



**JNIESTR TRUST'S
SMT. INDIRA GANDHI COLLEGE OF ENGINEERING**

An Autonomous Institute with NAAC 'A' Grade
Approved by AICTE, Affiliated to the University of Mumbai

**DEPARTMENT OF COMPUTER SCIENCE ENGINEERING
(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)**



Department of CSE AIML

CURRICULUM AND SYLLABI

EXIT DEGREE B. TECH (CSE AIML)	
CURRICULUM STRUCTURE:	For All Semester
DETAILED SYLLABI:	For SEM III, SEM IV
BATCH:	2025-2028
WITH EFFECT FROM:	A.Y. 2026-27
VERSION:	SIGCE-NEP-R25-Y2

Board of Studies Approval Date:	14 th May 2026
Academic Council Approval Date:	30 th JUNE 2026

Prof. S. N. Deshpande
HOD (CSE AIML)

Dr. V. P. Patil
Dean (Academics)

Dr. Sunil Chavan
Principal

Document Control**a. Document History**

Ver.	Effective Date	Compiled By	Approved by	Description
0.0	8 May 2026	NEP Cell	AC	Initial Version and template and Curriculum Structure (Version SIGCE-NEP-R25-Y2 – III and IV Sem 2026-27)
1.0	14 May 2026	BoS	AC and GB	Detailed Syllabus (Version SIGCE-NEP-R25-Y2 – III and IV Sem 2026-27)

b. Document Approvals

- i) The latest version is :- **Version 1.0 (SIGCE-NEP-R25-Y2)**
- ii) COMPILED by :- **NEP Cell and BOS**
- iii) APPROVED by :-
 - a) **BOS** in its meeting held on **14th May 2026**
 - b) **Academic Council** in its meeting held on **30th June 2026**
 - c) **Governing Body** in its meeting held on



Dr. Sunil Chavan
Member Secretary
Governing Body / CDC

Table of Contents

CHAPTER 1: PREAMBLE	1
CHAPTER 2: VISION, MISSION AND OUTCOMES.....	3
2.1 VISION AND MISSION OF SIGCE.....	3
<i>Vision</i>	3
<i>Mission</i>	3
2.2 VISION AND MISSION OF CSE AIML DEPARTMENT	3
<i>Vision of the Department</i>	3
<i>Mission of the Department.....</i>	3
2.3 PROGRAM EDUCATION OUTCOMES	4
2.4 PROGRAM OUTCOMES	4
2.5 PROGRAM SPECIFIC OUTCOMES	5
2.6 KNOWLEDGE AND ATTITUDE PROFILE (WK)	5
CHAPTER 3: CURRICULUM STRUCTURE AND SCHEME	7
3.1 NOMENCLATURE OF THE COURSE CATEGORIES.....	7
3.2 CREDIT DISTRIBUTION STRUCTURE	8
3.3 COMPONENTS OF CURRICULUM	8
3.4 COURSE CODES – LETTER PLACEMENT AND MEANING.....	9
3.5 COMPARISON OF SIGCE CREDIT STRUCTURE WITH THE G.R RECOMMENDATION.....	10
3.6 SEMESTER WISE ALLOCATION OF CREDITS	11
<i>Semester III.....</i>	11
<i>Semester IV</i>	11
3.7 PROGRAM EXAMINATION SCHEME	12
<i>Semester III.....</i>	12
<i>Semester IV</i>	12
3.8 FRAMEWORK FOR ASSESSMENT AND EVALUATION	12
<i>Assessment Instruments</i>	13
<i>Assessment Methods / Mode</i>	14
<i>Evaluation Mechanism</i>	15
CHAPTER 4: INDICATIVE LIST OF COURSES	17
4.1 BASIC SCIENCE AND ENGINEERING COURSES	17
4.2 HUMANITIES, SOCIAL SCIENCE AND MANAGEMENT COURSES	17
4.3 CO-CURRICULAR COURSES	17
4.4 OPEN ELECTIVE	18
CHAPTER 5: MAPPING AND JUSTIFICATION	19

5.1	INDICATIVE MAPPING OF COURSES TO PO	19
	<i>Semester III</i>	19
	<i>Semester IV</i>	19
5.2	INDICATIVE MAPPING OF COURSES TO WK.....	20
	<i>Semester III</i>	20
	<i>Semester IV</i>	20
CHAPTER 6: SUBJECT-MATHEMATICS FOR COMPUTER ENGINEERING (SEM III)		21
6.1	TEACHING & LEARNING SCHEME	21
6.2	EXAMINATION SCHEME	21
6.3	COURSE OBJECTIVES.....	21
6.4	COURSE OUTCOMES.....	22
6.5	MODULES / SYLLABUS CONTENT	22
	<i>Theory Component</i>	22
	<i>Tutorial</i>	23
6.6	ASSESSMENT METHODOLOGIES AND TOOLS	24
	<i>Theory Component</i>	24
6.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	24
6.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	25
6.9	RESOURCES	25
	<i>Textbooks</i>	25
	<i>Reference Books</i>	25
	<i>Online Resources</i>	26
CHAPTER 7: SUBJECT- ANALYSIS OF ALGORITHM (SEM III)		27
7.1	TEACHING & LEARNING SCHEME	27
7.2	EXAMINATION SCHEME	27
7.3	COURSE OBJECTIVES.....	27
7.4	COURSE OUTCOMES.....	28
7.5	MODULES / SYLLABUS CONTENT	28
	<i>Theory Component</i>	28
	<i>Laboratory Component (Suggested List of Experiments)</i>	29
7.6	ASSESSMENT METHODOLOGIES AND TOOLS	29
	<i>Theory Component</i>	29
	<i>Lab Component</i>	30
7.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	30
7.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	30
7.9	RESOURCES	31
	<i>Textbooks</i>	31
	<i>Reference Books</i>	31

<i>Online Resources</i>	31
CHAPTER 8: SUBJECT- DISCRETE STRUCTURE AND GRAPH THEORY (SEM III)	32
8.1 TEACHING & LEARNING SCHEME	32
8.2 EXAMINATION SCHEME	32
8.3 COURSE OBJECTIVES.....	32
8.4 COURSE OUTCOMES.....	33
8.5 MODULES / SYLLABUS CONTENT	33
<i>Theory Component</i>	33
8.6 ASSESSMENT METHODOLOGIES AND TOOLS	34
<i>Theory Component</i>	34
8.7 SUGGESTED CO-PO/PSO CORRELATION MATRIX	34
8.8 COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	35
8.9 RESOURCES	35
<i>Textbooks</i>	35
<i>Reference Books</i>	36
<i>Online Resources</i>	36
CHAPTER 9: SUBJECT- OPERATING SYSTEM (SEM III)	37
9.1 TEACHING & LEARNING SCHEME	37
9.2 EXAMINATION SCHEME	37
9.3 COURSE OBJECTIVES.....	37
9.4 COURSE OUTCOMES.....	38
9.5 MODULES / SYLLABUS CONTENT	38
<i>Theory Component</i>	38
<i>Laboratory Component (Suggested List of Experiments)</i>	39
9.6 ASSESSMENT METHODOLOGIES AND TOOLS	40
<i>Theory Component</i>	40
<i>Lab Component</i>	40
9.7 SUGGESTED CO-PO/PSO CORRELATION MATRIX	40
9.8 COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	41
9.9 RESOURCES	41
<i>Textbooks</i>	41
<i>Reference Books</i>	41
<i>Online Resources</i>	42
CHAPTER 10: SUBJECT- ENTREPRENEURSHIP AND BUSINESS MODEL DEVELOPMENT (SEM III).....	43
10.1 TEACHING & LEARNING SCHEME	43
10.2 EXAMINATION SCHEME	43
10.3 COURSE OBJECTIVES.....	43

10.4	COURSE OUTCOMES	44
10.5	MODULES / SYLLABUS CONTENT	44
	<i>Demonstration Component</i>	44
	<i>Laboratory Component (Suggested List of Experiments)</i>	45
	<i>Assignments (Suggested list of Assignments)</i>	45
10.6	ASSESSMENT METHODOLOGIES AND TOOLS	46
	<i>Lab Component</i>	46
10.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	46
10.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	46
10.9	RESOURCES	47
	<i>Textbooks</i>	47
	<i>Reference Books</i>	47
	<i>Online Resources</i>	47
CHAPTER 11: SUBJECT- ADVANCED JAVA (SEM III)		48
1.1	TEACHING & LEARNING SCHEME	48
11.2	EXAMINATION SCHEME	48
11.3	COURSE OBJECTIVES	48
11.4	COURSE OUTCOMES	49
11.5	MODULES / SYLLABUS CONTENT	49
	<i>Demonstration Component</i>	49
	<i>Laboratory Component (Suggested List of Experiments)</i>	50
11.6	ASSESSMENT METHODOLOGIES AND TOOLS	50
	<i>Lab Component</i>	50
11.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	51
11.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	51
11.9	RESOURCES	51
	<i>Textbooks</i>	51
	<i>Reference Books</i>	52
	<i>Online Resources</i>	52
CHAPTER 12: SUBJECT- COMPREHENSIVE SOFT SKILLS & PROFESSIONAL DEVELOPMENT (SEM III)		53
12.1	TEACHING & LEARNING SCHEME	53
12.2	EXAMINATION SCHEME	53
12.3	COURSE OBJECTIVES	53
12.4	COURSE OUTCOMES	54
12.5	MODULES / SYLLABUS CONTENT	54
	<i>Demonstration Component</i>	54
12.6	ASSESSMENT METHODOLOGIES AND TOOLS	55
	<i>Lab Component</i>	55

12.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	56
12.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	56
12.9	RESOURCES	56
	<i>Textbooks</i>	56
	<i>Reference Books</i>	57
	<i>Online Resources</i>	57
CHAPTER 13: SUBJECT- STATISTICAL METHODS IN DATA SCIENCE (SEM IV)		59
13.1	TEACHING & LEARNING SCHEME	59
13.2	EXAMINATION SCHEME	59
13.3	COURSE OBJECTIVES.....	59
13.4	COURSE OUTCOMES.....	60
13.5	MODULES / SYLLABUS CONTENT	60
	<i>Theory Component</i>	60
	<i>Laboratory Component (Suggested List of Experiments)</i>	61
13.6	ASSESSMENT METHODOLOGIES AND TOOLS	62
	<i>Theory Assessment</i>	62
	<i>Lab Assessment</i>	62
13.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	62
13.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	63
13.9	RESOURCES	63
	<i>Textbooks</i>	63
	<i>Reference Books</i>	64
	<i>Online Resources</i>	64
CHAPTER 14: SUBJECT- COMPUTATIONAL THEORY (SEM IV)		65
14.1	TEACHING & LEARNING SCHEME	65
14.2	EXAMINATION SCHEME	65
14.3	COURSE OBJECTIVES.....	65
14.4	COURSE OUTCOMES.....	66
14.5	MODULES / SYLLABUS CONTENT	66
	<i>Theory Component</i>	66
14.6	ASSESSMENT METHODOLOGIES AND TOOLS	67
	<i>Theory Component</i>	67
14.7	SUGGESTED CO-PO/PSO/PEO CORRELATION MATRIX.....	68
14.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	68
14.9	RESOURCES	69
	<i>Textbooks</i>	69
	<i>Reference Books</i>	69
	<i>Online Resources</i>	69

CHAPTER 15: SUBJECT- DATABASE MANAGEMENT SYSTEM (SEM IV).....	70
15.1 TEACHING & LEARNING SCHEME	70
15.2 EXAMINATION SCHEME	70
15.3 COURSE OBJECTIVES.....	70
15.4 COURSE OUTCOMES.....	71
15.5 MODULES / SYLLABUS CONTENT	71
<i>Theory Component</i>	71
<i>Laboratory Component (Suggested List of Experiments)</i>	73
15.6 ASSESSMENT METHODOLOGIES AND TOOLS	75
<i>Theory Component</i>	75
<i>Lab Component</i>	75
15.7 SUGGESTED CO-PO/PSO CORRELATION MATRIX	76
15.8 COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	76
15.9 RESOURCES	77
<i>Textbooks</i>	77
<i>Reference Books</i>	77
<i>Online Resources</i>	77
CHAPTER 16: SUBJECT- COMPUTER NETWORKS (SEM IV)	78
16.2 TEACHING & LEARNING SCHEME	78
16.3 EXAMINATION SCHEME	78
16.4 COURSE OBJECTIVES.....	78
16.5 COURSE OUTCOMES.....	79
16.6 MODULES / SYLLABUS CONTENT	79
<i>Theory Component</i>	79
<i>Laboratory Component (Suggested List of Experiments)</i>	80
16.7 ASSESSMENT METHODOLOGIES AND TOOLS	81
<i>Theory Component</i>	81
<i>Lab Component</i>	81
16.8 SUGGESTED CO-PO/PSO CORRELATION MATRIX	82
16.9 COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	82
16.10 RESOURCES	83
<i>Textbooks</i>	83
<i>Reference Books</i>	83
<i>Online Resources</i>	83
CHAPTER 17: SUBJECT- DESIGN THINKING (SEM IV)	85
17.1 TEACHING & LEARNING SCHEME	85
17.2 EXAMINATION SCHEME	85

17.3	COURSE OBJECTIVES.....	85
17.4	COURSE OUTCOMES.....	86
17.5	MODULES / SYLLABUS CONTENT	86
	<i>Theory Component</i>	86
	<i>Laboratory Component (Suggested List of Experiments)</i>	87
	<i>Assignments (Suggested list of Assignments)</i>	87
17.6	ASSESSMENT METHODOLOGIES AND TOOLS	88
	<i>Lab Component</i>	88
17.7	SUGGESTED CO-PO/PSO CORRELATION MATRIX	88
17.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	88
17.9	RESOURCES	89
	<i>Textbooks</i>	89
	<i>Reference Books</i>	89
	<i>Online Resources</i>	89
CHAPTER 18: SUBJECT- ENGINEERING FUNDAMENTALS & TECHNICAL SKILLS (SEM IV)		91
18.1	TEACHING & LEARNING SCHEME	91
18.2	EXAMINATION SCHEME	91
18.3	COURSE OBJECTIVES.....	91
18.4	COURSE OUTCOMES.....	92
18.5	MODULES / SYLLABUS CONTENT	93
	<i>Demo Component</i>	93
18.6	ASSESSMENT METHODOLOGIES AND TOOLS	94
	<i>Lab Component</i>	94
18.7	SUGGESTED CO-PO/PSO/PEO CORRELATION MATRIX.....	94
18.8	COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK).....	94
18.9	RESOURCES	95
	<i>Textbooks</i>	95
	<i>Reference Books</i>	95
	<i>Online Resources</i>	96
CHAPTER 19: SUBJECT - AI TOOLS (SEM IV)		97
19.1	TEACHING & LEARNING SCHEME	97
19.2	EXAMINATION SCHEME	97
19.3	COURSE OBJECTIVES.....	97
19.4	COURSE OUTCOMES.....	98
19.5	MODULES / SYLLABUS CONTENT	98
	<i>Demonstration Component</i>	98
	<i>Laboratory Component (Suggested List of Experiments)</i>	99
19.6	ASSESSMENT METHODOLOGIES AND TOOLS	100

<i>Lab Component</i>	100
19.7 SUGGESTED CO-PO/PSO CORRELATION MATRIX	100
19.8 COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	100
19.9 RESOURCES	101
<i>Textbooks</i>	101
<i>Reference Books</i>	101
<i>Online Resources</i>	101
CHAPTER 20: SUBJECT- MINI PROJECT (SEM IV)	103
20.1 TEACHING & LEARNING SCHEME	103
20.2 EXAMINATION SCHEME	103
20.3 COURSE OBJECTIVES.....	103
20.4 COURSE OUTCOMES.....	104
20.5 MODULES / SYLLABUS CONTENT	104
<i>Laboratory Component (Suggested List of Experiments)</i>	104
20.6 ASSESSMENT METHODOLOGIES AND TOOLS	105
<i>Lab Component</i>	105
20.7 SUGGESTED CO-PO/PSO CORRELATION MATRIX	105
20.8 COURSE TO KNOWLEDGE AND ATTITUDE PROFILE (WK) MAPPING	105
20.9 RESOURCES	106
<i>Textbooks</i>	106
<i>Reference Books</i>	106
<i>Online Resources</i>	106
20.10 GENERAL GUIDELINES FOR MINI PROJECT	107
20.11 MINI PROJECT ASSESSMENT CRITERIA.....	107
20.12 RECOMMENDED SELF LEARNING RESOURCES FOR AIML MINI PROJECT	108
20.13 RECOMMENDED COURSES FOR MINI PROJECT	108

Chapter 1: Preamble

Ensuring excellence in engineering education in alignment with the National Education Policy (NEP) 2020 requires continuous emphasis on academic quality, innovation, flexibility, and outcome-based learning. In the era of rapid technological transformation and evolving industry expectations, engineering education must bridge the gap between theoretical knowledge and practical application while nurturing socially responsible and ethically grounded professionals.

