-layer neural networks – Activation Functions, Error back-propagation and Optimization. Advanced topics on Machine Learning such as convolutional neural network architectures, transfer learning, and case studies

3. **Course Outcomes:**

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

   i) Able to explain the fundamental concepts of machine learning including data and model complexity.

ii) To choose or design an appropriate machine learning algorithm for solving a given problem.

iii) To perform the dimensionality reduction to deal with the dynamically growing data.

iv) To analyze the performance of given or implemented machine-learning solutions on practical datasets.

4. Text Books:

a) Bishop, Christopher M., Pattern Recognition and Machine Learning, Springer, 2006, ISBN 978-0-387-31073-2

b) Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, 2nd Edition, Publisher John Wiley & Sons, 2006, ISBN: 978-0-471-05669

5. Reference Books:

a) Ethem Alpaydin, Introduction to Machine Learning, Fourth Edition, The MIT Press, October 2004, ISBN 0-262-01211-1

b) Tom Mitchell, Machine Learning, McGraw Hill, 1997, ISBN 0070428077

c) M. Narasimha Murty, V. Susheela Devi, Pattern Recognition An Algorithmic Approach, Springer, 2011, ISBN 978-0-85729-495-1

d) James, G., Witten, D., Hastie, T., Tibshirani, R, An Introduction to Statistical Learning, Springer, 2013, 978-1-4614-7137-0

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	4	3	5	3	1	2
CO2	5	1	4	3	5	3	1	2
CO3	5	1	4	3	3	3	1	2
CO4	5	1	1	2	3	3	1	2

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-AIML-01	PSO-AIML-02
CO1	5	5	1	5	3
CO2	5	5	1	5	4
CO3	5	5	1	5	4
CO4	5	5	1	4	4

Natural Language Processing

Program Elective

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

1. **Course Objectives:**

   This course introduces the fundamental concepts, techniques and challenges of natural language processing (NLP) and provide hands-on experience of text analysis. It will introduce different approaches of analyzing texts to discover structures and motivate in the field of NLP where students can try to find solutions towards reducing the gap between computers and humans to understand natural language.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Background – Introduction, Applications, NLP-Hard; Ambiguity

   Unit – 2 [4 Hours]: Speech Processing - Phonetics & Phonology, Sequence labelling

   Unit – 3 [9 Hours]: Data Preprocessing/Understanding - Regular Expressions, Morphology; Finite State Automata; Project Evaluation Start

   Unit – 4 [6 Hours]: Language Modeliing - N-Gram, HMM, Evaluation methods and metrics

   Unit – 5 [7 Hours]: Syntax Parsing and Deep Parsing - Syntax and Parsing, Part of Speech tagging; Named Entity Recognition

   Unit – 6 [4 Hours]: Semantic Analysis - Semantic Analysis, Pragmatics, Discourse

3. **Course Outcomes:**

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

   i) Ability to get an idea of the current challenges in NLP and assess/classify new NLP problems based on their difficulty.

   ii) To utilize speech processing applications/tools.

   iii) To develop NLP routines using regular expressions and morphology and context-free grammars for small fragments of natural language.

   iv) Ability to build various language models and their evaluation metrics and use them effectively for solving real world problems.

   v) To demonstrate knowledge of syntactic parsing, POS tagging and utilizing them for training of NER classifiers, to be used as component of various NLP applications.

   vi) To develop conversational systems that could make use of semantic and syntactic analysis, pragmatics and discourse resolution.

4. Text Books:

a) Dan Jurafsky, James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Prentice Hall, 2009, ISBN: 9780131873216

b) Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT press, 1999., ISBN: 978-0262133609

5. Reference Books:

a) Bird, Steven, et al. Natural Language Processing with Python. United States, O'Reilly Media, 2009, ISBN: 9780596555719

b) Eisenstein, Jacob. Introduction to Natural Language Processing. United Kingdom, MIT Press, 2019, ISBN: 9780262042840

c) Lieberman, Philip. Toward an Evolutionary Biology of Language. Cambridge, Belknap Press of Harvard University Press, 2006, ISBN: 9780674021846

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

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

Principles of Cyber-Physical Systems Computation

Program Elective

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

1. **Course Objectives:**

   The objective of this course is to enable students: to understand the varied requirements of programming CPS compared to general purpose systems; and to know the model-based design approach for building CPS and meeting the requirements of design such as safety, liveliness, stability, and performance.

2. **Syllabus:**

   Unit – 1 [3 Hours]: Introduction: What is CPS? Applications of CPS. Design Process: Modelling, Design, and Analysis.

   Unit – 2 [6 Hours]: Synchronous Model Part 1: Reactive Components-Variables, Valuations, and Expressions; Inputs, Outputs, and States, Initialization, Update, Executions, and Extended State Machine. Properties of Components-Finite State Components, Combinational Components, Event Triggered Components, Nondeterministic Components, Input-Enabled Components, Task graph and Await Dependencies.

   Unit – 3 [6 Hours]: Synchronous Model Part 2: Composing Components-Block Diagram, Input and Output Variable Renaming, Parallel Composition, and Output Hiding. Synchronous Design-Synchronous Circuits, Cruise Controls, Synchronous Networks.

   Unit – 4 [6 Hours]: Safety Requirements - Safety specifications: Invariants of Transition System, Role of Requirements in System Design, Safety Monitors. Verifying Invariants-Proving Invariants, Automated Invariant Verification, Enumerative Search, Symbolic Search

   Unit – 5 [9 Hours]: Asynchronous Model: Asynchronous Processes-States, Inputs, and Outputs, Input, Output, and Internal Actions, Executions, Extended State Machines, Operations on Processes, Safety Requirements, Asynchronous Design Primitives Blocking Vs Non-Blocking Synchronization, Deadlocks, Shared Memory, Fairness Assumptions, Asynchronous Coordination Protocols

   Unit – 6 [6 Hours]: Liveness Requirements: Temporal Logic - Linear Temporal Logic, LTL Specifications, LTL Specifications for Asynchronous Processes and Model Checking-Buchi Automata, From LTL to Buchi Automata, Nested Depth First Search, Symbolic Repeatability Checking

3. **Course Outcomes:**

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

   i) To identify the difference in design automation flow for the CPS and General Purpose System.

ii) To model a real-life case study (e.g. car cruise controller) with reactive components using discrete, synchronous model, and asynchronous models.

iii) To use tools adopted in industry for formal verification of CPS.

4. Text Books:

a) Rajeev Alur, Principles of Cyber-Physical System, MIT Press, 2015, ISBN: 9780262029117.