Smt. Indira Gandhi College of Engineering, through its autonomous curriculum framework, is committed to developing competent, innovative, and industry-ready engineers capable of contributing effectively to society and technological advancement. The curriculum has been designed in accordance with the guidelines of NEP 2020 and relevant directives of the Directorate of Technical Education (DTE), ensuring a learner-centric, multidisciplinary, and holistic educational experience.

The syllabus framework is developed with a strong focus on flexibility, experiential learning, skill enhancement, and outcome-based education. The curriculum aims to transform learners from passive recipients of knowledge into creative thinkers, problem solvers, and placement-ready professionals. It emphasizes the development of scientific temper, analytical ability, communication skills, vocational competencies, and ethical values among students.

To address current and future industry requirements, the curriculum integrates vocational and skill-based learning through courses such as programming practices, workshops, placement-oriented training, community engagement, and co-curricular activities. Open elective courses and choice-based topic pools provide students with opportunities to explore interdisciplinary domains and pursue their individual interests aligned with emerging technological trends.

In accordance with NEP 2020, the curriculum adopts a learner-centric credit framework where credits are assigned based on the total learning effort rather than only classroom teaching hours. The teaching-learning process is structured over a 15-week semester model, wherein the syllabus delivery is completed within 12–13 weeks, allowing the remaining period for tutorials, self-learning, review sessions, guest lectures, project-based learning, and topics beyond the syllabus.

The curriculum also incorporates Universal Human Values (UHV), Indian Knowledge System (IKS), Environmental Science, and Professional Communication to nurture ethical responsibility, sustainability awareness, leadership qualities, and social sensitivity among learners. Clearly defined

Course Objectives (COs) and Course Outcomes (COs) ensure uniformity in academic delivery and facilitate effective attainment of Program Outcomes.

The overall curriculum framework is designed to provide a balanced blend of fundamental sciences, core engineering principles, emerging technologies, vocational skills, liberal learning, and professional development. It promotes multidisciplinary exposure and supports academic mobility through multiple entry and exit provisions as envisioned in NEP 2020.

The curriculum structure enables students to acquire industry-relevant competencies at different stages of their academic journey through modular learning pathways. The inclusion of core courses, professional electives, open electives, vocational skill enhancement courses, community engagement projects, and placement-oriented courses ensures holistic development of learners.

Special emphasis has been placed on practical learning, innovation, entrepreneurship, research orientation, and employability enhancement. The curriculum is designed to support evolving domains such as Artificial Intelligence, Machine learning, Deep Learning, GenAI, LLM and other emerging technologies while simultaneously strengthening the learners' foundational engineering knowledge.

The Second Year Engineering curriculum has been carefully designed to support students in their transition from foundational studies to discipline-specific engineering education. Recognizing the academic and psychological adjustment required at this stage, the curriculum strategically reduces excessive syllabus burden and credit load while maintaining academic rigor and quality.

The curriculum provides opportunities for students to strengthen their core technical knowledge along with vocational, computational, communication, and professional skills. Through open electives, co-curricular courses, placement-oriented training, and skill enhancement modules, students are encouraged to develop creativity, innovation, and practical problem-solving abilities.

The curriculum framework for Second Year Engineering for the academic year 2026–27 has been structured to align with the autonomous academic model and NEP 2020 guidelines. This framework will subsequently be extended to Third Year Engineering in the academic year 2027–28 and Final Year Engineering in the academic year 2028–29, ensuring a smooth and progressive implementation of the autonomous curriculum structure across all years of engineering education.

Chapter 2:

Vision, Mission and Outcomes

2.1 Vision and Mission of SIGCE

Vision

- To serve and have a transformative impact on society by constantly pursuing excellence in technical education, innovation, and entrepreneurship for human development with strong ethical values.

Mission

- Serve and help transform society by graduating talented, broadly educated engineers, equipped with state of art technology resources for developing sustainable solutions.
- Academic excellence in Science, Engineering and Technology through dedication to duty, commitment to research, innovation in learning and faith in human values.
- Cultivate the spirit of entrepreneurship and the connection between academia and industry that fosters problem solving through collaboration
- Enable the students to develop into outstanding professionals with high ethical standards capable of creating, developing, and managing global engineering enterprises.

2.2 Vision and Mission of CSE AIML Department

Vision of the Department

- To provide employable CSE-AIML engineers for Society and Industry needs.

Mission of the Department

M1. Empower students with strong foundation.

M2. Develop technical and non-technical Skills for lifelong learning.

M3. To promote student's interest in higher studies, research and entrepreneurship to meet global challenge

2.3 Program Education Outcomes

PEO-1: Graduates will be prepared for analyzing, designing, and developing software with creativity.

PEO-2: Graduates will be skilled in the use of modern tools for problem solving and analyzing industrial and societal requirements.

2.4 Program Outcomes

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, making effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

2.5 Program Specific Outcomes

PSO1: Student will be able to apply, analyze, and design applications by adopting the dynamic nature of software developments.

PSO2: Students will be able develop their skills to solve socially relevant problems using different projects in inter-discipline

2.6 Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. engineering

WK3: A systematic, theory-based formulation of fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Chapter 3:

Curriculum Structure and Scheme

3.1 Nomenclature of the Course Categories

Abbreviation	Course Category	Description
BSES	Basic Science and Engineering Sciences	Consist of Basic Science (BS) and Engineering Sciences (ES) which serves as foundation of Engineering
PRC	Program Related Courses	Consists of: Program Core (the primary, in-depth subject of study which ensures foundational knowledge and expertise in a chosen discipline. Program Elective (an optional course a student chooses that directly aligns with, supports, or deepens their specific field of study or major)
MDM	Multi-Disciplinary Minor	A structured, secondary area of study taken alongside a student's primary major to gain foundational knowledge in a different field. It fosters interdisciplinary expertise, employability, and holistic skill sets.
OE	Open Elective	Institute level course chosen from outside a student's main department or discipline
SEC	Skill Enhancement Courses	A specialized, practical training program designed to provide students with industry-relevant skills, value-based knowledge, and hands-on experience, aimed at increasing employability
HSSM	Humanities, Social Sciences, and Management	Academic disciplines focused on understanding human culture, behaviour, society, and organizational leadership. They foster critical thinking, communication, and ethical perspectives.
CC (LLC)	Co-Curricular Courses (Liberal Learning Courses)	Structured educational experiences that take place outside the traditional classroom but are intentionally designed to complement, supplement, and enhance the academic curriculum

3.2 Credit Distribution Structure

Broad Category Code	Course Catg. Code	Semester→ Course Type	1	2	3	4	5	6	7	8	Sub-Total	Tot	%
BSES	BS	Basic Science	07	07	03	03					20	29	18.13
	ES	Engineering Science	06	03							09		
PRC (Program Related Courses)	PC	Program Core		03	11	11	08	08	04		45	80	50
	PE	Program Elective					04	03	06		13		
	RM	Research Methodology							02		02		
	CP	Community Engagement Project							02		02		
	PR	Project				01	01	02	02		06		
	IN	Internship / OJT								12	12		
MDM + OE	MM	Multidisciplinary Minor					03	03	04	04	14	22	13.75
	OE	Open Elective			02	02	02	02			08		
SEC (Skill Enhancement Courses)	VS	Voc. and Skill Enhancement	02	04	02	03		01			12	22	13.75
	AE	Ability Enhancement	02		01		01				04		
	IK	Indian Knowledge System		02							02		
	VE	Value Education	02	02							04		
HSSM	EM	Entrepreneurship / Mgmt.			02	02					04	04	2.50
CC (LLC)	CC	Co-Curricular	02		01						03	03	1.87
Total			21	21	22	22	19	19	20	16	160	160	100

3.3 Components of Curriculum

Curriculum Component	Curriculum Content %	Total number of contact hours	Total number of credits
Basic Science	12.5	6,00	20
Engineering Science	5.63	270	09
Program Core	28.13	1,350	45
Program Elective	8.13	390	13
Research Methodology	1.25	60	02
Community Engagement	1.25	60	02
Project	3.75	180	06
Internship / OJT	7.5	360	12

Multidisciplinary Minor	8.75	420	14
Open Elective	5	240	08
Voc. and Skill Enhancement	6.25	360	12
Ability Enhancement	2.5	120	04
Indian Knowledge System	1.25	60	02
Value Education	2.5	120	04
Entrepreneurship / Mgmt.	2.5	120	04
Co-Curricular	1.88	90	03
Any other (Please specify)	-	-	-
Total	100	4800	160

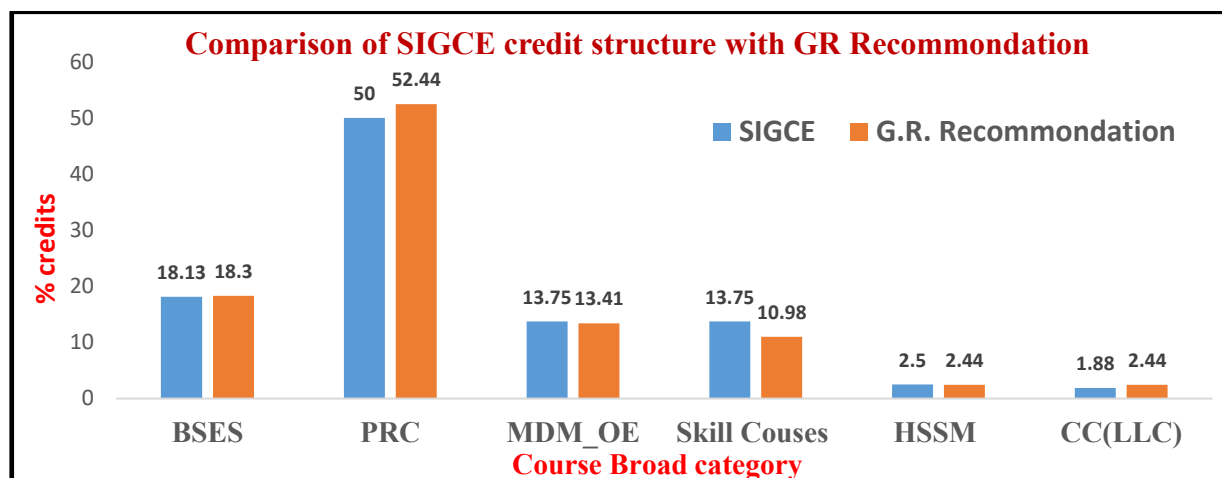
3.4 Course Codes – Letter Placement and Meaning

COURSE CODES - LETTER PLACEMENT						
1	2	3	4	5	6	7
Department / Program Name		Course Category Code		Course Level *	Course Number**	
AD - AI and Data Science AS - Applied Science & Humanities CA - CSE-AIML CE - Computer Engg. CCI - CSE-IOTCSBT EE -Electrical Engg. IG - SIGCE (Institute Level) ME - Mechanical Engg.		AE - Ability Enhancement BS - Basics Science CC - Cocurricular Course CP - Community Engaged Project EM - Entrepreneurship/Economics/Management ES - Engineering Science HS - Humanities Social Science IK - Indian Knowledge System IN - Internship/On job Training MM - Multi-Disciplinary Minor OE - Open Elective PC - Program Core PE - Program Elective PR - Project RM - Research Methodology VE – Value Education VS - Vocational and skill enhancement course		0 - Pre-requisite 1 - Foundation 2 - Intermediate 3 - Higher-level 4 - Advanced	0	1

* **Course Level** : Please refer NEP GR to determine the levels

** **Course Number**: Sequence number of course in that Course Category offered by a specific department

3.5 Comparison of SIGCE credit structure with the G.R recommendation



3.6 Semester wise allocation of credits

Semester III

Course Code	Broad Catg.	Course Name	Course Choice	Teaching Scheme (Hrs)						Credit Assigned			
				CR		Lab		SL	TE	L	T	P/D	TC
				L	T	P	D						
CABS231	BS	Mathematics for Computer Engineering	Compulsory	2	1	-	-	3	6	2	1	-	3
CAPC231	PC	Analysis of Algorithm	Compulsory	3	-	2	-	3	8	3	1	-	4
CAPC232	PC	Discrete Structure and Graph Theory	Compulsory	3	-	-	-	3	6	3	-	-	3
CAPC233	PC	Operating System	Compulsory	3	-	2	-	3	8	3	1	-	4
IGOE23X	OE	Open Elective	Choice Based*	2	-	-	-	2	4	2	-	-	2
CAVS231	VS	Advanced Java	Compulsory	-	-	2	2	-	4	-	-	2	2
IGAE231	AE	Comprehensive Soft Skill and Professional Development	Compulsory	-	-	-	2	-	2	-	-	1	1
IGEM231	EM	Entrepreneurship and Business Model Development	Compulsory	-	-	2	2	-	4	-	-	2	2
IGCC23x	CC	Cocurricular Course	Choice Based*	-	-	2	-	-	2	-	-	1	1
TOTAL				13	1	10	6	14	44	13	3	6	22

*CR=Classroom Teaching; L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning; TE = Total Engagement Hours; TC = Total Credit

*Students will have to do one course from the Basket. Refer to Indicative Open Elective and Indicative Cocurricular Course in Chapter 4.

Semester IV

Course Code	Broad Catg.	Course Name	Course Choice	Teaching Scheme (Hrs)						Credit Assigned			
				CR		Lab		SL	TE	L	T	P/D	TC
				L	T	P	D						
CABS241	BS	Statistical Methods in Data Science	Compulsory	2	-	2	-	2	6	2	-	1	3
CAPC241	PC	Computational Theory	Compulsory	3	-	-	-	3	6	3	-	-	3
CAPC242	PC	Database Management System	Compulsory	3	-	2	-	3	8	3	-	1	4
CAPC243	PC	Computer Networks	Compulsory	3	-	2	-	3	8	3	-	1	4
IGOE24x	OE	Open Elective	Choice Based*	2	-	-	-	-	2	2	-	-	2
CAVS241	VS	AI Tools	Compulsory	-	-	2	2	-	4	-	-	2	2
IGVS241	VS	Engineering Fundamentals and Technical Skills	Compulsory	-	-	-	2	-	2	-	-	1	1
IGEM241	EM	Design Thinking	Compulsory	-	-	2	2	-	4	-	-	2	2
CAPR241	PR	Mini Project-I	Compulsory			2			2			1	1
TOTAL				13	-	12	6	11	42	13	-	9	22

3.7 Program Examination Scheme

Semester III

Course Code	Category	Course Name	Course Choice	Evaluation Scheme (Marks)										Evaluation Scheme (%)											
				Theory						LAB/TUT			TH+L AB	Theory					LAB/TUT						
				IA1	IA2	FA	ESE	Tot	ESE Hrs	CIE	ESE	Tot		GT	IA1	IA2	FA	ESE	Total	CIE	ESE	Total			
CABS231	BS	Mathematics for Computer Engineering	Compulsory	15	15	10	60	100	2.5	25	-	-	125	15	15	10	60	100	100	-	-				
CAPC231	PC	Analysis of Algorithm	Compulsory	15	15	10	60	100	2.5	25	25	50	150	15	15	10	60	100	50	50	100				
CAPC232	BS	Discrete Structure and Graph Theory	Compulsory	15	15	10	60	100	2.5	-	-	-	100	15	15	10	60	100	-	-	-				
CAPC233	PC	Operating System	Compulsory	15	15	10	60	100	2.5	25	25	50	150	15	15	10	60	100	50	50	100				
IGOE23x	OE	Open Elective	Choice – Based	15	15	10	60	100	2.5	-	-	-	100	15	15	10	60	100	-	-	-				
CAVS231	VS	Advanced Java	Compulsory	-	-	-	-	-	-	50	25	75	75	-	-	-	-	-	50	50	100				
IGAE231	AE	Comprehensive Soft Skill and Proff.	Compulsory	-	-	-	-	-	-	25	-	25	25	-	-	-	-	-	100	-	100				
IGEM231	EM	Entrepreneurship and Business Model Development	Compulsory	-	-	-	-	-	-	50	-	50	50	-	-	-	-	-	100	-	100				
IGCC23x	CC	Cocurricular Course	Choice – Based	-	-	-	-	-	-	25	-	25	25	-	-	-	-	-	100	-	100				
TOTAL				75	75	50	300	500	-	225	75	275	800												

Semester IV

Course Code	Category	Course Name	Course Choice	Evaluation Scheme (Marks)										Evaluation Scheme (%)								
				Theory						LAB/TUT			TH+L AB	Theory					LAB/TUT			
				IA1	IA2	FA	ESE	Tot	ESE Hrs	CIE	ESE	Tot		GT	IA1	IA2	FA	ESE	Total	CIE	ESE	Total
CABS241	BS	Statistical Methods in Data Science	Compulsory	15	15	10	60	100	2.5	25	-	25	125	15	15	10	60	100	100	-	100	
CAPC241	PC	Computational Theory	Compulsory	15	15	10	60	100	2.5	-	-	-	100	15	15	10	60	100	-	-	-	
CAPC242	PC	Database Management System	Compulsory	15	15	10	60	100	2.5	25	25	50	150	15	15	10	60	100	50	50	100	
CAPC243	PC	Computer Networks	Compulsory	15	15	10	60	100	2.5	25	25	50	150	15	15	10	60	100	50	50	100	
IGOE24x	OE	OPEN ELECTIVE	Choice – Based	15	15	10	60	100	2.5	-	-	-	100	15	15	10	60	100	-	-	-	
CAVS241	VS	AI Tools	Compulsory	-	-	-	-	-	-	25	25	50	50	-	-	-	-	-	50	50	100	
IGVS241	VS	Engg. Fundamentals and Tech Skills	Compulsory	-	-	-	-	-	-	25	-	25	25	-	-	-	-	-	100	-	100	
IGEM241	EM	Design Thinking	Compulsory	-	-	-	-	-	-	50	-	50	50	-	-	-	-	-	100	-	100	
CAPR241	PR	Mini Project-I	Compulsory	-	-	-	-	-	-	25	25	50	50	-	-	-	-	-	50	50	100	
Total				75	75	50	300	500		200	100	300	800									

3.8 Framework for Assessment and Evaluation

At SIGCE, alignment with NEP 2020 and targeting Outcome based education, assessment instruments and methods go beyond traditional written examination.

Assessment instruments and methods and evaluation mechanism should be multi-dimensional and should measure leanings of students through various ways as all students may not demonstrate their learning if only limited instruments and methods are used. Faculty members are encouraged to use various combination of Instruments, Methods and Evaluation and just not rely on traditional tools. Following section list some “suggested” Assessment instruments, methods and mechanism. However, teachers are encouraged to be creative in using different assessment instruments and methods to evaluate learners.

Assessment Instruments

Assessment Instruments define “what evidence-producing task has been given to student to evaluate his/her learning. Following is the indicative list of Assessment Instruments.

SN	ASSESSMENT INSTRUMENTS	Description
1	Paper – Pen/Pencil	Students are assessed through written examinations, tests, assignments, numerical problems, or analytical exercises. It evaluates conceptual understanding, problem-solving ability, application of knowledge, and written communication skills
2	Quiz	Short, focused assessments conducted in oral, written, or digital mode to evaluate understanding of specific concepts and topics. Quizzes provide timely feedback and support continuous monitoring of student learning.
3	Case Studies	Students analyse real-world or simulated situations to identify problems, evaluate alternatives, and propose justified solutions. It assesses analytical thinking, decision-making, application of interdisciplinary knowledge, and professional judgement
4	Presentation	Students communicate technical, conceptual, or project-based content through structured oral and visual presentations. It evaluates subject understanding, communication skills, logical organization, confidence, and ability to respond to questions.
5	Attendance	Student participation is assessed based on regularity, punctuality, and consistent engagement in scheduled academic activities. It reflects continuity in the learning process; however, its weightage should be governed by institutional academic regulations.
6	Portfolio / e-Portfolio	A systematic collection of student work demonstrating learning progress, achievements, competencies, and reflections over a defined period. It enables longitudinal assessment of knowledge, skills, creativity, and continuous improvement.
7	Teachers Observation	Faculty systematically observe student performance, participation, practical skills, teamwork, professional behaviour, and learning engagement. Assessment should be based on predefined criteria, checklists, rating scales, or rubrics to ensure objectivity.

8	e-Parikshak	A technology-enabled assessment instrument used for conducting, evaluating, and analysing student performance through digital platforms for programming (coding) subjects.
9	Mini Project	Students undertake a limited-scope project to apply theoretical knowledge to a defined engineering or interdisciplinary problem. It assesses problem identification, design thinking, technical implementation, teamwork, documentation, and presentation skills.
10	Major Project	Students undertake a comprehensive project involving problem formulation, design, development, experimentation, analysis, and validation. It assesses integration of disciplinary knowledge, innovation, project management, teamwork, ethics, and professional competence.
11	Field Project	Students engage with real-world environments, industries, communities, or field settings to investigate and address practical problems. It evaluates experiential learning, observation, data collection, contextual analysis, stakeholder interaction, and solution development.
12	Dissertation / Report	Students prepare a structured academic or technical document presenting objectives, methodology, analysis, findings, conclusions, and recommendations. It assesses depth of study, research ability, technical writing, critical analysis, and adherence to academic integrity.
13	Oral Examination	Students respond verbally to questions related to concepts, experiments, projects, design work, or practical applications. It evaluates depth of understanding, clarity of thought, technical articulation, reasoning ability, and ability to defend decisions.
14	Group Discussion	Students collaboratively discuss a given technical, social, ethical, or contemporary topic within a structured setting. It assesses communication, teamwork, listening skills, critical thinking, leadership, reasoning, and respect for diverse perspectives.
15	Role Play	Students enact assigned roles in simulated professional, technical, managerial, or societal situations to demonstrate applied understanding. It evaluates communication, decision-making, empathy, teamwork, ethical reasoning, and response to real-world scenarios.

Assessment Methods / Mode

Assessment Methods or Modes are methods / mode which define “WHERE, WHEN, and under WHAT condition is assessment conducted”.

SN	ASSESSMENT METHODS / MODE	DESCRIPTION
1	Supervised In-Class Mode	Assessment is conducted physically during scheduled academic time under faculty or authorised supervision.
2	Open book Mode	Students are permitted to consult specified books, notes, standards, or approved resources during the assessment. Tasks should emphasise application, analysis, synthesis, and judgement rather than direct recall.
3	Closed-Book Mode	Students complete the assessment without access to external learning resources, except specifically permitted materials. This mode is generally used to assess retained understanding, procedural fluency, and independent application.
4	Online Assessment	Assessment is conducted through an approved digital platform under defined access, duration, submission, and authentication conditions. It may be synchronous or asynchronous and supervised or unsupervised.
5	Take home Test	Students complete an assessment outside scheduled classroom conditions within a specified submission period. Permitted resources, collaboration rules, originality requirements, and academic integrity expectations are clearly defined
6	In Class Assignment	Students complete a defined assignment during scheduled class time under specified conditions and with stated levels of faculty guidance. The mode enables immediate application of concepts and controlled completion of learning tasks.
7	Field Based Mode	Assessment is conducted in authentic environments such as industries, communities, laboratories, sites, or field locations. Students generate evidence through observation, investigation, data collection, interaction, or practical engagement.
8	Peer Assessment	Students evaluate the work or performance of their peers using faculty-approved criteria, checklists, rating scales, or rubrics. Peer judgements may be used for formative feedback or controlled scoring, with appropriate faculty moderation to ensure fairness and consistency
9	Self-Assessment	Students evaluate their own learning, performance, or work against predefined criteria, expected outcomes, checklists, or rubrics. The process is used to identify strengths, gaps, learning needs, and improvement actions, with faculty validation where required.

Evaluation Mechanism

Evaluation mechanism define “How the performance of the learners is Judged, scored or interpreted”

	EVALUATION MECHANISM	DESCRIPTION
1	Answer Key-Based Evaluation	Student responses are evaluated against predetermined correct answers or acceptable response options. It is most appropriate for objective based assessment instruments
2	Model Answer / Model Solution-Based Evaluation	Responses are compared with an approved model answer or solution indicating expected content, methodology, steps, and outcomes. Marks are awarded according to the extent and quality of demonstrated achievement
3	Rubric-Based Evaluation	Performance is judged against predefined criteria with clearly described levels of achievement. Scores or grades are assigned by matching demonstrated performance with descriptors for each criterion
4	Checklist-Based Evaluation	Performance is evaluated by recording the presence, absence, or completion of predefined behaviours, steps, features, or requirements. It is particularly suitable for practical tasks, procedures, and compliance-oriented performance.
5	Milestone-Based Evaluation	Performance is evaluated at predefined stages of a project, dissertation, design activity, or extended task. Each milestone is judged against specified deliverables, progress expectations, and achievement criteria.

Chapter 4:

Indicative List of Courses

Apart from Program related courses, students are expected to take Basic Science and Engineering courses, Humanities, Social Science and Management courses and co-curricular courses. Indicative list of these courses which are offered in III and IV Sem are as follows.

4.1 Basic Science and Engineering Courses

SN	LIST OF SUGGESTED OPEN ELECTIVES	COURSE CODE	Semester
1	Mathematics for Computer Engineering	CABS231	III
2	Statistical Methodes in Data Science	CABS241	IV

4.2 Humanities, Social Science and Management Courses

Following courses are offered in Sem III and IV from the basket of HSSM (Humanities, Social Science and Management).

SN	LIST OF SUGGESTED OPEN ELECTIVES	COURSE CODE	Semester
1	Entrepreneurship and Business Model development	IGEM231	III
2	Design Thinking	IGEM242	IV

4.3 Co-Curricular Courses

Following courses are offered in Sem III and IV from the basket of CC (Co-Curricular). Students should refer CC syllabus document for the detailed syllabus

SN	LIST OF SUGGESTED Co-curricular courses	COURSE CODE	Semester
1	Theater Drama	IGCC231	III
2	Social Science and Community Services	IGCC232	III
3	Analytical and Aptitude Skills	IGCC233	III

Link for Co-curricular Course [syllabus](#)

4.4 Open Elective

Following courses are offered in Sem III and IV from the basket of OE (Open Electives). Students should refer OE syllabus document for the detailed syllabus

SN	LIST OF SUGGESTED OPEN ELECTIVES	COURSE CODE	Semester
1	Financial Management	IGOE231	III
2	Financial Literacy	IGOE232	III
3	Fin Tech	IGOE233	III
4	Disaster Management and Mitigation Measures	IGOE234	III
5	Leadership Management	IGOE241	IV
6	Waste Management	IGOE242	IV
7	Principles and Practices of Management	IGOE243	IV
8	Cyber and Digital safety	IGOE244	IV

Link for Open Elective Course [syllabus](#)

Chapter 5:

Mapping and Justification

5.1 Indicative Mapping of Courses to PO

All the courses are mapped to PO by taking average of CO-PO mapping from individual courses.

These values are just indicative, and individual faculty can change it based on the depth of coverage and pedagogical tools used which will be reflected in the lesson plans.