5. Reference Books:

a) Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, 2nd Edition, MIT Press, 2017, ISBN 978-0-262-53381-2.

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

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

Institute Elective Courses

of the B.Tech. (CSE) Programme

Applied Stochastic Models

Institute Elective

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

1. **Course Objectives:**

   The objective of the course is to enable students to develop the fundamentals and advanced concepts of stochastic models. The course aims to equip the students with the necessary mathematical tools to use probabilistic models in solving modern engineering problems.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction - Introduction to Stochastic Models, Motivation and Applications; Advanced Probability Overview - Random Variables, Expectation, Probability Distribution, Moments, Moment Generating Functions, Functions of Random Variables, Conditional Expectation, Exponential Distribution, Lack of Memory, Limit Theorems;

   Unit – 2 [7 Hours]: Stochastic Process - Definition and Examples of Stochastic Processes, Classification of Stochastic Processes, Moving Average and Auto-regressive Processes, Elementary Problems; Stationarity - Strong and Weak;

   Unit – 3 [8 Hours]: Markov Chain - Markov Chain (MC), Discrete Time Markov Chain, Continuous Time Markov Chain, Examples of MCs, Applications of MCs, Transition Probability Matrix, Chapman-Kolmogorov Equations, Calculation of n-step Transition Probabilities, Limiting Probabilities, Stationary Distribution, Transient MC;

   Unit – 4 [4 Hours]: Random Walk Models - Random Walk and Simple Random Walk, Duality in Random Walks, Gambler's Ruin Problem and applications, Martingales, Brownian Motion;

   Unit – 5 [7 Hours]: Queueing Models - Poisson Process with Examples, Inter-arrival and Waiting Time Distributions, Queues, Little's Theorem, Single Server and Multi Server Queue, Infinite Server Queue, Queue Length, Waiting Time in the Queue and Waiting Time in the System;

   Unit – 6 [6 Hours]: Markov Chain Monte Carlo (MCMC) - Motivation and Application, Monte Carlo Sampling, Rejection and Importance Sampling, Metropolis Hastings Algorithm, Gibbs Sampler, Model Simulations in R/Python/Matlab;

3. **Course Outcomes:**

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

   i) To anticipate different possibilities and quantify underlying uncertainties in Markov environment.

ii) To apprehend different scenarios and underlying uncertainties in specific stochastic environment and make appropriate decisions.

iii) To interpret situations that may evolve in different real world queuing systems and make necessary decisions.

iv) To use stochastic simulation in respective fields of interest for further explanation of real world intricacies.

4. Text Books:

a) Sheldon M. Ross., STOCHASTIC PROCESSES, New York. JOHN WILEY & SONS, Second Edition, 1996, ISBN: 0-471-12062-6

b) Gregory F. Lawler, Introduction to Stochastic Processes, Chapman & Hall/CRC, Second Edition, 2018, ISBN: 9781482286113

5. Reference Books:

a) Sheldon M. Ross., Introduction to Probability Models, Elsevier, 11th Edition, 2014, ISBN: 978-0-12-407948-9

b) Samuel Karlin and Howard E. Taylor, A First Course in Stochastic Processes, Academic Press, 2nd Edition, 1975

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

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

Brain Computer Interaction

Institute Elective

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

1. **Course Objectives:**

   The objective of this course is to equip students with the knowledge of various methodologies and technologies used to collect information from the brain and learn about their applications and enable them to further pursue this emerging topic as a career option.

2. **Syllabus:**

   Unit – 1 [3 Hours]: Introduction to Brain Computer Interface - Definition and overview of BCI - History of BCI - Application of BCI in medical and non-medical fields.

   Unit – 2 [3 Hours]: Introduction to Basic Neuroscience - Synapses and neurons; Working of the brain and its various lobes; Neural mechanisms- transfer of neuronal information.

   Unit – 3 [9 Hours]: Modelling and Recoding of the Brain Signals- Brain computer interface types - Invasive, Semi-invasive, Non-invasive techniques; An Introduction to Non-Invasive Acquisition approaches - EEG, MEG, fNIRS, fMRI; EEG and Why EEG ; EEG Hardware-EEG electrode systems, EEG Data Acquisition approaches, Experimental setups, EEG Recording and analysis software; Neural Potentials- ERP, P300, SSVEP, ASSR, SCP, Motor Imagery. analysis softwares - Neural Potentials- ERP, P300, SSVEP, ASSR, SCP, Motor Imagery

   Unit – 4 [8 Hours]: Signal processing - Biological artifacts; Signal Pre-processing- Epoching, noise removal; Filtering techniques - Temporal and Spatial Filters

   Unit – 5 [9 Hours]: Signal Analysis using Machine Learning Approaches - Feature Engineering- Feature extraction, reduction, and optimization - Classification and Clustering (Supervised and unsupervised learning of EEG Data)

   Unit – 6 [4 Hours]: BCI Applications - Cognitive Engineering - Probing mind - Vigilance detection using EEG signals - Mental workload and Cognitive load estimation - BCI in consumer marketing - BCI for lie detection.

3. **Course Outcomes:**

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

   i) To apply the knowledge of the components of Brain Computer Interface System, its applications in Medical and Non-Medical Fields
   ii) To demonstrate the knowledge of basic neuroscience to collect information from the brain and translate the information using advances in neural interfacing and neural imaging technology.
   iii) To analyse the commonly used signal processing and machine learning methods and apply these methods on real neural data.

iv) To experience on the recent tools and applications of BCI and ablility to solve BCI problems by working in teams and aware towards the moral & ethical responsibility while using interfacing system.

4. Text Books:

a) Rajesh P. N. Rao, Brain-Computer Interfacing: An Introduction, Cambridge university press, 2019, ISBN: 978-1108708012.