Mapping of 3 signifies “High Correlation”, Mapping of 2 signifies “Medium Correlation” and mapping of 1 signifies “Low Correlation”

Semester III

Course Code	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CABS231	Mathematics for Computer Engineering	3.0	3.0	2.0	2.0	2.3	-	-	-	-	2.0	2.0	2.0	3.0
CAPC231	Analysis of Algorithm	3.0	3.0	3.0	-	3.0	-	-	-	2.0	2.0	3.0	3.0	3.0
CAPC232	Discrete Structure and Graph Theory	3.0	3.0	3.0	-	-	-	-	-	-	-	3.0	3.0	3.0
CAPC233	Operating System	3.0	3.0	2.5	3.0	3.0	-	-	-	-	-	-	3.0	3.0
CAVS231	Advanced Java	2.5	2.7	2.7	2.7	2.6	2.0	-	-	-	-	-	3.0	2.7
IGVS231	Comprehensive Soft Skill and Proff. Development	2.0	2.3	2.5	2.0	2.0	2.3	-	2.3	2.8	3.0	2.0	2.7	2.0
IGEM231	Entrepreneurship and Business Model Development	2.2	2.2	3.0	-	2.0	2.3	2.0	2.3	2.2	2.0	2.0	2.0	3.0

Semester IV

Course Code	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CABS241	Statistical Methods in Data Science	2.3	2.8	2.2	2.6	2.2	-	-	-	-	-	2.0	2.3	2.0
CAPC241	Computational Theory	3.0	3.0	3.0	-	-	-	-	-	-	-	3.0	3.0	3.0
CAPC242	Database Management System	3.0	2.7	2.7	-	2.8	-	-	3.0	2.5	-	3.0	3.0	3.0
CAPC243	Computer Networks	2.7	2.2	2.3	2.0	3.0	-	-	-	2.0	2.0	2.0	3.0	-
CAVS241	AI Tools	2.6	2.0	2.6	3.0	2.4	2.3	2.8	-	-	-	-	3.0	3.0
IGVS241	Engg. Fundamentals and Tech Skills	2.0	2.3	2.0	2.0	2.0	2.0	-	2.3	2.8	3.0	2.0	2.7	2.0
IGEM241	Design Thinking	2.3	2.5	2.4	2.2	2.0	-	-	2.0	2.0	-	-	2.8	2.0
CAPR241	Mini Project-I	-	-	2.0	2.3	2.5	-	-	2.2	2.2	2.3	2.5	2.0	2.8

5.2 Indicative Mapping of Courses to WK

Semester III

Course Code	Course Name	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CABS231	Mathematics for Computer Engineering		✓	✓	✓					
CAPC231	Analysis of Algorithm		✓	✓		✓				
CIPC232	Discrete Structure and Graph Theory	✓	✓	✓	✓				✓	
CAPC233	Operating System		✓	✓			✓			
CIVE232	Advanced Java	✓	✓	✓	✓					
IGVE231	Comprehensive Soft Skill and Proff. Development	✓					✓	✓	✓	
IGEM231	Entrepreneurship and Business Model Development		✓		✓	✓		✓		

Semester IV

Course Code	Course Name	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CABS241	Statistical Methods in Data Science	✓	✓	✓	✓	✓	✓			
CIPC241	Computational Theory	✓	✓	✓	✓				✓	
CAPC242	Database Management System	✓	✓	✓	✓	✓	✓		✓	
CAPC243	Computer Networks	✓	✓	✓	✓	✓				
CAVS241	AI TOOLS	✓		✓	✓		✓			✓
IGVS241	Engg. Fundamentals and Tech Skills	✓	✓	✓		✓	✓			
IGEM241	Design Thinking		✓			✓		✓	✓	
CAPR241	Mini Project-I					✓	✓		✓	✓

Chapter 6:

Subject-Mathematics for Computer Engineering (Sem III)

Overview			
Course code:	CABS231	Course Category:	Basic Science
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

6.1 Teaching & Learning Scheme

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	2	1	-	-	3	6
Hours/Sem	30	15	-	-	45	90
Credits	2	1	-	-	-	3

6.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	2
Tutorial	100%	-	100%	1

6.3 Course Objectives

Pre-requisite Course / Knowledge	Knowledge of Applied Mathematics I and II
Course Overview: This course provides a comprehensive foundation in mathematical concepts and analytical techniques essential for engineering and applied sciences. It integrates topics from linear algebra, Fourier analysis, number theory, optimization, and statistics to develop strong problem-solving and modelling skills.	
Course Objectives: 1. To introduce concepts and fundamentals Matrix algebra for engineering problems. 2. To enhance the skills to expand Fourier series for periodic functions with various periods. 3. To introduce the concept of modular arithmetic 4. To enable students to formulate and solve linear optimization problems using appropriate mathematical methods. 5. To develop the ability to analyse and optimize non-linear problems using classical optimization techniques. 6. To develop proficiency in statistical techniques arising in engineering applications.	

6.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CABS231.1	Apply the concepts of eigenvalues and eigenvectors in engineering problems.	Apply(L3)
CABS231.2	Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.	Apply(L3)
CABS231.3	Analyse modular arithmetic for security applications.	Analyze(L4)
CABS231.4	Formulate and solve linear optimization problems using Simplex and Duality methods.	Evaluate(L5)
CABS231.5	Optimize non-linear functions using Lagrange multipliers and KKT conditions.	Evaluate(L5)
CABS231.6	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.	Apply(L3)

6.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Linear Algebra (Theory of Matrices)	CO1	L3	T1, R4	5
	1.1	Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof)				
	1.2	Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials				
	1.3	Similarity and diagonalization of matrices, Linearly Dependent and Independent Vectors.				
2	Title	Fourier Series	CO2	L3	T2, R2	5
	2.1	Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).				
	2.2	Fourier series of periodic functions with period 2π and $2l$.				
	2.3	Fourier series of even and odd functions				
3	Title	Modular Arithmetic	CO3	L4	T3, R3	5
	3.1	Introduction to Congruence, Linear congruence, Chinese remainder theorem (CRT), solving polynomials, system of linear congruence.				
	3.2	Euler's Totient theorem, Fermat's little theorem				
	3.3	Application of congruence-RSA algorithm				
4	Title	Linear Programming Problems	CO4	L5	T1, R1	5
	4.1	Types of Solutions, Standard and Canonical form of LPP, Basic and Feasible Solution				

	4.2	Simplex Method					
	4.3	Duality and Dual Simplex Method					
5	Title	Non-Linear Programming Problems	CO5	L5	T1, R1	5	
	5.1	Quadratic Programing Problems					
	5.2	NLPP with one and two equality constraints (two or three variables) using the method of Lagrange’s multipliers					
	5.3	NLPP with inequality constraints (Kuhn-Tucker conditions)					
6	Title	Statistical Techniques	CO6	L3	T1, R1	5	
	6.1	Karl Pearson’s coefficient of correlation (r)					
	6.2	Spearman’s Rank correlation coefficient (R) (with repeated and non-repeated ranks)					
	6.3	Fitting of first-degree and second-degree curve.					
Self-Study	1.1	Diagonalizable and non-diagonalizable matrices, Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.					3 hrs. /wk.
	2.1	Orthogonal and orthonormal set of functions, Complex form of Fourier Series, Fourier Transforms					
	3.1	Divisibility, GCD, properties of prime numbers, fundamental theorem of arithmetic.					
	4.1	Sensitivity Analysis, Big-M method, Transportation Problems					
	5.1	Optimization Techniques in Engineering Applications, Introduction to Integer and Dynamic Programming					
	6.1	Covariance, Fitting of exponential curve					

Tutorial

SN	Topics to be covered	CO
1	Tutorial No 1 – Module 1 – Linear Algebra (Theory of Matrices)	CO1
2	Tutorial No 2 – Module 2 – Fourier Series	CO2
3	Tutorial No 3 – Module 3 – Modular Arithmetic	CO3
4	Tutorial No 4 – Module 4 – Linear Programming Problems	CO4
5	Tutorial No 5 – Module 5 – Non-Linear Programming Problems	CO5
6	Tutorial No 6 – Module 6 – Statistical Techniques	CO6

6.6 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA-1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
2	IA-2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
3	FA	2	CAT	Teacher choice*	Teacher choice*	10	10	-
4	ESE	1	ESE	Paper- Pen	Class Rom Test	60	60	2.5 Hrs

(Note: Add separate row for each assessment type)

***IA** = Internal Assessment; **FA** = Formative Assessment;

IA-1 will be conducted after completion of 3 modules; IA-2 will be conducted after completion of next 3 modules

*Assessment Instruments → **What** Tools and instruments are used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed

Tutorial Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Tutorial	6	CAT	Tutorial	Rubrics Based	10	40	1 Hr
2	Mini Project	1	CAT	Mini Project Presentation	Rubrics based	10	40	15 min
3	Classroom Participation	1	CAT	Attendance	Record Based	5	20	-

6.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CABS231.1	3	3	-	-	2	-	-	-	-	-	-	2	-
CABS231.2	3	3	-	2	-	-	-	-	-	-	-	2	-
CABS231.3	3	3	-	-	2	-	-	-	-	-	-	2	3
CABS231.4	3	3	2	-	-	-	-	-	-	2	-	2	-
CABS231.5	3	3	2	-	-	-	-	-	-	2	-	2	-
CABS231.6	3	3	-	2	3	-	-	-	-	-	2	2	3

6.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.	The syllabus directly includes matrices, numerical methods, statistics, differential equations, and mathematical modelling required in computer engineering.
2	WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.	Engineering mathematics provides theoretical and analytical foundations for core computer engineering subjects.
3	WK4	Engineering specialist knowledge provides theoretical frameworks and bodies of knowledge for accepted practice areas in the engineering discipline.	Mathematical concepts support specialized computing domains such as AI, machine learning, graphics, and data analytics.

6.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Engineering Mathematics-III (NEP)	1 st	G.V. Kumbhojkar	P. Jamnadas LLP	2025
T2	Engineering mathematics	44 th	Dr. B.S Grewal	Khanna Publications	2017
T3	Number Theory	1 st	M. G. Nadkarni & J. S. Dani	Tata McGraw Hill Education	1992

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Advance Engg. Mathematics	4 th	R.K. Jain & S.R.K Iyengar	Narosha Publication	2014
R2	Advance Engg. Mathematics	10 th	Erwin Kreyszig	Wiley	2011
R3	Elementary Number Theory	7 th	David M. Burton	McGraw Hill	2010
R4	Text Book of Matrices	6 th	Shanti Narayan & P.K. Mittal	S. Chand Publication	2010

Online Resources

SN	Title	Description
O1	https://nptel.ac.in/courses/122107037	NPTEL
O2	https://www.researchgate.net/publication/350973707_A_study_about_Fourier_series_Mathematical_and_graphical_models_and_application_in_electric_current_and_square_oscillations	Research Paper
O3	https://youtu.be/PG_ax_HmS0?si=yhmR83JXF5jGyqMg	YouTube video

Chapter 7:

Subject- Analysis of Algorithm (Sem III)

Overview			
Course code:	CAPC231	Course Category:	Program Core
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

7.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	3	-	2	-	3	8
Hours/Sem	45	-	30	-	45	120
Credits	3	-	1	-	-	4

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

7.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	3
Labs	50%	50%	100%	1

7.3 Course Objectives

Pre-requisite Course / Knowledge	C Programming, Data Structure
Course Overview: This course focuses on the study of computational efficiency and performance of algorithms. Through theoretical understanding and practical problem-solving, students learn to design efficient algorithms, evaluate trade-offs and apply suitable approaches to real-world computational problems.	
Course Objectives: 1. To provide a mathematical approach for analyzing the performance of algorithms. 2. To apply different algorithm design paradigms for solving problems. 3. Evaluate & compare various algorithm design strategies that can help in solving the real world problem effectively.	

7.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPC231.1	Apply time and space complexity using asymptotic notation.	Apply(L3)
CAPC231.2	Analyze the time complexity of divide and conquer algorithm.	Analyze(L4)
CAPC231.3	Construct solutions to optimization problems using greedy algorithms.	Apply(L3)
CAPC231.4	Formulate and solve dynamic programming algorithms efficiently to solve optimization problems.	Apply(L3)
CAPC231.5	Apply backtracking and branch and bound techniques to solve real world problems.	Apply(L3)
CAPC231.6	Apply string matching techniques for efficient patterns matching.	Apply(L3)

7.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Fundamentals of Algorithm	CO1	L3	T1, O1	7
	1.1	Definition of Algorithms, Properties of Algorithms, Expressing Algorithms, Order of Growth, Asymptotic Notations, Substitution method, Master Theorem, Recurrence tree.				
	1.2	Sorting techniques: Insertion sort, Selection sort, Heap sort.				
	1.3	Complexity classes: P, NP, NP-Complete, NP Hard problems.				
2	Title	Divide and conquer	CO2	L4	T1, T2, R1, O1	6
	2.1	General method, Merge sort, Quick sort, Randomized Quick Sort.				
	2.2	Finding Maximum and Minimum element, Binary search.				
3	Title	Greedy algorithms	CO3	L3	T1, T2, R1, O2	7
	3.1	General method, Fractional Knapsack problem.				
	3.2	Minimal Spanning Trees Prim and Kruskal algorithm, Single source shortest path: Dijkstra's algorithm.				
	3.3	Job sequencing with Deadline.				
4	Title	Dynamic Programming	CO4	L3	T1, T2, O3	8
	4.1	General method, Multistage graph, Bellman ford, All pair shortest path: Floyd warshall.				
	4.2	0/1Knapsack problem, Longest Common Subsequence, Travelling salesperson problem.				
5	Title	Backtracking and Branch & Bound	CO5	L3	T2, O3	6
	5.1	Backtracking: General method, Queen's problem, Graph Coloring, Sum of Subset.				
	5.2	Branch and Bound: General method, 15 puzzles, job assignments and scheduling problems.				
6	Title	String Matching	CO6	L4	T1, O4	5
	6.1	General method, Naïve String Matching, Rabin Karp matching algorithm, Knuth Morris Pratt, Finite Automata Matcher.				
Self-study	SS.1	Tight vs Loose bounds (Big-O, Ω , Θ in depth)				3 hrs./wk.
	SS.2	Strassen's Matrix Multiplication				
	SS.3	Huffman Coding algorithm				
	SS.4	Matrix Chain Multiplication				

	SS.5	Sudoku solver using backtracking Hamiltonian Cycle problem	
	SS.6	Z-algorithm for pattern matching, Boyer-Moore algorithm	

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs.
1	Implement Selection sort and evaluate Time complexity in best, average and worst case.	CO1	2
2	Implement Insertion sort and evaluate Time complexity in best, average and worst case.	CO1	2
3	Implement Merge sort using divide and conquer strategy and evaluate Time complexity in best, average and worst case.	CO2	2
4	Implement Quick sort using divide and conquer strategy and evaluate Time complexity in best, average and worst case.	CO2	2
5	Implement Binary search using divide and conquer strategy and evaluate Time complexity in best, average and worst case.	CO2	2
6	Implement the Dijkstra algorithm using a greedy approach.	CO3	2
7	Implement Fractional knapsack using a greedy approach.	CO3	2
8	Implement Belman ford Algorithm using dynamic programming approach.	CO4	2
9	Implement Floyd warshall Algorithm using dynamic programming approach.	CO4	2
10	Implement Longest Common Subsequence (LCS) using dynamic programming approach.	CO4	2
11	Implement N queen problem using backtracking approach.	CO5	2
12	Implement 15 puzzle problems using branch and bound approach.	CO5	2
13	Implement Naive string-matching algorithm.	CO6	2
14	Implement Robin Karp string matching algorithm.	CO6	2

7.6 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA-1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
2	IA-2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
3	FA	2	CAT	Teachers Choice*	Teachers Choice*	10	10	--
4	ESE	1	ESE	Paper- Pen	In Class Exam	60	60	2.5hrs

*IA = Internal Assessment; FA = Formative Assessment;

IA 1 will be conducted after completion of 3 modules; IA 2 will be conducted after completion of next 3 modules

*Assessment Instruments → **What** Tools and instruments used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed.

* Refer section 3.8

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiment	10	CAT	Lab Experiment	e- Parikshak	15	30	2 hrs.
2	Classroom Participation	-	CAT	Attendance	Record based	5	10	-
3	Presentation	1	CAT	Lab Presentation	Rubrics Based	5	10	15 min
4	ESE	1	ESE	Oral and Practical's	e- Parikshak	25	50	2 hrs.

Note:

1. CAT Activity will be part of Term Work.
2. The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.
3. Learners will perform minimum 10 experiments at least 1 experiment from each module.
4. Presentation topics strictly based on Application of Analysis of Algorithms in various domains.