5. Reference Books:

a) Brain-Computer Interfaces: Principles and Practice, Jonathan Wolpaw (editor), Oxford university Press, 2012
b) Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience, Second Edition, Bernard J. Baars, Nicole M. Gage, Academic Press, 2010
c) Bishop, Christopher M. Pattern recognition and machine learning. springer, 2006.
d) Satish Kumar, Neural networks: A classroom approach, Tata McGraw Hill, 2011.
e) J. S. R. Lang, C. T. Sun and E. Mizutaju, Neuro-fuzzy and soft computing, Pearson Education, 1996.
f) David E. Goldberg , Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989
g) https://sccn.ucsd.edu/wiki/Introduction_To_Modern_Brain-Computer_Interface_Design

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

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

Cryptography

Institute Elective

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

1. **Course Objectives:**

   In this course, students will learn cryptographic algorithms and techniques to achieve basic security goals such as confidentiality, integrity, authentication and non-repudiation. At the end of this course, students will know how to apply cryptographic techniques in the design and analysis of security protocols for industry applications.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Number Theory Basics: Modular arithmetic, Primes, Euclidean Algorithm, Chinese Remainder Theorem

   Unit – 2 [6 Hours]: Shannon's Theory: Perfect Secrecy, Entropy, Security analysis of Classical ciphers

   Unit – 3 [6 Hours]: Symmetric Key Cryptography: DES, Finite Fields, AES, Security Analysis

   Unit – 4 [6 Hours]: Public Key Cryptography: RSA, ElGamal, Elliptic Curve Cryptography

   Unit – 5 [6 Hours]: Digital Signatures: Hash functions, Digital Signature Algorithm, ElGamal Digital Signature

   Unit – 6 [6 Hours]: Applications: Key Distribution, Diffi-Helman Kay Exchange, Key Management in Distributed Systems

3. **Course Outcomes:**

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

   i) To understand the basic arithmetics required to design cryptographic algorithms.

   ii) To understand the cryptographic algorithms such as symmetric ciphers, asymmetric ciphers, hash functions and digital signatures.

   iii) To analyses the security of cryptographic algorithms and protocols.

   iv) To design and analyses the performance of cryptographic protocols for practical perspective.

4. **Text Books:**

   a) Douglas Stinson, "Cryptography: Theory and Practice", Chapman and Hall/CRC, 3rd Edition, 2006.
   b) Behrouz A Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, McGraw-Hill Education, 2011.

5. Reference Books:

a) William Stallings, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson Education, 2014.
b) Neal Koblitz, A course in number theory and cryptography, Second Edition, Springer.
c) Alfred J. Menezes, Paul C. van Oorschot, and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press.
d) D. Yaga, P. Mell, N. Roby, and K. Scarfone, Blockchain Technology Overview, NISTIR 8202.
e) Satoshi Nakamoto, Bitcoin: A peer-to-peer electronic cash system, Manubot, 2019.
f) Classroom Lecture Notes

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

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

Digital Image Processing

Institute Elective

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

1. **Course Objectives:**

   The first objective of this course is to describe and explain basic principles of digital image processing. Secondly, students will learn how to design and implement algorithms for basic image processing (e.g., image enhancement and noise removal) and advanced image analysis (e.g., image compression, image segmentation and image representation). Finally, students will also know how to assess the performance of image processing algorithms.

2. **Syllabus:**

   Unit – 1 [5 Hours]: Introduction - Introduction to digital image processing, elements of visual perception, image sensing and acquisition, image sampling and quantization, relationship between pixels.

   Unit – 2 [6 Hours]: Image Enhancement in Spatial Domain - Gray level transformations, histogram processing, spatial filters, smoothing and sharpening in spatial domain.

   Unit – 3 [6 Hours]: Image Enhancement in Frequency Domain - 1-D Fourier transform and its inverse, 2-D discrete Fourier transform, discrete cosine transform, low pass filters, high pass filters, smoothing and sharpening in frequency domain.

   Unit – 4 [7 Hours]: Image Restoration - Noise models, spatial domain filtering, frequency domain filtering, estimating degradation function, inverse filtering, Wiener filtering; Multiresolution Processing - image pyramids, subband coding, Haar transform, Wavelet functions, 1-D and 2-D Wavelet transform, fast Wavelet transform; Color Image Processing - color models, color transformations. Advance algorithms.

   Unit – 5 [6 Hours]: Image Compression - Error free compression such as variable length coding, LZW, bit-plane coding, lossless predictive coding, Lossy compression such as Lossy predictive coding, transform coding, Wavelet coding, overview of compression standards. Advance algorithms.

   Unit – 6 [6 Hours]: Morphological Image Processing - Dilation, erosion, opening, closing, Hit-or-Miss transformation, morphological algorithms; Image Segmentation - segmentation using thresholding, region based segmentation, segmentation by morphological watersheds. Advance algorithms.

3. **Course Outcomes:**

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

   i) To understand and analyze problems in image processing and image analysis.

ii) To understand the fundamental of image processing (e.g., image enhancement and image denoising) and image analysis techniques (e.g., image compression, image segmentation and image representation).

iii) To design and implement algorithms to solve image processing and image analysis problems.

iv) To assess the performance of image processing algorithms, including shortcomings.

v) To develop real-time efficient image processing algorithm and system for an industrial application in healthcare, retail shop, manufacturing industry, agriculture, defense etc.

vi) To acquire and demonstrate knowledge on recent advances in image processing.

4. Text Books:

a) R. C. Gonzalez and R. E. Woods, Digital Image processing, Prentice Hall, 3rd Edition, 2018, ISBN: 978-0-13-168728-8.

5. Reference Books:

a) K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1995, ISBN: 978-0133361650.

b) R. C. Gonzalez and R. E. Woods, Digital Image Processing with MATLAB, Prentice Hall, 2003, ISBN: 978-0982085417.

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

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

Introduction to Data Analytics

Institute Elective

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

1. **Course Objectives:**

   The objective of the course is to enable students to graphically interpret data and find meaningful pattern out of it. It also equips students with required statistical tools to model data from various domains and to develop decision support systems.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Data Definitions - Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing

   Unit – 2 [6 Hours]: Descriptive Statistics - Measures of central tendency, Measures of location of dispersions; Pre-process the data - Data cleaning, missing data treatment, outliers; Correlation analysis.

   Unit – 3 [4 Hours]: Estimation - Overview of Sampling Theory, Different Sampling Techniques; Important Univariate Distributions - Z, t, Chi Squared, F; Estimation Theory - MLE, MME, Unbiasedness and other properties of a good estimator, RMSE, Standard Error.

   Unit – 4 [6 Hours]: Parametric and Non-parametric Tests - Statistical hypothesis generation and testing, Introduction to Parametric Tests and Non-Parametric Tests; Parametric Tests - Z test, t-Test (paired and independent); Non-parametric Tests - Mann Whitney U Test, Sign Test and Wilcoxon signed Rank Test.

   Unit – 5 [6 Hours]: Introduction to Regression and ANOVA - Simple regression, Logistic regression; ANOVA (Analysis of Variance) - Between Group variability and within Group variability, One-way ANOVA, Two-way ANOVA.

   Unit – 6 [10 Hours]: Machine Learning techniques - Classification techniques (Bayesian Classifier, Decision trees, SVM); Sensitivity Analysis, Similarity measures; Clustering - Clustering techniques, Measuring Cluster Goodness; Associative Rule Mining.