7.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPC231.1	3	3	2	-	3	-	-	-	2	2	3	3	3
CAPC231.2	3	3	2	-	3	-	-	-	2	2	3	3	3
CAPC231.3	3	3	2	-	3	-	-	-	2	2	3	3	3
CAPC231.4	3	3	2	-	3	-	-	-	2	2	3	3	3
CAPC231.5	3	3	2	-	3	-	-	-	2	2	3	3	3
CAPC231.6	3	3	2	-	3	-	-	-	2	2	3	3	3

7.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modeling applicable to the discipline. Engineering	Use of mathematical tools to analyze algorithm efficiency
2	WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.	Design paradigms provide systematic, theory-based algorithm design methods.
3	WK5	Knowledge, including efficient resource use, environmental impacts,	Designing efficient algorithms for real-world problems

	whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
--	--

7.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Introduction to Algorithms	3 rd	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	MIT Press	2009
T2	Fundamentals of Algorithms	2 nd	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran	Universities Press	2008
T3	Design and Analysis of Algorithms	2 nd	Chandra Mohan	PHI	2015

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Introduction to design and analysis of algorithm	2 nd	Anany Levitin	Pearson Education	2007
R2	The Art of Computer programming	3 rd	Donald E Knuth	Addison-Wesley	1997
R3	Design and analysis of algorithm	2 nd	S. Sridhar	Oxford University Press	2014
R4	Algorithm	4 th	Robert Sedgewick and Kevin Wayne	Addison-Wesley	2011

Online Resources

SN	Title	Description
O1	https://nptel.ac.in/courses/106105164	Asymptotic notation, Spanning Tree, Divide and conquer ,greedy , dynamic programming
O2	https://www.w3schools.com/dsa/dsa_intro.php	DSA Introduction :Sorting,0/1 knapsack, spanning tree
O3	https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-and-algorithms/	DSA Tutorial - GeeksforGeeks :Sorting, Divide and conquer , dynamic programming, backtracking and branch and bound
O4	https://www.tutorialspoint.com/data_structures_algorithms/dsa_pattern_searching.htm	DSA - Pattern Searching Tutorials points: String matching

Chapter 8:

Subject- Discrete Structure and Graph Theory (Sem III)

Overview			
Course code:	CAPC232	Course Category:	Program Core
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

8.1 Teaching & Learning Scheme

Components	Class room Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	3	-	-	-	3	6
Hours/Sem	45	-	-	-	45	90
Credits	3	-	-	-	-	3

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

8.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	3

8.3 Course Objectives

Pre-requisite Course / Knowledge	Set Theory, Basic Algebra and Number Theory, Fundamental Counting Principle, Permutations, Combinations. Graph Basics.
Course Overview: The study of Discrete Structures and Graph Theory enables students to develop strong logical reasoning, combinatorial techniques, and mathematical structures that are essential in programming, algorithm design, networking, database design, artificial intelligence, and cryptography.	
Course Objectives: 1. Cultivate clear thinking and creative problem solving. 2. Thoroughly prepare for the mathematical aspects of other Relations and Functions in Computer Engineering course. 3. Solve real-world problems using counting principles, recurrence relations. 4. Use of graph theory in solving practical problems. 5. Strengthen mathematical foundations for research and higher studies in Computer Engineering.	

8.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPC232.1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving using set theory and logic.	Apply(L3)
CAPC232.2	Apply properties of Relation sets in real-life problem-solving domains.	Apply(L3)
CAPC232.3	Apply properties of function sets in real-life problem-solving domains.	Apply(L3)
CAPC232.4	Apply counting principles, Pigeonhole principle, Inclusion Exclusion principle solves combinatorial problems.	Apply(L3)
CAPC232.5	Apply algebraic structure for a given mathematical problem.	Apply(L3)
CAPC232.6	Apply graph theory in solving computing problems.	Apply(L3)

8.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	SET THEORY & LOGIC	CO1	L3	T3, T4, T1, R3, R4	7
	1.1	Set Theory: Sets, Subsets, Universal and Empty sets, Set Operations, Set Representation, Laws of Set theory				
	1.2	Logic: Propositional logic, Predicate logic, Quantifiers (Universal and Existential)				
	1.3	Types of Mathematical Proof: Direct proof, Proof by contradiction, Proof by deduction, Proof by cases, Proof by exhaustion, Proof by counterexample, Mathematical Induction				
2	Title	RELATIONS	CO2	L3	T3, T1, T2, R1, R4	8
	2.1	Relations : Definition, Representation of Relations, Properties of relations, Equivalence relations, Equivalence Classes, Closures of Relations, Warshall's algorithm				
	2.2	Posets and Lattice: Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattice, Sub lattice				
3	Title	FUNCTIONS	CO3	L3	T3, T4, T1, R3, R4	3
	3.1	Functions: Definition, Types of functions, Composition of functions, Identity and Inverse function, Real life applications of functions				
4	Title	COUNTING	CO4	L3	T2, T4	6
	4.1	Pigeonhole Principle, Inclusion-Exclusion Principle				
	4.2	Recurrence relations, Solving recurrence relations, Applications of Recurrence relations				
5	Title	ALGEBRAIC STRUCTURES	CO5	L3	T2, T4, R3, R4	7
	5.1	Algebraic structures with one binary operation: Semi group, Monoid				
	5.2	Groups, Subgroups, Abelian Group, and Cyclic group				
	5.3	Algebraic structures with two binary operations: Ring, Applications of algebraic structures				
6	Title	GRAPH THEORY	CO6	L3	T3, T4, R1, R3	8
	6.1	Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs				
	6.2	Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex, Real life applications of graph theory				

Self - Study	SS.1	PROLOG / LISP programming to create expert systems using Propositional and Predicate Logic, Practical applications of Logic in Computer Engineering	2 hrs. / wk.
	SS.2	Practical applications of relations in real life in the field of Database Management, Economics, Social Network, Sports, Medical Diagnosis, Weather, etc.	
	SS.3	Practical applications of function in Neural Network, Determining risk factors for insurance rates, Taxes and tax brackets, Vending machines, etc.	
	SS.4	Applications of Recurrence Relations – Analysis of recursive algorithms in computing. Combinatorial Problem Solving – Using counting techniques in probability and decision-making	
	SS.5	Error Correcting codes	
	SS.6	Network Flow Problems – Understanding flow in networks and its optimization. Graph Coloring Applications in Scheduling – Use of graph coloring in timetabling and resource allocation. Optimization Techniques – Application of graphs in shortest path problems, spanning trees, and clustering	

8.6 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA 1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
2	IA 2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
3	FA	2	CAT	Teachers Choice*	Teachers Choice*	10	10	-
4	ESE	1	ESE	Paper- Pen	Classroom Test	60	60	2.5 Hrs

*IA = Internal Assessment; FA = Formative Assessment;

IA 1 will be conducted after completion of 3 modules; IA 2 will be conducted after completion of next 3 modules

*Assessment Instruments → **What** Tools and instruments are used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed.

* Refer section 3.8

8.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPC232.1	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC232.2	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC232.3	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC232.4	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC232.5	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC232.6	3	3	3	-	-	-	-	-	-	-	3	3	3

8.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	A systematic, theory-based understanding of the nature sciences applicable to the discipline and awareness of relevant social sciences.	The subject Discrete structure and graph theory gives a foundational and core understanding of Computer Science and Engineering.
2	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.	Use of Logical and Mathematical concepts in problem solving.
3	WK3	A systematic theory-based formulation of engineering fundamentals in the engineering discipline.	A systematic formulation of Logical reasoning, Graphical theory, and other mathematical concepts in engineering discipline.
4	WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.	Knowledge of Logical reasoning, Graphical theory, and other mathematical concepts usage in various subjects and applications in computer engineering.
5	WK8	Engagement with selected knowledge in the current literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.	Engaging with current literature in Discrete Structures and Graph Theory requires moving beyond rote formula memorization. It involves active, logical deduction and graph modeling to solve dynamic computational problems. This process relies heavily on critical analysis, algorithmic reasoning, and creative problem-solving.

8.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Discrete Mathematics with Applications	5 th	Susanna S. Epp	Cengage Publications	2020
T2	Discrete Mathematics	5 th	Kenneth A. Ross	Pearson Publications	2019
T3	Discrete Mathematical Structures	6 th	Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman	Pearson Education	2015

T4	Discrete mathematics with Graph Theory and Combinatorics	1 st	T. Veera Rajan	McGraw Hill Publications	2006
----	--	-----------------	----------------	--------------------------	------

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Elements of Discrete Mathematics	2 nd	C. L. Liu	McGraw-Hill Book Company	2008
R2	Textbook of Discrete Mathematics	9 th	Swapan Kumar Sarkar	S. Chand Publications	2016
R3	Discrete and Combinatorial Mathematics	5 th	Ralph P. Grimaldi	Pearson Publications	2019
R4	Discrete Mathematical structures with applications to computer science.	1 st	J P Tremblay , R Manohar	McGraw-Hill International Edition	2017

Online Resources

SN	Title	Description
O1	https://nptel.ac.in/courses/111104416	Logic
O2	https://onlinecourses.nptel.ac.in/noc23_cs60/preview	Relations , Functions and Algebraic structures
O3	https://onlinecourses.nptel.ac.in/noc25_ma26/preview	Posets and Lattice & Graph Theory
O4	https://onlinecourses.nptel.ac.in/noc26_cs68/preview	Counting
O5	https://nptel.ac.in/courses/111107127	Graph Theory
O6	https://nptel.ac.in/courses/106108227	Discrete Mathematics
O7	https://nptel.ac.in/courses/106106183	Introduction to Course Discrete Mathematics
O8	https://nptel.ac.in/courses/106103205	Discrete Mathematics

Chapter 9:

Subject- Operating System (Sem III)

Overview			
Course code:	CAPC233	Course Category:	Program Core
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

9.1 Teaching & Learning Scheme

Components	Class room Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	3	-	2	-	3	8
Hours/Sem	45	-	30	-	45	120
Credits	3	-	1	-	-	4

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

9.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	3
Labs	50%	50%	100%	1

9.3 Course Objectives

Pre-requisite Course / Knowledge	Data Structure, Digital System (Computer organization & Architecture Fundamentals)
Course Overview: This course provides conceptual and practical knowledge of operating systems, focusing on the design and functioning of system software that manages resources, processes, memory, files, and I/O systems. It covers key topics such as process scheduling, synchronization, memory management, and file systems, while also emphasizing the implementation of OS algorithms using programming and Linux tools.	
Course Objectives: 1. To introduce the basic concepts, functions and services of Operating systems. 2. To introduce the concept of a process and its management like transition, scheduling, etc. 3. To understand the concepts related to process synchronization. 4. To understand the basic concept of Deadlock management. 5. To understand the various memory management techniques 6. To understand the File system & IO management techniques	

9.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPC233.1	Understand the basic concepts of the operating system, its operations, services and structures of OS.	Understand (L2)
CAPC233.2	Evaluate the performance of process scheduling algorithms.	Evaluate (L5)
CAPC233.3	Apply synchronization primitives to address process coordination	Apply (L3)
CAPC233.4	Apply the concept of deadlocks to solve the problems.	Apply (L3)
CAPC233.5	Analyze the concepts of memory management techniques.	Analyze (L4)
CAPC233.6	Analyze different techniques of file systems and I/O management.	Analyze (L4)

9.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Introduction to Operating System:	CO1	L2	T1, T2, T3, R1	5
	1.1	Objectives, functions and services of operating systems				
	1.2	Operations of operating system				
	1.3	Operating system Structure: Layered, Monolithic and Microkernel				
	1.4	Types of Operating Systems				
	1.5	Shell, System Calls				
2	Title	Process Management	CO2	L4	T1, T2, T3, R1	7
	2.1	Concept of a Process: Process State Transition Model, operations, Process Control Block, Context switching				
	2.2	Threads: Introduction, Types and Models, Concept of Multithreading				
	2.3	Types of Schedulers, Process Scheduling Criteria, Types of Process Scheduling: Preemptive and Non-Preemptive, Scheduling criteria				
	2.4	FCFS, SJF, SRTF				
	2.5	Priority based, Round Robin				
3	Title	Process Synchronization	CO3	L3	T1, T2, T3, R1	7
	3.1	Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization				
	3.2	Mutual Exclusion: Requirements, Critical Section Problem				
	3.3	Peterson's Solution				
	3.4	Hardware Support (TSL), OS Support (Semaphores)				
	3.5	Classical synchronization problem: Producer and Consumer problem, Readers - Writers Problem, Dining philosophers' problem				
4	Title	Deadlock Management	CO4	L3	T1, T2, T3, R1	6
	4.1	Principles of deadlock, System Model, Deadlock Characterization, Resource Allocation Graph				
	4.2	Deadlock Prevention				
	4.3	Deadlock Avoidance: Banker's algorithm for Single & Multiple Resources				
	4.4	Deadlock Detection and Recovery				
5	Title	Memory Management	CO5	L4	T1, T2, T3, R1	7
	5.1	Memory Management Requirements, Memory Partitioning, Swapping, Memory Allocation Strategies (First Fit, Best Fit, Next Fit, Worst Fit)				

	5.2	Paging: Concept, Structure of Page Table, Address Translation, Translation Lookaside Buffer (TLB)				
	5.3	Segmentation: Concept and Comparison with Paging				
	5.4	Virtual Memory: Concept, Demand Paging, Copy-on-Write				
	5.5	Page Replacement Algorithms: FIFO, LRU, Optimal				
	5.6	Performance Issues: Thrashing				
	6	Title	File system and IO Management	CO6	L4	T1, T2, T3, R1
6.1		File System: Overview, Attributes, Operations, Types of file organization				
6.2		File Access Methods: Sequential, Direct, Indexed				
6.3		File Allocation Methods: Contiguous, Linked, Indexed				
6.4		IO Management & Disk Scheduling: IO Devices, IO Buffering techniques				
6.5		I/O System Organization, Disk Structure and Organization.				
6.6		Disk Scheduling Algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK				
Self - Study	SS.1	Study of Advanced Operating System Architecture				3hrs./wk.
	SS.2	Real-time Scheduling algorithms and applications.				
	SS.3	Lock-Free & Wait-Free Algorithms				
	SS.4	Study a real time case study for Deadlock detection and recovery				
	SS.5	Memory Management of IoT, Android Operating System				
	SS.6	Disk scheduling optimization				

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs.
1	Explore the internal commands of Linux.	CO1	2
2	Write shell scripts to do the following: a. Display top 10 processes in descending order Display processes with highest memory usage. b. Display current logged in user and log name. c. Display current shell, home directory, operating system type, current path setting, current working directory. d. Display OS version, release number, kernel version. e. Illustrate the use of sort, grep, awk, etc.	CO1	2
3	Demonstrate the use of system calls	CO1	2
4	Implementation of non-preemptive scheduling algorithms (anyone)	CO2	2
5	Implementation of Preemptive scheduling algorithms (anyone)	CO2	2
6	Implementation of Multithreading concept	CO2	2
7	Implement the solution of Producer and Consumer problem through Semaphore	CO3	2
8	Implement the solution of Readers - Writers Problem through Semaphore	CO3	2
9	Implementation of Peterson's Solution or algorithm	CO3	2
10	Implementation of deadlock avoidance concept through Banker's algorithm	CO4	2
11	Implementation of deadlock detection algorithm	CO4	2
12	Design the Resource Allocation Graph & Wait for Graph for your own problem statement	CO4	2
13	Implement the concept of MVT and MFT memory management techniques	CO5	2
14	Implementation of dynamic partitioning placement algorithms	CO5	2
15	Implementation of page replacement policies for handling page faults	CO5	2
16	Implementation of File Allocation methods	CO6	2
17	Implementation of disk scheduling algorithms	CO6	2

18	Implementation of IO Buffering techniques	CO6	2
----	---	-----	---

9.6 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA-1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
2	IA-2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
3	FA	2	CAT	Teachers Choice*	Teachers Choice*	10	10	TBD
4	ESE	1	ESE	Paper- Pen	In Class- Exam	60	60	2.5hrs

*IA = Internal Assessment; FA = Formative Assessment;

IA 1 will be conducted after completion of 3 Modules; IA 2 will be conducted after completion of next 3 modules

*Assessment Instruments → **What** Tools and instruments are used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed.