3. **Course Outcomes:**

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

   i) To collect, organize, prepare data and conduct data analytics using scientific methods, and to apply statistical data analysis techniques for solving real-world problems.
   ii) To demonstrate understanding of the data analytics fundamentals, and to be aware of the scopes and limitations of model application.
   iii) To infer population characteristics from available sample information.
   iv) To demonstrate the fundamentals of machine learning techniques and apply them to model real world data.
   v) To communicate with an insightful and well-organized report, including thoughtful and convincing details.

4. Text Books:

a) Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 2017, ISBN: 978-1119492443

b) Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Edition, Prentice Hall Inc., ISBN: 978-0134115856

c) Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Data Mining, Inference, and Prediction, Springer, 2nd Edition, 2014, ISBN: 978-0387848570

5. Reference Books:

a) Gareth M. James, Daniela Witten, Trevor Hastie and Robert Tibshirani, An Introduction to Statistical Learning: with Applications in R, Springer, 2013, ISBN: 978-1461471370.

b) John M. Chambers, Software for Data Analysis: Programming with R (Statistics and Computing), Springer, 2008, ISBN: 978-0387759357.

c) Mohammed J. Zaki and Wagner Meira Jr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge, 1st edition, 2012, ISBN: 978-0521766333.

d) Mark Gardener, Beginning R: The Statistical Programming Language, Wiley, 2013, ISBN: 978-1118164303.

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

a) Mapping of COs to POs

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

b) Mapping of COs to PSOs

	PSO-01	PSO-02	PSO-03	PSO-DS-01	PSO-DS-02
CO1	3	3	5	5	5
CO2	4	3	5	5	5
CO3	3	3	5	5	5
CO4	4	3	5	5	5
CO5	3	3	5	5	5

Spcialization Elective Courses

B.Tech. (CSE) Programme
with Specialization in Artificial Intelligence
and Machine Learning (AIML)

Deep Learning

Specialization Elective

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

1. **Course Objectives:**

   This course covers the foundation and implementation of Deep Learning models, including how to build neural networks and how to lead successful deep learning projects.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Neural Networks - Introduction of Machine Learning, Linear Classifiers, Perceptron, Multi-class Classification, Non-linear Classification, Neural Networks

   Unit – 2 [6 Hours]: Multilayer Perceptron - Multilayer Perceptron, Backpropagation; Model Training - Training Aspects of Neural Networks, Hyperparameter Tuning, Gradient Descent Optimization, Regularization, Transfer Learning

   Unit – 3 [6 Hours]: Convolutional Neural Network - CNN and Architectures

   Unit – 4 [6 Hours]: Recurrent Neural Network - Word Embeddings, RNN, LSTM, GRU, Attention in RNN

   Unit – 5 [6 Hours]: Network Visualization and Fooling - Visualization Techniques, Network Fooling and Defense; Generative Neural Network - Autoencoders, Generative Adversarial Network, Variational Autoencoder

   Unit – 6 [6 Hours]: Advanced Topics and Case Studies - Deep Reinforcement Learning, Self-supervised Learning, Transformers, Neuroscience Approaches, Case Studies

3. **Course Outcomes:**

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

   i) To gain the fundamentals of deep learning and its uses to tackle non-linear data.

   ii) To utilize various training tricks for deep learning models.

   iii) To apply the convolutional neural networks for processing of image and video data for different applications.

   iv) To apply the recurrent neural networks to deal with the sequential and time step data for NLP and Speech applications.

   v) To apply the generative models to cater the need of sample generation to solve the real world problems.

vi) To apply the deep learning techniques using recent trends for real applications using case studies.

4. Text Books:

a) Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, The MIT Press, Illustrated edition, 2016, ISBN: 978-0262035613

5. Reference Books:

a) Michael Nielsen, Neural Networks and Deep Learning, 2016, ebook, http://neuralnetworksanddeeplearning.com/

b) Yoshua Bengio, Learning Deep Architectures for AI, Now Publishers Inc, 2009, ISBN: 978-1601982940

c) Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 1st edition, 2018, ISBN: 978-3319944623

d) François Chollet, Deep Learning with Python, Manning Publications; 1st edition, 2017, ISBN: 978-1617294433

e) Rowel Atienza, Advanced Deep Learning with Keras, Ingram short title, 2018, ISBN: 978-1788629416

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	3	3	5	3	3	5
CO2	3	5	5	5	5	5	5	5
CO3	4	5	4	4	5	5	5	5
CO4	4	5	4	4	5	5	5	5
CO5	5	5	5	4	5	5	5	5
CO6	5	5	5	5	5	5	5	5

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-AIML-01	PSO-AIML-02
CO1	5	5	3	4	3
CO2	5	5	5	5	5
CO3	5	5	5	5	5
CO4	5	5	5	5	5
CO5	5	5	5	5	5
CO6	5	5	5	5	5

Reinforcement Learning

Specialization Elective

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

1. **Course Objectives:**

   The objective of the course is to provide the fundamentals and applications of reinforcement learning and will cover the methods used to create agents that can solve a variety of complex tasks, with applications ranging from gaming to finance to robotics.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction - Origin and history of Reinforcement Learning, Introduction to RL terminologies, RL framework and applications

   Unit – 2 [6 Hours]: Markov Decision Process - Introduction to Markov property, Markov chains, Markov reward process (MRP), Introduction to Bellman equations for MRPs, Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, Optimality of value functions and policies, Bellman optimality equations

   Unit – 3 [6 Hours]: Prediction and Control by Dynamic Programming - Overview of dynamic programming for MDP, Principle of optimality, Iterative policy evaluation, Policy iteration, Value iteration, Banach fixed point theorem

   Unit – 4 [8 Hours]: Monte Carlo & Temporal Difference Methods - Overview of Monte Carlo methods for model free RL, Control in Monte Carlo, On policy and off policy learning, Overview of TD(0), TD(1) and TD(λ), TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants, Practice with OPENAI GYM toolkit for building RL algorithms

   Unit – 5 [6 Hours]: Function Approximation Methods - Function approximation, Linear parameterization, State aggregation methods, Eligibility traces for function approximation, Afterstates, Control with function approximation

   Unit – 6 [6 Hours]: Policy Gradient Approaches - Policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, Bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, Advantage function, Actor-critic methods

3. **Course Outcomes:**

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

   i) To understand and automate goal-directed learning and decision making using RL techniques.

   ii) To decide and formulate a RL problem for the given application and to be able to define it formally in terms of state space, action space, dynamics and reward model.

   iii) To frame RL problems and to tackle algorithms from dynamic programming, Monte Carlo and temporal-difference learning.

iv) To understand and apply tabular methods and approximate solutions to solve classical control problems.

v) To implement in code common algorithms following code standards and libraries used in RL.