*Refer section 3.8

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiment	12	CAT	Practical - Experiment	Rubrics Based	20	40	2 hrs.
2	Classroom Participation	-	CAT	Attendance	Record based	5	10	-
3	ESE	1	ESE	Oral and Practical	-	25	50	2 hrs.

Note:

1. CAT Activity will be part of Term Work.
2. The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.
3. Learners will perform minimum 10 experiments at least 1 experiment from each module.
4. Presentation topics strictly based on Application of Analysis of Algorithms in various domains.
5. ESE will be combination of executing any one program from exp1-exp10 followed by Oral by external examiner.

9.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPC233.1	3	3	-	-	3	-	-	-	-	-	-	3	3
CAPC233.2	3	3	-	3	3	-	-	-	-	-	-	3	3
CAPC233.3	3	3	3	3	3	-	-	-	-	-	-	3	3
CAPC233.4	3	3	2	3	3	-	-	-	-	-	-	3	3
CAPC233.5	3	3	-	3	3	-	-	-	-	-	-	3	3
CAPC233.6	3	3	-	3	3	-	-				-	3	3

9.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. engineering	OS involves algorithm analysis, scheduling calculations, paging numerical, and performance metrics, requiring strong mathematical and analytical skills
2	WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.	Core OS topics are fundamental engineering concepts in computer science
3	WK6	Knowledge of engineering practice (technology) in the practice area in the engineering discipline.	OS labs involve Linux, C programming, system calls, IPC, and real system tools, giving hands-on exposure to engineering practice and technologies.

9.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Operating System Concepts	10 th	A. Silberschatz, P. Galvin, G. Gagne	Wiley	2018
T2	Operating Systems: Internal and Design Principles	9 th	W. Stallings,	Pearson	2018
T3	Modern Operating Systems	4 th	A. Tanenbaum	Pearson	2015

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Principles of Operating Systems	1 st	N. Chauhan	Oxford University Press	2014
R2	Operating System Design and Implementation	3 rd	A. Tanenbaum and A. Woodhull	Pearson	–
R3	Operating Systems	3 rd	Achyut Godbole and Atul Kahate	McGraw Hill Education	-
R4	Operating Systems: Three Easy Pieces	1 st	R. Arpaci-Dusseu and A. Arpaci-Dusseu	CreateSpace Independent Publishing Platform	2018

Online Resources

SN	Title	Description
O1	https://www.youtube.com/watch?v=2i2N_Qo_FyM&list=PLEbnTDJUr_lf_BnzJkkN_JOTI3iXtL8vq	GATE Computer Science
O2	https://www.youtube.com/watch?v=RozoeWzT7IM&list=PLdo5W4Nhhv31a5ucW_S1K3-x6ztBRD-PNa	Computer Science & IT
O3	https://www.youtube.com/watch?v=bkSWJJZNgf8&list=PLxCzCOWd7aiGz9donHRrE9I3Mwn6XdP8p	GATE Smashers
O4	https://www.nptel.ac.in	
O5	https://swayam.gov.in	
O6	https://www.coursera.org/	

Chapter 10:

Subject- Entrepreneurship and Business Model Development (Sem III)

Overview			
Course code:	IGEM231	Course Category:	Entrepreneurship /Eco / Mgmt.
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

10.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-	2	2	-	4
Hours/Sem	-	-	30	30	-	60
Credits	-	-	2		-	2

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

10.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	-	-	-	-
Labs	100%	-	100%	2

10.3 Course Objectives

Pre-requisite Course / Knowledge	Basic design thinking principles
Course Overview: A course on Business Model Development typically teaches how to design, analyze, and refine the way a company creates, delivers, and captures value.	
Course Objectives: 1. To introduce a learner to entrepreneurship and its role in economic development. 2. To familiarize a learner with the start-up ecosystem and government initiatives in India. 3. To explain the process of starting a business. 4. To familiarize a learner with the building blocks of a business. 5. To teach a learner to plan their own business with the help of Business model canvas. 6. To teach a learner to have a financial plan for a business model.	

10.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
IGEM231.1	Discuss the role of entrepreneurship in the economic development of a nation and describe the process of starting a business.	Understand(L2)
IGEM231.2	Describe start-up ecosystem in Indian and global context.	Understand(L2)
IGEM231.3	Identify different types of business models.	Understand(L2)
IGEM231.4	Identify customer segments, channels and customer relationship components for a particular business.	Apply(L3)
IGEM231.5	Identify key activities, key partners and key resources for a particular business.	Apply(L3)
IGEM231.6	Develop a financial plan for a business with the help of cost structure and revenue model.	Create(L6)

10.5 Modules / Syllabus Content

Demonstration Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Introduction Entrepreneurship	CO1	L2	T1, T2, R1, R2	4
	1.1	Introduction, definition of entrepreneurship				
	1.2	The role of entrepreneurship in economic development				
	1.3	Women entrepreneurs, Corporate entrepreneurship				
	1.4	Entrepreneurial mindset, feasibility planning's (four stage growth model, feasibility plan)				
2	Title	Entrepreneurship Development	CO2	L2	T1, T2, R1, R2	4
	2.1	Types of business ownership: Proprietorship, success factor for entrepreneurs				
	2.2	Public and Private Companies,				
	2.3	Micro, Small and Medium Enterprises (MSME): Definition Role of MSMEs in economic development				
	2.4	Synopsis for learning and stating how MSME works				
3	Title	Start-up financing	CO3	L2	T1, T2, R1, R2	5
	3.1	Cost and revenue models,				
	3.2	Sources of start-up findings: Angel investors, Venture capitalists, Crowd funding,				
	3.3	Government schemes for start-up funding Self-learning Topics: Successful business pitching				
	3.4	Franchising, structuring of acquisition				
4	Title	Intellectual Property Rights (IPR)	CO4	L3	T1, T2, R1, R2	4
	4.1	Intellectual Property Rights (IPR): Types of IPR: Patents, trademarks and copyrights				
	4.2	Patent search and analysis, Strategies for IPR protection				
	4.3	Ethics in technology and innovation				
	4.4	Patents, type, disclosure process				
5	Title	Business Model Development	CO5	L3	T1, T2, R1, R2	5

	5.1	Business Model Development: Types of business models, Value proposition				
	5.2	Customer segments, Customer relationships				
	5.3	Channels, Key partners, Key activities				
	5.4	Key resources, Prototyping and MVP				
	5.5	Perspective of marketing research, market research in pre-startup phase				
6	Title	Digital Business Management	CO6	L6	T1, T2, R1, R2	4
	6.1	Digital Business Management: Digital Business models (Subscription, Freemium etc.)				
	6.2	Digital marketing: Search Engine Optimization (SEO)				
	6.3	Search Engine Marketing (SEM), social media and influencer marketing				
	6.4	Disruption and innovation in digital business				

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs.
1	Problem identification (pain point, market survey)	CO1	2
2	Design a digital solution for the problem (ideation techniques)	CO1	2
3	Preparing a business model canvas value proposition, key patterns, key resources, key activities	CO2	2
4	Preparing a business model canvas: customer segment, customer relationship and channels	CO2	2
5	Preparing a business model canvas: cost and revenue structure	CO3	2
6	Prototype development: low fidelity	CO3	2
7	Prototype development: customer feedback	CO4	2
8	Prototype development: HIGH Fidelity	CO4	2
9	Feasibility plan of an idea	CO5	2
10	Franchisee plan of your company	CO6	2

Assignments (Suggested list of Assignments)

SN	Title of Assignments	CO
1	Presentation on case study of a failed business model	CO1
2	presentation on case study of a woman entrepreneur	CO2
3	Case study Angel investor and venture capitalist	CO3
4	Case study of trademarks and copyright	CO4
5	Business model prototyping	CO5
6	Innovation in digital business	CO6

10.6 Assessment Methodologies and Tools

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiment	10	CAT	Practical-Experiment	Rubrics Based	25	50	2Hrs
2	Assignment	6	CAT	Written	Rubrics Based	10	20	-
3	Report	1	CAT	Presentation	Rubrics based	10	20	-
4	Classroom Participation	1	CAT	Attendance	Record Based	5	10	-

Note:

- 1 CAT Activity will be part of Term Work.
- 2 The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.
- 3 Learners will perform minimum 10 experiments at least 1 experiment from each module.

10.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
IGEM231.1	2	2	-	-	-	3	2	-	2	2	2	-	3
IGEM231.2	2	2	-	-	-	3	-	-	2	2	2	-	3
IGEM231.3	2	2	3	-	-	2	-	-	-	2	2	2	3
IGEM231.4	-	2	3	-	-	2	-	2	3	2	2	2	3
IGEM231.5	2	2	3	-	-	2	-	3	2	3	2	2	3
IGEM231.6	3	3	3	-	2	2	-	2	2	3	2	2	3

10.8 Course to Knowledge and Attitude Profile (WK)

Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modeling applicable to the discipline.	The subject involves financial planning, cost structure analysis, and revenue modeling, which require strong analytical and quantitative decision-making skills.
2	WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering	Focuses on business model development, startup ecosystems, and strategic frameworks, requiring domain-specific knowledge of business and entrepreneurship.

		discipline; much is at the forefront of the discipline.	
3	WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.	Emphasizes efficient use of resources, cost optimization, and long-term sustainability in business planning and value creation.
4	WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.	Highlights the impact of entrepreneurship and startups on economic development, employment generation, and societal growth.

10.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Entrepreneurship – David A	1 st	Kirby	McGraw Hill	2002
T2	Harvard Business Review: Entrepreneurs Handbook	2 nd	HBR Press	HBR Press	2018

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Entrepreneurship: New venture creation – David Holt, Prentice Hall of India Pvt. Ltd.	2 nd	David Holt	Prentice Hall of India Pvt. Ltd.	2005
R2	E-Business & E-Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education	3 rd	Implementation	Pearson Education	2018
R3	Business model generation; Alexander ostlewalder and YVES Pigneur	1 st	Strategyzer	Pearson Education	2010

Online Resources

SN	Title	Description
O1	Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma	The purpose of Innovation, Business Models, and Entrepreneurship is to help readers understand how innovation, business models, and entrepreneurship work together to create and grow successful businesses.
O2	https://onlinecourses.nptel.ac.in/no_c21_mg63/preview	

Chapter 11:

Subject- Advanced Java (Sem III)

Overview			
Course code:	CAVS231	Course Category:	Vocational and Skill Enhancement
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

1.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-	2	2	-	4
Hours/Sem	-	-	30	30	-	60
Credits	-	-	2		-	2

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

11.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	-	-	-	-
Labs	50%	50%	100%	2

11.3 Course Objectives

Pre-requisite Course / Knowledge	Basics of Java Programming, OOP Concepts, Basic HTML and SQL
Course Overview: This course covers advanced features of Java programming including multithreading, collection framework, GUI development using AWT and Swing, database connectivity using JDBC, and web application development using Servlets and JSP. It also introduces enterprise application development concepts using MVC architecture, Spring, Hibernate, and REST APIs.	
Course Objectives: 1. To understand Object-Oriented Programming concepts and advanced Java features such as packages, interfaces, exception handling, multithreading, and file handling. 2. To apply Collection Framework and Generics for efficient data management. 3. To develop GUI applications using AWT and Swing with event handling. 4. To implement database connectivity using JDBC and perform CRUD operations. 5. To build dynamic web applications using Servlets and JSP. 6. To introduce enterprise application development concepts using MVC, Spring, Hibernate, and REST APIs.	

11.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAVS231.1	Apply Object-Oriented Programming concepts and advanced Java features such as packages, interfaces, exception handling, multithreading, and file handling.	Apply (L3)
CAVS231.2	Use Collection Framework and Generics for efficient data processing	Apply (L3)
CAVS231.3	Develop GUI applications using AWT and Swing with event handling	Create (L6)
CAVS231.4	Design and implement database-driven applications using JDBC	Apply (L3)
CAVS231.5	Build dynamic web applications using Servlets and JSP with session management	Create (L6)
CAVS231.6	Apply basic enterprise application development concepts using MVC, Spring, Hibernate, and REST APIs	Apply (L3)

11.5 Modules / Syllabus Content

Demonstration Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Module 1: Object-Oriented Programming and Advanced Core Java Concepts	CO1	L3	T1	5
	1.1	Object-Oriented Programming Concepts: Class, Object, Encapsulation, Inheritance, Polymorphism, and Abstraction				
	1.2	Packages and Access Modifiers				
	1.3	Interfaces and Abstract Classes				
	1.4	Exception Handling (try-catch-finally, throw/throws, custom exceptions)				
	1.5	Multithreading (Lifecycle, Creating Threads, Synchronization), Java I/O Streams and File Handling				
2	Title	Collection Framework & Generics	CO2	L3	T1, T3	5
	2.1	Introduction to Collection Framework				
	2.2	List Interface: ArrayList, LinkedList				
	2.3	Set Interface: HashSet, TreeSet				
	2.4	Map Interface: HashMap, Hashtable				
	2.5	Iterators, Comparable, Comparator, and Generics basics				
3	Title	GUI Programming using AWT & Swing	CO3	L6	T1	5
	3.1	Introduction to GUI programming				
	3.2	AWT components (Label, Button, TextField, Checkbox)				
	3.3	Layout managers and event handling				
	3.4	Swing components: JFrame, JButton, JTable, JComboBox				
	3.5	Dialog boxes and menu creation				
4	Title	JDBC	CO4	L3	T1, T3	4
	4.1	Introduction to JDBC, architecture, and types of drivers				
	4.2	Establishing database connection; Statement, PreparedStatement, CallableStatement				
	4.3	ResultSet and CRUD operations				
	4.4	Transaction handling				
5	Title	Servlets	CO5	L6	T2	4
	5.1	Introduction to web applications; Servlet architecture and lifecycle				
	5.2	Generic Servlet and HTTP Servlet; handling client requests				

	5.3	Session tracking: Cookies, URL rewriting				
	5.4	Filters and listeners				
6	Title	JSP & Introduction to Frameworks	CO6	L3	T2, T4	3
	6.1	JSP lifecycle, JSP tags				
	6.2	implicit objects Session management in JSP , MVC architecture				
	6.3	Introduction to Spring Framework and Hibernate ORM REST API basics				
Self - Study	SS.1	Packages, interfaces, exceptions, threads, I/O				1hr/wk.
	SS.2	Collections, Generics, List/Set/Map				
	SS.3	AWT, Swing, event handling				
	SS.4	JDBC basics, CRUD				
	SS.5	Servlets, session tracking				
	SS.6	JSP. MVC. Spring. REST				

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs.
1	Write a Program on Packages and Custom Exception Handling	CO1	2
2	Write a Program on Multithreading with Synchronization	CO1	2
3	Write a Program on Collection Framework using Array List and Iterator	CO2	2
4	Write a Program on Set and Map Interface (HashSet, HashMap)	CO2	2
5	Write a Program on GUI Form using AWT Components	CO3	2
6	Write a Program on AWT components (Label, Button, Text Field, Checkbox)	CO3	2
7	Write a program on JDBC connectivity to establish a connection with a database using Driver Manager and execute SQL queries using Statements and Prepared Statement.	CO4	2
8	Write a Program on JDBC CRUD Operations using Prepared Statement	CO4	2
9	Write a Program on Servlet for Form Handling and Session Management	CO5	2
10	Write a Program on Servlet Filters and Listeners to log user requests and responses	CO5	2
11	Write a program on session management in JSP to implement a login system using session tracking.	CO6	2
12	Write a program on JSP form handling to accept user input and display the result dynamically.	CO6	2

11.6 Assessment Methodologies and Tools

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiments	10	CAT	Practical / Experiments/Tutorials	Rubrics Based	10	20	2hr
2	Classroom Participation	-	CAT	Attendance	Record and Rubrics	5	10	-
3	Mini project	1	CAT	Mini project	Rubrics Based	10	20	-
4	ESE	1	ESE	Oral and Practical	Rubrics based	25	50	2hr

Note:

1. CAT Activity will be part of Term Work.
2. The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.
3. Learners will perform minimum 10 experiments at least 1 experiment from each module.