4. Text Books:

a) Richard S. Sutton and Andrew G. Barto, Reinforcement learning: An introduction, Second Edition, MIT Press, 2019, ISBN: 978-0262039246

5. Reference Books:

a) Marco Wiering and Martijn van Otterlo (Eds.), Reinforcement Learning: State-of-the-Art, 2012, ISBN: 978-3642276446.

b) Stuart J. Russell and Peter Norvig, Artificial Intelligence - A Modern Approach, 3rd edition, 2016, ISBN: 978-0136042594.

c) Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, The MIT Press, 2016, ISBN: 978-0262035613.

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	3	2	5	3	5	5	5	5
CO2	3	2	5	3	5	5	5	5
CO3	3	2	5	4	5	5	5	5
CO4	3	2	5	3	5	5	5	5
CO5	3	2	5	3	5	5	5	5

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-AIML-01	PSO-AIML-02
CO1	3	3	5	5	2
CO2	3	5	5	5	5
CO3	5	5	5	5	5
CO4	5	5	5	5	5
CO5	5	5	5	5	5

Soft Computing and Evolutionary AI

Specialization Elective

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

1. **Course Objectives:**
   The objective of the course is to introduce soft computing fundamentals, techniques and its applications. The course will cover the methods for representing real-world problems appropriately to be solved with a suitable soft computing technique.

2. **Syllabus:**
   Unit – 1 [3 Hours]: Introduction - Basic concepts and fundamental components of soft computing, Probabilistic Reasoning with Bayesian Network, Dempster-Shafer Theory.

   Unit – 2 [3 Hours]: Neural Computing - Artificial Neural Network, Self-organizing Feature Map, Boltzman Machines.

   Unit – 3 [9 Hours]: Fuzzy Logic - Introduction, Fuzzy Membership Functions, Fuzzy Operations, Fuzzy Relations, Fuzzy Arithmetic and Fuzzy Measures, Defuzzification Techniques, Fuzzy Logic Controller, Fuzzy Clustering, Applications of fuzzy logic.

   Unit – 4 [7 Hours]: Evolutionary AI - Basic concepts of Evolutionary Computing (EC) and EC Strategies; Genetic Algorithm - Basic concepts, working principle, procedures of GA, flow chart of GA, genetic representations(encoding), initialization and selection, genetic operators, mutation, generational cycle, applications.

   Unit – 5 [7 Hours]: Multi-Objective Optimization - Problem Solving, Concept of Domination, Pareto-based and Non-Pareto based Approaches, Applications.

   Unit – 6 [7 Hours]: Emerging Areas of Soft Computing and its applications - Fundamentals of Particle Swarm Optimization, Basic Concepts of
   Ant Colony Optimization, etc.

3. **Course Outcomes:**
   At the end of the course, students should have the ability:

   i) To explain the foundations of soft computing approaches and solve a given problem using probabilistic reasoning.

   ii) To design artificial neural networks for supervised as well as unsupervised learning.

   iii) To apply fuzzy logic to solve real-world problems and develop inference systems.

   iv) To use evolutionary computing to solve optimization problems and also apply genetic algorithms and its various features and operators.

   v) To develop algorithms to solve multi-objective optimization problems and find pareto-optimal solutions.

vi) To choose and apply suitable emerging evolutionary algorithms for solving complex real-world optimization problems.

4. Text Books:

a) D. K. Pratihar, Soft Computing: Fundamentals and Applications, Alpha Science International Ltd., 2015, ISBN : 978-1783322053

b) S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, Wiley India, 2011, ISBN: 978-8126527410

5. Reference Books:

a) Chin-Teng Lin and C. S. George Lee, Neural Fuzzy Systems: A Neuro-Fuzzy Synergism to Intelligent Systems, Prentice Hall PTR, 1996, ISBN : 978-0132351690

b) S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Network, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall India, 2013, ISBN: 9788120321861

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	5	3	4	1	1	1
CO2	5	2	5	4	5	1	1	1
CO3	5	2	5	4	5	4	3	4
CO4	5	2	5	4	5	4	3	4
CO5	5	2	5	4	5	4	3	4
CO6	5	4	5	4	5	4	3	4

b) Mapping of COs - PSOs

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

Specialization Elective Courses

B.Tech. (CSE) Programme
with Specialization in Cyber Security

Network and Data Security

Specialization Elective

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

1. **Course Objectives:**

   The objective of this course is to comprehend the security issues in modern networked computer systems and to secure the personal data and computer networks.

2. **Syllabus:**

   Unit – 1 [4 Hours]: Introduction - Client server Architecture, Multi-server Architecture, Security Threats and Requirements, Security Challenges

   Unit – 2 [6 Hours]: Network Attacks - MITM, DoS/DDoS, ARP Spoofing, IP Spoofing, DNS Spoofing, and Other Attacks

   Unit – 3 [8 Hours]: Intrusion Detection and Prevention - Intruders, Intrusion Detection, Host-Based Intrusion Detection, Network-Based Intrusion Detection, Distributed or Hybrid Intrusion Detection, Firewalls, Intrusion Prevention Systems.

   Unit – 4 [6 Hours]: Security Protocols - Basics of cryptography, Certificates - X509, SSL and TLS protocols, Kerbeors

   Unit – 5 [6 Hours]: Access Control - Access Control Principles and Methods, DAC, MAC, RBAC, ABAC

   Unit – 6 [6 Hours]: Web Application Security - Introduction to Web Applications, Injection Attacks, Session Management, Vulnerabilities at the application layer

3. **Course Outcomes:**

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

   i) To identify different computer network architectures and the associated security requirements and risks.

   ii) To describe the major network attacks and their launching strategies.

   iii) To design effective defense methods for various attacks using state-of-the-art tools and techniques.

   iv) To analyze various security protocols and apply them for enhancing the network and data security.

   v) To verify the identity of a user and design effective access control mechanism for user authorization.

   vi) To apply various web application security methods and tools.

4. Text Books:

a) William Stallings and Lawrie Brown, Computer Security Principles and Practice, Pearson Education India, 3rd Edition, 2014, ISBN: 978-0-13-377392-7

b) William Stallings, Cryptography and Network Security, Principles and Practices, Pearson Education India, 4th Edition, 2005, ISBN: 978-0-13-187319-3

5. Reference Books:

a) Dafydd Stuttard and Marcus Pinto, The web application hacker's handbook: Finding and exploiting security flaws. John Wiley & Sons, 2nd Edition, 2011, ISBN: : 978-1-118-02647-2

b) Roberta Bragg, Mark Rhodes, Keith Strassberg, Network Security the Complete Reference, Tata McGraw Hill Publication, 1st Edition, 2004.

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	2	1	4	2	1	1	1	1
CO2	1	1	4	2	1	1	1	1
CO3	4	1	2	5	4	3	1	4
CO4	2	1	2	2	3	1	1	1
CO5	3	1	2	3	3	3	1	3
CO6	3	1	4	2	2	1	1	1

b) Mapping of COs – PSOs

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

Threat Intelligence

Specialization Elective

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

1. **Course Objectives:**

   The objective of this course is to design and develop a threat intelligence system to help organizations to identify and mitigate security risks.

2. **Syllabus:**

   Unit – 1 [6 Hours]: Introduction to Threat Intelligence - Cybercrime and cyber threat intelligence (CTI), Roles and requirements of CTI, Threat intelligence platform/frameworks, Intelligence Lifecycle, Types of Threat Intelligence, Threat Intelligence Tools

   Unit – 2 [6 Hours]: Threat Intelligence Data Collection and Processing - Data collection, Data collection methods, Types of data, Data management, Data acquisition, Data Processing and methods, Data exploitation

   Unit – 3 [6 Hours]: Threat Intelligence Data Analysis - Introduction to data analysis, Data analysis techniques, Threat analysis, Threat analysis process, Threat intelligence evaluation, Threat Modelling

   Unit – 4 [6 Hours]: Intelligence Reporting and Dissemination - Threat Intelligence Reports, Types of Intelligence Reports, Intelligence Dissemination, Challenges, Sharing Platforms, Sharing Acts and Regulations, Threat Intelligence Integration

   Unit – 5 [6 Hours]: Threat Intelligence for Vulnerability Management, Threat Hunting, Fraud Management - Application of TI to SOC, IR, VM, TH, Fraud Management etc.

   Unit – 6 [6 Hours]: Threat Intelligence Standards: STIX and TAXII - Introduction to Threat Intelligence Standards : STIX and TAXII; Hands-on Lab - Hands-on Lab exercise for STIX, TAXII, Threat Intel Aggregation, Enrichment and Analysis.

3. **Course Outcomes:**

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

   i) To define various cyber threats, threat actors, their motives and objectives to launch cybersecurity attacks.

   ii) To describe the threat intelligence data collection and processing through the use of state-of-the-art tools and techniques.

   iii) To analyze the intelligence data using different data analysis tools and develop a threat intelligence system to detect, respond to, and defeat cyber threats.

   iv) To design and conduct the experiments to generate and disseminate intelligence reports.

v) To apply the threat intelligence in various cyber security operations.

vi) To implement the threat intelligence standards in real world and also play with the important TI lifecycle phases in practical.

4. Text Books:

a) Roberts, Scott J., and Rebekah Brown. Intelligence-Driven Incident Response: Outwitting the Adversary. O'Reilly Media, Inc., 2017, ISBN: 9781491934944

b) Bautista, Wilson. Practical cyber intelligence: how action-based intelligence can be an effective response to incidents. Packt Publishing Ltd, 2018. ISBN: 978-1788625562

5. Reference Books:

a) Stallings, William. Network Security Essentials: Applications and Standards, Pearson Education India, 4th Edition, 2011, ISBN: 978-0-13-610805-4

b) Wilson, Clay., Botnets, cybercrime, and cyberterrorism: Vulnerabilities and policy issues for congress, LIBRARY OF CONGRESS WASHINGTON DC CONGRESSIONAL RESEARCH SERVICE, 2008.

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	1	1	4	2	1	1	1	1
CO2	2	1	3	2	1	1	1	1
CO3	3	1	2	3	3	2	1	1
CO4	4	1	2	5	3	3	1	2
CO5	4	1	2	3	3	3	1	1
CO6	5	1	2	4	4	3	1	2

b) Mapping of COs – PSOs

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

Software Security

Specialization Elective

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

1. **Course Objectives:**
   The course is meant to give an overview of security issues for software, and provides programming methods for the development of secure applications.

2. **Syllabus:**
   The following list of topics is tentative. Based on available time slots, some topics may be dropped or added or reordered.

   Unit – 1 [4 Hours]: Overview - Requirements, Threat Modelling, Policy and Mechanism, Assumptions and Trust, Assurance, Operational Issues

   Unit – 2 [6 Hours]: Security Principles- Design Principles, Least Privilege, Separation of Duties, Defense in Depth, Failing Securely, Identity and Access Control Mechanisms, Information Flow, Confinement

   Unit – 3 [6 Hours]: Common Security Flaws - Process and Thread Security, Memory Safety; Control Hijacking – Buffer and Integer overflows, bypassing memory protections; Secure File Systems, Secure Messaging

   Unit – 4 [7 Hours]: Security Testing - Vulnerability Patterns, Code Checking, Tools, Test Cases, Static and Dynamic Analysis, White Box and Black Box Testing, Penetration Testing, Code Review; Security Response - Security Bulletins, Patches, Disclosure, Vulnerability Scoring System

   Unit – 5 [7 Hours]: Secure Software Development Methodologies - Secure Software Development Lifecycle (SSDLC), Guidelines for Secure Software, SD-3 Principles, Security Practices, Secure coding standards, OWASP, ISO15408, Common Criteria (CC), Build-in security

   Unit – 6 [6 Hours]: Security Assurance and Auditing - Introduction to Assurance, Building Secure and Trusted Systems, Assurance at different stages; Auditing - Anatomy of an Auditing System, Auditing Mechanisms

3. **Course Outcomes**
   At the end of the course, students should have the:
   i) Ability to define and analyze the security requirements and threat models for software development
   ii) Ability to describe the fundamental principles and tools of software security
   iii) Ability to analyze, exploit and defend against common software flaws
   iv) Ability to identify, analyze and report vulnerabilities in software
   v) Ability to use secure software development methodologies
   vi) Ability to perform security audits and provide security assurance for software

4. Text Books:

a) Matt Bishop, Computer Security: Art and Science, Addison-Wesley Professional, 2003. ISBN: 0-201-44099-7.

b) Julia H. Allen, Sean Barnum, Robert J. Ellison, Gary McGraw and Nancy Mead, Software Security Engineering: A Guide for Project Managers, Addison-Wesley Professional, 2008. ISBN: 0-321-50917-X

5. Reference Books:

a) Matthew A. Bishop, Introduction to Computer Security, Addison-Wesley Professional, 2005.

b) Ross Anderson, Security Engineering, Wiley, Second Edition, 2008. ISBN: 9788126516674

c) Michael Howard, David LeBlanc and John Viega, 24 Deadly Sins of Software Security: Programming Flaws and How to Fix Them, McGraw-Hill Education, 2009. ISBN: 978-0-07-162676-7

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	3	1	4	2	1	1	1	1
CO2	3	1	4	2	1	1	1	1
CO3	4	1	3	5	4	3	1	4
CO4	4	1	3	2	3	1	1	1
CO5	4	1	3	3	3	3	1	3
CO6	4	1	4	2	2	1	1	2

b) Mapping of COs - PSOs

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

Cyber Security Regulations

Seminar Course

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

1. **Course Objectives:**

   The objective of this course is to generate awareness about the cyber security rules and regulations. This course will also provide an understanding of ethical issues on the use of IT on global networks.