11.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAVS231.1	3	2	2	2	2	-	-	-	-	-	-	3	2
CAVS231.2	2	2	3	3	3	-	-	-	-	-	-	3	3
CAVS231.3	3	3	3	3	3	2	-	-	-	-	-	3	3
CAVS231.4	2	3	3	3	2	2	-	-	-	-	-	3	3
CAVS231.5	2	3	3	3	3	2	-	-	-	-	-	3	3
CAVS231.6	2	3	2	2	-	-	-	-	-	-	-	3	2

11.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	Basic knowledge of mathematics, science, and engineering fundamentals	Required to understand programming logic, multithreading concepts, and system-level execution
2	WK2	Problem analysis	Used in debugging Java programs, handling exceptions, and analyzing application requirements
3	WK3	Design/development of solutions	Applied in developing GUI applications, JDBC-based systems, and web applications using Servlets & JSP
4	WK4	Modern tool usage	Use of Java frameworks, JDBC drivers, IDEs, and libraries for application development

11.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Java: The Complete Reference	11 th	Herbert Schildt	McGraw Hill	2018
T2	Core Java Volume I – Fundamentals	11 th	Cay S. Horstmann	Pearson	2018
T3	Core Java Volume II – Advanced Features	11 th	Cay S. Horstmann	Pearson	2019
T4	Headfirst Servlets and JSP	2 nd	Bryan Basham, Kathy Sierra, Bert Bates	O'Reilly	2008

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Effective Java	3 rd	Joshua Bloch	Addison-Wesley	2018
R2	Java Concurrency in Practice	1 st	Brian Goetz	Addison-Wesley	2006
R3	Thinking in Java	4 th	Bruce Eckel	Prentice Hall	2006
R4	Head First Java	2 nd	Kathy Sierra, Bert Bates	O'Reilly Shroff	2005

Online Resources

SN	Title	Description
O1	Oracle Java Documentation	Official documentation for Java, covering core concepts, APIs, JDBC, multithreading, and advanced features
O2	Java Tutorials by Oracle	Beginner to advanced tutorials on Java programming, including GUI, collections, and networking
O3	GeeksforGeeks – Java	Comprehensive articles, examples, and practice problems on Java, JDBC, Servlets, JSP, and frameworks
O4	W3Schools Java Tutorial	Simple and easy-to-understand tutorials on Java basics, advanced topics, and web technologies
O5	TutorialsPoint Java	Step-by-step tutorials covering core and advanced Java concepts including Servlets and JSP
O6	Baeldung	In-depth articles on Java, Spring, JDBC, and enterprise application development
O7	Javatpoint	Detailed tutorials on Java, AWT, Swing, JDBC, Servlets, JSP, and frameworks
O8	Udemy Java Courses	Paid online courses covering Java programming, GUI, JDBC, and web development

Chapter 12:

Subject- Comprehensive Soft Skills & Professional Development (Sem III)

Overview			
Course code:	IGAE231	Course Category:	Ability Enhancement
Sem:	III	Syllabus & Version:	SIGCE-NEP-R25-Y2

12.1 Teaching & Learning Scheme

Components	Class room Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-	2		-	2
Hours/Sem	-	-	30		-	30
Credits	-	-	1		-	1

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

12.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	-	-	-	-
Lab/ Demo/Activity	100%	-	100%	1

12.3 Course Objectives

Pre-requisite Course / Knowledge	Knowledge of Principles of Communication and Ethics (PCE)
Course Overview: This course is designed to develop students' communication, interpersonal, presentation, and professional skills required for academic and career success. It focuses on personality development, verbal and written communication, group discussions, resume writing, interview preparation, workplace etiquette, aptitude training, and career planning. The course helps students build confidence, teamwork, leadership qualities, and professional readiness for modern corporate and engineering environments.	
Course Objectives: - To develop effective verbal, non-verbal, written, and digital communication skills among students. - To enhance personality development, self-confidence, interpersonal skills, and professional behaviour.	

3. To train students in group discussions, teamwork, leadership, and collaborative problem-solving techniques.
4. To prepare students for professional recruitment processes through resume writing, interview preparation, and mock interview practice.
5. To build awareness of workplace etiquette, corporate communication, time management, and professional ethics in modern work environments.
6. To strengthen aptitude, reasoning, career planning, and personal branding skills for improving employability and career growth.

12.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
IGAE231.1	Demonstrate effective verbal and non-verbal communication using the 7Cs and self-awareness tools to enhance personality and confidence.	Apply (L3)
IGAE231.2	Develop professional written communication including formal emails and LinkedIn profiles while practicing digital etiquette.	Create(L6)
IGAE231.3	Participate actively and confidently in group discussions by applying group behaviour techniques and teamwork skills.	Apply (L3)
IGAE231.4	Create structured and ATS-compliant resumes and prepare for interviews using the STAR method and professional etiquette.	Create(L6)
IGAE231.5	Exhibit professional behaviour at the workplace through appropriate time management, ethical conduct, and corporate communication.	Apply(L3)
IGAE231.6	Solve aptitude problems and outline a career plan using test strategies and personal branding tools.	Analyze (L4)

12.5 Modules / Syllabus Content

Demonstration Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Fundamentals of Communication & Personality	CO1	L3	T1, R1	5
	1.1	Importance of Soft Skills in Engineering & Career, Verbal & Non-verbal Communication, 7Cs of Effective Communication				
	1.2	Body Language, Facial Expressions & Grooming Etiquette				
	1.3	Self-awareness, Personality Types & SWOT Analysis, Activities: Icebreakers, Self-introduction Video & Confidence-building Exercises				
	1.4	Activity: Conduct self-introduction video recording to evaluate verbal and non-verbal communication skills including body language and confidence.				
	1.5	Activity: Perform SWOT analysis and personality type assessment to understand self-awareness and personality development				
2	Title	Verbal, Written & Digital Communication Skills	CO2	L6	T2, R2	5
	2.1	Public Speaking, JAM & Storytelling Techniques, Professional Email Writing: Structure, Tone & Etiquette				
	2.2	Grammar Improvement & Vocabulary Enhancement				

	2.3	LinkedIn Profile Creation, Digital Behavior & Personal Branding, Activities: Draft Emails, LinkedIn Review & Mock JAM Rounds				
	2.4	Activity: Draft and submit professional emails based on given workplace scenarios focusing on tone, structure, and etiquette				
	2.5	Activity: Create and optimize LinkedIn profile to practice digital branding and professional online presence				
3	Title	Group Discussion & Team Dynamics	CO3	L3	T3, R3	4
	3.1	Introduction to Group Discussion & Types of GDs, GD Techniques: Entry, Lead, Counter & Conclude				
	3.2	Group Behavior, Leadership Roles & Team Dynamics, Teamwork, Cooperation & Collaborative Problem-solving, Activities: Mock GDs, Peer Feedback & Role Rotation				
	3.3	Activity: Conduct mock group discussions with assigned topics focusing on entry, lead, counter, and conclusion techniques				
	3.4	Activity: Perform role rotation activity in team tasks to understand leadership, cooperation, and teamwork dynamics				
4	Title	Resume Building & Interview Readiness	CO4	L6	T4, R4	4
	4.1	Resume Format, Keywords & Achievement Writing, ATS-friendly Resume Preparation for Engineers				
	4.2	HR & Technical Interview Questions, STAR Method, Interview Etiquette & Virtual Interview Activities: Resume Clinic, Mock Interviews & Peer Reviews				
	4.3	Activity: Prepare ATS-friendly resume using proper keywords, achievements, and structured formatting.				
	4.4	Activity: Conduct mock interview sessions using STAR method with peer evaluation and feedback				
5	Title	Workplace & Corporate Etiquette	CO5	L3	T5, R5	4
	5.1	Work Ethics & Professionalism, Time Management Tools: Pomodoro & Eisenhower Matrix				
	5.2	Email, Meeting & Call Etiquette, Work-from-home/Hybrid Professionalism & Accountability, Activities: Etiquette Checklist, Planner Setup & Roleplay				
	5.3	Activity: Perform workplace roleplay activities focusing on email, meetings, and communication etiquette scenarios.				
	5.4	Activity: Create personal time management planner using Pomodoro and Eisenhower matrix techniques				
6	Title	Aptitude Test Strategies & Career Planning	CO6	L4	T6, R6	4
	6.1	Overview of Quantitative, Reasoning & Verbal Aptitude, Aptitude Test Strategies & Speed Improvement Techniques				
	6.2	Previous Year Placement Aptitude Questions (TCS, Infosys, etc.), Career Goal Setting, Personal Branding & Self-pitch, Activities: Mini Aptitude Quiz, Pitch Presentation & Career Map Submission				
	6.3	Activity: Attempt mini aptitude tests covering quantitative, reasoning, and verbal sections with timed evaluation				
	6.4	Activity: Prepare and present personal career roadmap and self-pitch presentation for placement readiness				

12.6 Assessment Methodologies and Tools

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Activity	12	CAT	Activity	Rubrics Based	20	80	2 Hrs.

2	Attendance	-	CAT	Teachers Observation	Record	5	20	-
---	------------	---	-----	----------------------	--------	---	----	---

CAT Activity will be part of Term Work

12.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
IGAE231.1	2		-	-	-	2	-	2	3	3	-	-	-
IGAE231.2	2	2	-	-	2	-	-	-	-	3	-	2	-
IGAE231.3	-	-	3	2	-	2	-	2	-	-	2	-	-
IGAE231.4	2	-	-		2	-	-	-	3	3	-	3	2
IGAE231.5	-	2	-	-	2	3	-	3	3	-	2	-	-
IGAE231.6	2	3	2	-	2	2	-	2	2	3	2	3	2

12.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	A systematic, theory-based understanding of the natural sciences applicable to engineering fundamentals.	Students develop foundational understanding of communication principles, personality development, and professional behavior that is essential for engineering environments.
2	WK6	Knowledge of engineering practice includes technologies, processes, and standards in practical situations.	Workplace etiquette, virtual meeting behavior, email etiquette, and hybrid work professionalism expose students to modern corporate practices.
3	WK7	Comprehension of the role of engineering in society and identified issues in engineering practice.	Group discussions, leadership exercises, and teamwork activities develop collaboration, ethical awareness, and social interaction skills.
4	WK8	Engagement with selected knowledge in the research literature of the discipline.	Students explore placement trends, aptitude patterns, and professional communication strategies through self-learning and practical assignments.

12.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	<i>Soft Skills: Know Yourself and Know the World</i>	3rd	Dr. K. Alex	S. Chand Publishing	2019

T2	<i>Personality Development and Soft Skills</i>	2nd	Barun K. Mitra	Oxford University Press	2016
T3	<i>Business Communication and Personality Development</i>	1st	Biswajit Das & Ipseeta Satpathy	Excel Books	2009
T4	<i>Interview and Group Discussion</i>	1st	T. Sudha	Tata McGraw Hill	2010
T5	<i>English and Soft Skills</i>	1st	S.P. Dhanavel	Orient BlackSwan	2010
T6	<i>Campus to Corporate: Your Roadmap to Employability</i>	1st	Gangadhar Joshi	Cengage Learning India	2021

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	<i>Business Communication</i>	2 nd	Meenakshi Raman & Prakash Singh	Oxford University Press	2012
R2	<i>The 7 Cs of Communication: A Skills Workbook</i>	1 st	Lucas Burns	Independently Published	2020
R3	<i>Body Language: How to Read Others' Thoughts by Their Gestures</i>	Revised	Allan Pease	Manjul Publishing	2017
R4	<i>Group Discussion and Interview Skills</i>	1 st	Priyadarshi Patnaik & Barun K. Mitra	Cambridge University Press India	2011
R5	<i>Workplace Etiquette: A Guide to Career Success</i>	1 st	Barbara Pachter	Career Press	2014
R6	<i>Quantitative Aptitude for Competitive Examinations</i>	2024	R.S. Aggarwal	S. Chand Publishing	2024

Online Resources

SN	Title	Description
O1	https://www.coursera.org/courses?query=communication%20skills	Offers professional courses on communication skills, public speaking, teamwork, and workplace communication from leading universities.
O2	https://www.linkedin.com/learning	Provides industry-oriented learning modules on professional communication, LinkedIn profile building, leadership, interview preparation, and career development.
O3	https://www.toastmasters.org	A global platform for improving public speaking, confidence, leadership, and presentation skills through practical activities.
O4	https://learning.tcsionhub.in/career-edge	Free employability enhancement program covering communication skills, resume writing, interview preparation, aptitude, and workplace etiquette.
O5	https://www.geeksforgeeks.org/aptitude-gq	Provides quantitative aptitude, logical reasoning, verbal ability practice questions, and placement preparation resources.