2. **Syllabus:**

   Unit – 1 [2 Hours]: Introduction to Cyber Security Regulations - Cyber regulations, Types of cyber-crime, Cyber paternalism, Cyber security control frameworks.

   Unit – 2 [2 Hours]: Cyber Security Regulations Implementation - Cyber security implementation, Developing cyber security policies, Maintaining cyber security policies, Difficulties in stopping cybercrime

   Unit – 3 [2 Hours]: Cyber Security Regulations Implementation Challenges - Issues and challenges in cyber security, Challenges in Cyber Laws implementation, Emerging cybersecurity challenges, Cyber conflict

   Unit – 4 [2 Hours]: Solutions to Implementation Challenges - Solutions of cyber security, Reducing cyber-attacks, Techniques to reduce security problems, Reducing Internet threats, Online safety

   Unit – 5 [2 Hours]: Governance and Compliance - Governance on Cyberspace, Different standards for cyber security compliance, Security compliance standards, Importance of cyber security compliance

   Unit – 6 [2 Hours]: Cyber Litigation - Cyber Litigation, Data Breach Litigation, Managing Evolving Litigation, Legal issues

3. **Course Outcomes:**

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

   i) To define the cyber regulations and the related cybersecurity control frameworks.

   ii) To comprehend the cybersecurity policies development and their implementation.

   iii) To describe the challenges in the implementation of cyber security regulations.

   iv) To analyze and design the effective cyber security solutions.

   v) To describe cyber and data breach Litigation with the related opportunities and challenges.

vi) To understand cyber and data breach Litigation with the related opportunities and challenges.

4. Text Books:

NA

5. Reference Books:

NA

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	1	1	3	2	1	1	1	1
CO2	1	1	3	1	1	1	1	1
CO3	1	1	3	1	1	1	1	1
CO4	2	1	1	4	3	3	1	2
CO5	1	1	3	1	1	1	3	1
CO6	1	1	3	1	1	1	2	1

b) Mapping of COs – PSOs

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

Specialization Elective Courses

B.Tech. (CSE) Programme
with Specialization in Data Science

Advanced Data Analytics

Specialization Elective

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

1. **Course Objectives:**

   The objective of the course is to enable students to use advanced statistical techniques for prediction, forecasting and gain meaningful valuable insights from real world multivariate data.

2. **Syllabus:**

   Unit – 1 [7 Hours]: Multivariate Statistics - Multivariate Descriptive Statistics, Multivariate Normal Distribution and Properties, Mahalanobis Distance, Multivariate Inferential statistics;

   Unit – 2 [8 Hours]: Regression Analysis - Multiple Linear Regression, Estimation and Sampling Distribution of regression coefficients, Model Adequacy and Diagnostics, Test of Assumptions, Case Study;

   Unit – 3 [5 Hours]: Multivariate Techniques - Overview of Different Multivariate Techniques, Principal Component Analysis, Factor Analysis and Applications;

   Unit – 4 [5 Hours]: Structural Equation Modeling - Introduction, Structural Model, Measurement Model, Model Adequacy Testing, Case Study;

   Unit – 5 [5 Hours]: Discriminant Analysis and Conjoint Analysis - Introduction and Objectives, Discriminant Analysis Model, Problem Formulation, Conjoint Model, Steps, Application, Limitations and Assumptions;

   Unit – 6 [6 Hours]: Time Series - Time Series Models, Stationarity, ACF, PACF, MA and AR Models, ARIMA Models, Estimation and Forecasting, Application using Matlab/ R/Python

3. **Course Outcomes:**

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

   i) To make decisions about large multivariate population considering uncertainty in sampling

   ii) To interpret, simplify and model multivariate data and provide prediction using multivariate techniques

   iii) To explain the structural relationship between measured variables and latent constructs.

   iv) To classify groups or objects by a set of independent variables and find most favoured combination of product or service features.

v) To explain characteristics of time dependent variables and provide forecast.

4. Text Books:

a) Johnson R. Arnold, and Dean W. Wichern. Applied multivariate statistical analysis. Prentice hall, Sixth Edition, 2007, ISBN: 0-13-187715-1

b) Joseph Hair, William Black, Barry Babin and Rolph Anderson, Multivariate Data Analysis, Cengage Learning EMEA, 8th Edition, 2018

c) Damodar N. Gujarati, Basic Econometrics, McGraw-Hill, 4th Edition, 2003, ISBN: 978-0-07-233542-2

5. Reference Books:

a) George E. P. Box, Gwilym M. Jenkins and Gregory C. Reinsel, Time Series Analysis, John Wiley & Sons, 4th edition, 2013.

b) Theodore W. Anderson, An Introduction to Multivariate Statistical Analysis, John Wiley & Sons Inc., 3rd Edition, 2003.

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	5	3	4	1	1	1
CO2	5	1	5	3	4	3	3	3
CO3	5	1	5	3	4	1	1	1
CO4	5	1	5	3	4	1	1	1
CO5	5	1	5	3	4	1	1	1

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-DS-01	PSO-DS-02
CO1	3	4	3	4	3
CO2	4	5	3	5	5
CO3	4	5	3	5	5
CO4	4	5	3	5	5
CO5	4	5	3	5	5

Big Data Analytics

Specialization Elective

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

1. **Course Objectives:**
   The objective of the course is to showcase how big data analytics is practiced in Industry, how to measure data science solutions and how to visualize and present a story. The course would provide a hands-on experience on entire data science life cycle for large scale applications like bots, recommender systems, etc.

2. **Revised Syllabus:**
   Unit – 1 [4 Hours]: Introduction to Data - Processing Data: Read Data from files, Cleaning; Describing data: Statistical details; Quick insights with matplotlib; Sneak peek into data vis Line, Bars, Histograms, Scatter Plots, Geoplots.

   Unit – 2 [8 Hours]: Data Engineering (Taking ML models to production) - Introduction to Data Engineering, What is data engineering?, Tasks of the data engineer, Problems; Data Engineering Tools: SQL vs NoSQL, DB's & Joins; ETL: Extract, Transform, Writing to files; Model Deployments: Deploy ML model using Flask; Intro to NLP & Bots: Build NLP chatbot using DialogFlow.

   Unit – 3 [6 Hours]: Life Cycle of data science solution - Lifecycle Phase1 - Requirement to Tech Solution; Lifecycle Phase2 - Tech Solution to business outcomes

   Unit – 4 [6 Hours]: Data Science Applications I- Supervised & Unsupervised Learning; Fintech use cases, Credit Risk modelling, Fraud, AML, Solve Dataset.

   Unit – 5 [6 Hours]: Data Science Applications II - Recommendation use cases, Personalization, Ranker, Retriever, Example problem & solving.

   Unit – 6 [6 Hours]: Statistics and Probability Theory - Use Cases with Probability Distributions (PDF's and CDF's); Generating Random Numbers in Python; Generating normal Distribution in python; Modeling central limit theorem in python; Introduction to confidence intervals; Experimentation & Hypothesis Testing - how it happens in industry

3. **Course Outcomes (Unit wise):**

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

   i) To preprocess data and to present a data story using data visualization techniques.
   ii) To describe and demonstrate data engineering pipelines such as extraction from Big-data sources like Hadoop and the steps involved in data science solutions.
   iii) To demonstrate how machine learning problems are solved in Fintech and to be able to build a credit risk model and recommender system.
   iv) To apply probability distributions to Industry problems and to have an understanding of foundations of experimentation.

4. Text Books:

a) Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea, Big Data: Algorithms, Analytics, and Applications, Chapman & Hall/CRC Big Data Series, 2015, ISBN: 978-1482240559.

b) Thomas Erl, Wajid Khattak, and Dr. Paul Buhler, Big Data Fundamentals: Concepts, Drivers & Techniques, The Prentice Hall Service Technology Series, 2016, ISBN-13: 978-0134291079.

5. Reference Books:

a) Introduction to Probability: By Dimitri P. Bertsekas

b) Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, WILEY Big Data Series, John Wiley & Sons, 2014.

c) Mathangi Sri, Practical Natural Language Processing with Python: With Case Studies from Industries Using Text Data at Scale, 2020, ISBN: 978-1484262467.

d) Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.

e) Recommender Systems By Charu C Aggarwal

f) Douglas Eadline, Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem, 1st Edition, Pearson Education, 2016.

g) Anil Maheshwari, Data Analytics, 1st Edition, McGraw Hill Education, 2017.

h) Tom White, Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media, 2015.

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	1	2	3	1	5	3	5	5
CO2	3	2	5	3	5	5	5	5
CO3	3	3	5	3	5	5	5	5
CO4	3	2	5	3	5	3	5	5

b) Mapping of COs - PSOs

	PSO-01	PSO-02	PSO-03	PSO-DS-01	PSO-DS-02
CO1	3	3	5	5	5
CO2	3	5	5	5	5
CO4	3	5	5	5	5
CO5	3	5	5	5	5

Python for Data Science

Specialization Elective

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

1. **Course Objectives:**
   The objective of the course is to equip students to use python programming for solving real-time data science problems. Students will learn how to prepare data for analysis, perform simple statistical analysis, create meaningful data visualizations and predict future trends from data.

2. **Revised Syllabus:**
   Unit – 1 [4 Hours]: Introduction to Python - Python environmental setup and Essentials; Data types, Control flow, functions, Exception handling, Organizing code, File handling

   Unit – 2 [6 Hours]: Introduction to NumPy and 2D plotting - Introduction to NumPy, Understanding N-dimensional data structure, Creating N-dimensional arrays, Indexing arrays and slicing, Boolean Indexing, Fancy Indexing, Data processing using arrays, File I/O with arrays, Plotting with matplotlib.Introduction to NumPy and 2D plotting - Introduction to NumPy, Understanding N-dimensional data structure, Creating N-dimensional arrays, Indexing arrays and slicing, Boolean Indexing, Fancy Indexing, Data processing using arrays, File I/O with arrays, Plotting with matplotlib.

   Unit – 3 [6 Hours]: Scientific computing using SciPy - Introduction to SciPy, Integration and optimization, Interpolation, Linear Algebra, Perform CDF and PDF using SciPy, Statistics, File I/O with SciPy.

   Unit – 4 [6 Hours]: Time-series analysis and data manipulation with Pandas - Pandas I/O operations, Series and Data frames; Data alignment, aggregation and Summarization; Computation and analysis with Pandas, visualization.

   Unit – 5 [6 Hours]: Data Access and Visualization - Querying SQL database with Python, Loading data from databases, Visual exploration with seaborn and matplotlib.

   Unit – 6 [8 Hours]: Introduction to machine learning with Scikit-Learn - Estimator, Predictor, transformer interfaces; Preprocessing Data; Regression models and evaluation; Classifier models and evaluation; Clustering models and evaluation.

3. **Course Outcomes (Unit wise):**

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

   i) To master Python tools that will accelerate productivity and making it ideal for data analysis.

   ii) To handle Python packages such as NumPy, SciPy, Pandas for dealing with multi-dimensional large datasets.

iii) To query SQL databases with Python and perform visualization using seaborn and matplotlib.

iv) To develop the machine learning models for data analysis and evaluate the model performance using Scikit-Learn package.

4. Text Books:

a) David Ascher and Mark Lutz, Learning Python, Publisher O'Reilly Media, 2003, ISBN: 9780596002817

b) Reema Thareja, Python Programming using Problem Solving approach, Oxford University press, 2019, ISBN: 9780199480173

c) Wes Mckinney, Python for Data Analysis, First edition, Publisher O'Reilly Media, 2011, ISBN: 9781491957660

5. Reference Books:

a) Allen Downey, Jeffrey Elkner, Chris Meyers, Learning with Python, Dreamtech Press.

b) David Taieb, Data Analysis with Python: A Modern Approach, 1st Edition, Packt Publishing.

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	2	1	3	2	2	3	5	5
CO2	2	2	3	4	5	5	5	5
CO3	2	2	3	4	5	5	5	5
CO4	2	2	3	4	5	5	5	5

b) Mapping of COs – PSOs

	PSO-01	PSO-02	PSO-03	PSO-DS-01	PSO-DS-02
CO1	3	2	5	5	5
CO2	3	3	5	5	5
CO3	3	5	5	5	5
CO4	3	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

CO-PO Mapping (CSE)

c)

	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