O6	https://www.yoodli.ai	AI-powered platform for practicing speeches, interviews, group discussions, and improving communication confidence with feedback.
----	---	---

Chapter 13:

Subject- Statistical Methods in Data Science (Sem IV)

Overview			
Course code:	CABS241	Course Category:	Basic Science
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

13.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	2	-	2	-	2	6
Hours/Sem	30	-	30	-	30	90
Credits	2	-	1	-	-	3

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

13.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	2
Labs	100%	-	100%	1

13.3 Course Objectives

Pre-requisite Course / Knowledge	Python, Measure of central tendency-EM3
Course Overview: This course introduces students to statistical methods as the backbone of data science. By covering probability theory, hypothesis testing, regression, and classification, it prepares learners to analyze complex datasets, draw valid conclusions, and apply statistical reasoning to real-world problems. The course ensures that students gain both theoretical understanding and practical skills, aligning academic training with industry expectations in data-driven decision-making.	
Course Objectives: 1. To understand the fundamentals of probability and probability distributions. 2. To apply statistical measures and exploratory data analysis techniques for data interpretation. 3. To analyze sampling distributions and hypothesis testing methods. 4. To understand statistical significance and inferential statistical techniques. 5. To apply ANOVA and nonparametric methods for data analysis. 6. To develop problem-solving skills using statistical and data analysis techniques	

13.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CABS241.1	Explain the fundamentals of probability, conditional probability, random variables, and probability distributions.	Understand-(L2)
CABS241.2	Apply statistical measures and exploratory data analysis techniques for summarizing and visualizing data.	Apply(L3)
CABS241.3	Analyze sampling distributions and inferential statistical methods for data interpretation.	Analyze(L4)
CABS241.4	Apply hypothesis testing methods and significance testing techniques in statistical experiments.	Apply(L3)
CABS241.5	Interpret cumulative distribution functions, bootstrap methods, and statistical summaries for data analysis.	Apply(L3)
CABS241.6	Apply ANOVA and nonparametric statistical methods for comparative data analysis and decision making.	Analyze(L4)

13.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs
1	Title	Probability	CO1	L2	T1, R1	4
	1.1	Basics of probability: Probability Fundamentals and Types of Probability, conditional probability- Bayes' theorem				
	1.2	Random Variables: Discrete and continuous random variable				
	1.3	Probability Distributions: Discrete- Binomial, Poisson and Continuous- Normal Probability Distributions				
2	Title	Basics of Statistics and Exploratory Data Analysis	CO2	L3	T3, R2	7
	2.1	Introduction to Statistics and data collection; Elements of Structured Data, Rectangular and Non-Rectangular Data				
	2.2	Estimates of Location and variability: Mean, Median and Robust Estimates, Standard Deviation and Estimates Based on Percentiles				
	2.3	Data visualization techniques: Percentiles and Box plots, Scatterplots, Frequency Tables and Histograms				
	2.4	Exploring Binary and Categorical Data, Hexagonal Binning				
3	Title	Data and Sampling Distributions	CO3	L2	T1, T4, R2	5
	3.1	Random Sampling and Sample Bias, Size Versus Quality, Sample Mean Versus Population Mean				
	3.2	Sampling Distribution of a Statistic, Central Limit Theorem				
	3.3	Long-Tailed Distributions, Student 's t-Distribution, Chi-Square Distribution, Poisson Distributions,				
4	Title	Statistical Experiments and Significance Testing	CO4	L4	T1, T4, R1	6
	4.1	A/B Testing, Hypothesis Tests: Null and Alternative Hypothesis, One-Tailed and Two-Tailed Hypothesis Tests, statistical re-sampling Test				
	4.2	Statistical Significance and p-Values, Type 1 and Type 2 Errors, Degrees of Freedom, Test Statistic: t-Tests, Z-Test, Chi-Square Test				
	4.3	Two-Way ANOVA: Fisher 's Exact Test, Re-sampling Approach and Their Statistical Theory, Relevance for Data Science Applications				

5	Title	Summarizing Data	CO5	L3	T2, R2	4	
	5.1	Methods Based on the Cumulative Distribution Function (CDF), Empirical Cumulative Distribution Function (ECDF), Survival Function, Quantile-Quantile (Q-Q) Plots with Graphical Interpretation					
	5.2	M- Estimates, Comparison of Location Estimates, Estimating Variability of Location Estimates using Bootstrap Method					
6	Title	The Analysis of Variance	CO6	L4	T1 R2	4	
	6.1	Analysis of Variance (ANOVA); Types of ANOVA; The ANOVA F-Test					
	6.2	The Problem of Multiple Comparisons; Nonparametric Method: The Kruskal-Wallis Test, Friedman 's Test					
Self-Study	SS.1	Probability Fundamentals: Expectation, Variance, Moment generating function					2hrs/ wk
	SS.2	Weibull Distribution. Exponential Distribution					
	SS.3	Multi-Arm Bandit Algorithm, Power and Sample Size					
	SS.4	Density Curves, and Stem-and-Leaf Plots, Measures of Location					

Laboratory Component (Suggested List of Experiments)

SN	Title of the Experiment	CO	Hrs.
	Study of Software Interface and Importing Structured Datasets		
1	Study of Basics of Statistics using measures of central tendency (Mean, Median, Mode) .	CO1	2
2	Perform Exploratory Data Analysis (EDA) using graphical methods (histogram, boxplot, scatter plot).	CO1	2
3	Computation of measures of dispersion: Range, Variance, Standard Deviation, and Coefficient of Variation	CO2	2
4	Implementation of Data and Sampling Distributions using Normal, Binomial, and Poisson distributions	CO2	2
5	Construction and interpretation of Sampling Distribution and Central Limit Theorem	CO2	2
6	Study and Perform Significance Testing using Z-test and t-test.	CO3	2
7	To Summarize Data using correlation analysis and covariance matrix.	CO4	2
8	Performing One-Way ANOVA for comparison of multiple groups.	CO 5	2
9	Perform Statistical Experiments using Hypothesis Testing for population mean and proportion	CO6	2
10	Mini Project: Exploratory Data Analysis on real-world dataset using Software Desktop	All CO	--
11	Case Study: Comparative statistical analysis and visualization using real-time data	All CO	--

Note:

1. Suggested list of Experiments (10-12 Experiments must be conducted)
2. Students must use online repository and collaborative platform like Kaggle, OpenML.
3. Common recommended Dataset: Iris, Titanic, Bank Marketing, Breast Cancer Wisconsin.

13.6 Assessment Methodologies and Tools

Theory Assessment

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA-1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
2	IA-2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
3	FA	2	CAT	Teacher Choice *	Teacher Choice *	10	10	-
5	ESE	1	ESE	Paper- Pen	In Class Exam	60	60	2.5 Hrs

*IA = Internal Assessment; FA = Formative Assessment;

IA-1 will be conducted after completion of 3 modules; IA-2 will be conducted after completion of next 3 modules

*Assessment Instruments → For Quiz- MCQ's (Paper-based)

For Case Study - Problem-based Scenarios (Evaluation Tool)

*Assessment Methods → Self-Assessment – Encourages students to reflect on their performance, identify areas for improvement, and take responsibility for their learning progress.

Lab Assessment

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiment	10	Practical	Practical Record / Journal	Rubrics Based	20	40	60 mins
2	Class Participation	1	CAT	Attendance	Record Based	5	10	-

CAT Activity will be part of Term Work

13.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CABS241.1	3	2	-	-	2	-	-	-	-	-	2	2	2
CABS241.2	3	3	2	2	3	-	-	-	-	-	2	3	2
CABS241.3	2	3	2	2	2	-	-	-	-	-	2	3	2
CABS241.4	2	3	2	3	2	-	-	-	-	-	2	3	2
CABS241.5	2	3	2	3	2	-	-	-	-	-	2	2	2
CABS241.6	2	3	3	3	2	-	-	-	-	-	2	3	2

13.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	A systematic, theory-based understanding of natural sciences and mathematics applicable to engineering	Provides foundations in descriptive statistics, probability, sampling distributions, and regression techniques essential for data analysis.
2	WK2	Conceptually based mathematics, numerical analysis, statistics, and formal aspects of computing	Engages students in statistical computations, hypothesis testing, ANOVA, and regression modelling using analytical methods.
3	WK3	Engineering specialist knowledge relevant to the program	Emphasizes exploratory data analysis, visualization, and regression modelling using modern analytical tools relevant to AI, Data Science, and engineering.
4	WK4	Knowledge that supports engineering design and development	Apply statistical analysis and predictive modelling to analyze trends and support data-driven decision making in engineering contexts.
5	WK5	Knowledge of engineering practice, technology, and software tools	Introduces practical use of statistical and visualization tools (e.g., Tableau Desktop) for implementing data analysis concepts.
6	WK6	Comprehension of engineering role in society, ethics, and sustainability	Encourages responsible interpretation of real-world datasets and informed decision-making based on statistical evidence.

13.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Miller and Freund's Probability and Statistics for Engineers	7 th	Johnson. R.A. and Gupta. C.B	Pearson Education	2007
T2	Statistical data analysis and inference	2 nd	Dodge, Yadolah	Elsevier	2014
T3	Introduction to Probability and Statistics	4 th	Milton. J. S. and Arnold. J.C	Tata McGraw Hill	2007
T4	Head first Statistics: Brain friendly Guide	1 st	Dawn Griffiths	O'Reilly/Shraoff	2025

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Statistical Inference via Data Science: A Modern Dive into R and the Tidyverse	1 st	Ismay, Chester, and Albert Y. Kim	CRC Press	2019
R2	Probability, Statistics, Random Processes and Queuing Theory	2 nd	A. Chandrasekaran, G. Kavitha	Dhanam Publications	2014
R3	Practical Statistics for Data Scientists	2 nd	Peter Bruce, Andrew Bruce	O'REILLY	

Online Resources

SN	Title	Description
O1	Coursera – Statistics with Python Specialization (https://youtu.be/LvySJGj-88U?list=PLoROMvovd4rPP6braWoRt5UCXYZ71GZIQ)	Resource for learning exploratory data analysis
O2	edX – Data Analysis and Statistical Inference (https://youtu.be/o7WkGYIPUM8?list=PLunlGNVWDAaY7AeDDzTeu4-DD3g7zmAXs)	Covers statistical experiments
O3	IBM – Exploratory Data Analysis for Machine Learning (https://www.coursera.org/learn/exploratory-data-analysis-machine-learning) (https://youtu.be/QiqZliDXCCg)	Learning material focused on data visualization, and preprocessing techniques.
O4	NPTEL – Introduction to Probability and Statistics (https://youtu.be/ZmCBF5JXOPM?list=PLFW6IRTa1g80s2MWqXNg2o0haq1k14v2l) (https://youtu.be/ugDJVWXGLj8) --(ANOVA)	Online course covering basics of statistics, descriptive statistics, probability distributions, and sampling techniques
O5	Tableau – Tableau Learning Resources (https://www.tableau.com/learn/training) (https://youtu.be/Ftc9nPKvv3Y?list=PLS1QulWo1RIbn2s-Nr5h11rtsAdAlt6kc)	Official tutorials for visualization, and summarizing datasets
O6	Google – Data Analytics Professional Certificate (https://www.coursera.org/professional-certificates/google-data-analytics)	Includes statistical analysis, ANOVA concepts, regression modelling, and data summarization

Chapter 14:

Subject- Computational Theory (Sem IV)

Overview			
Course code:	CAPC241	Course Category:	Program Core
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

14.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	3	-	-	-	3	6
Hours/Sem	45	-	-	-	45	90
Credits	3	-	-	-	3	3

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

14.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	3
Labs	-	-	-	-

14.3 Course Objectives

Pre-requisite Course / Knowledge	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions, Discrete Structures.
Course Overview: The study of Computational Theory enables students to develop strong understanding in Automata theory, Formal languages, decidability and undecidability. It enables to design automata models for computing problems. Analysing various automata models in its power, limitations, and applications.	
Course Objectives: 1. To acquire conceptual knowledge of grammar and languages. 2. To understand the relation between Regular Language and Finite Automata. 3. To understand the language hierarchy, CFG and CFL. 4. To design a PDA equivalent to a given context-free grammar/language. 5. To learn the principles of computation by designing a Turing Machine and understand the concept of decidability and undecidability.	

14.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPC241.1	To design regular expressions that represent regular languages and understand the properties of regular language.	Apply(L3)
CAPC241.2	To design and minimise and optimise Finite Automata for regular language recognition.	Apply(L3)
CAPC241.3	To design Context Free Grammars, simplify the CFG and understand the properties of CFL.	Apply(L3)
CAPC241.4	To design PDA for a given context-free grammar or language and enumerate its applications.	Apply(L3)
CAPC241.5	Design Turing machines as generators, deciders, and acceptors for various computational tasks.	Apply(L3)
CAPC241.6	Understand decidability and undecidability and apply it to learn the properties and problems of Recursive and Recursively enumerable languages.	Apply(L3)

14.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	BASIC CONCEPTS AND REGULAR LANGUAGES	CO1	L3	T1, T2, T3, R1, R2	6
	1.1	Importance of TCS, Alphabets, Strings, Grammar, Chomsky Hierarchy, Languages				
	1.2	Regular Expression, Arden's theorem, Regular Grammar, Regular Language, Closure properties. Decision properties of RL, Pumping lemma for RL				
2	Title	FINITE AUTOMATA	CO2	L3	T1, T3, R1, R2	8
	2.1	Finite State machine (FSM) , Finite Automata (FA) : Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA)				
	2.2	NFA with ϵ - transitions, NFA to DFA Conversion				
	2.3	FSM with output: Moore and Mealy machines, Applications and limitations of FA				
	2.2	Equivalence of Left and Right linear grammar, Equivalence of RG and FA				
3	Title	CONTEXT FREE GRAMMAR	CO3	L3	T1, T2, T3, R1, R2	8
	3.1	Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Normal Forms: Chomsky Normal Form (CNF) and Greibach Normal Form (GNF)				
	3.2	Simplification of CFG: Eliminating unit productions, useless production, useless symbols, and ϵ -productions				

	3.3	Normal Forms: Chomsky Normal Form (CNF) and Greibach Normal Form (GNF)					
	3.4	Pumping Lemma of CFL , Closure properties of CFL , Applications of CFL					
4	Title	PUSHDOWN AUTOMATA	CO4	L3	T1, T3, R1, R2	6	
	4.1	Definition, Language of PDA, PDA as generator, decider and acceptor of CFG					
	4.2	Deterministic PDA , Non- Deterministic PDA, Applications of PDA.					
	4.3	Equivalence of PDA and CFG.					
5	Title	TURING MACHINE	CO5	L3	T1, T3, R1, R2	7	
	5.1	Definition, Design of TM as generator, decider and acceptor					
	5.2	Variants of TM: Multitrack, Multitape, Universal TM, Applications of TM, Power and Limitations of TMs.					
6	Title	Decidability and Computability	CO6	L3	T1, T3, R1, R2	4	
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Language, Properties of Re cursive and Recursively Enumerable language.					
	6.2	Halting Problem, Rice’s Theorem, Post Correspondence Problem					
Self-Study	SS.1	RE in text search and replace, Application of Regular Languages in Compiler Design, Text Processing, and Natural Language Processing (NLP)					2 hrs/ wk
	SS.2	Minimization of DFA , Conversion of Moore to Mealy & Mealy to Moore machine.					
	SS.3	Applications of CFL : Parser, Markup languages					
	SS.4	Parsing & PDA: Top-Down Parsing, Bottom-up Parsing, Closure properties and Deterministic PDA.					
	SS.5	Algorithms using Turing Machine, The Model of Linear Bounded Automata					
	SS.6	NP Completeness of the SAT Problem, A Restricted Satisfiability Problem					

14.6 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA-1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr.
2	IA-2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr.
3	FA	2	CAT	Teachers Choice*	Teachers Choice*	10	10	--
4	ESE	1	ESE	Paper- Pen	In Class- Exam	60	60	2.5 Hrs.

*IA = Internal Assessment; FA = Formative Assessment;

IA 1 will be conducted after completion of 3 Modules; IA 2 will be conducted after completion of 3 modules

*Assessment Instruments → **What** Tools and instruments are used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed.

*refer section 3.8

14.7 Suggested CO-PO/PSO/PEO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPC241.1	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC241.2	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC241.3	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC241.4	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC241.5	3	3	3	-	-	-	-	-	-	-	3	3	3
CAPC241.6	3	3	3	-	-	-	-	-	-	-	3	3	3

14.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	A systematic, theory-based understanding of the nature sciences applicable to the discipline and awareness of relevant social sciences.	Computational theory provides a common language—algorithms and information structure—that allows scientists to formalize their theories and simulate complex systems, leading to more profound insights, higher predictability, and a greater awareness of the underlying mechanisms in both natural and social worlds.
2	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.	Computational theory provides the foundational mathematical framework that enables the transition from abstract concepts to practical computer-based solutions. By classifying problems based on their inherent difficulty, it supports detailed analysis and modeling across numerical methods, data analysis, statistics, and formal computer science.
3	WK3	A systematic theory-based formulation of engineering fundamentals in the engineering discipline.	Computational theory acts as a systematic translator, converting abstract engineering mathematics into efficient, computable algorithms, thus providing a sound foundation for advanced engineering fields like robotics, AI, and complex simulations.
4	WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering	Computational theory (or the Theory of Computation) serves as the foundational, theoretical framework for modern engineering, providing mathematical models, algorithms, and logical structures

		discipline; much is at the forefront of the discipline.	that enable advanced, software-driven, and simulation-based engineering practices. It bridges abstract mathematics with practical engineering applications, driving innovation in areas such as AI, autonomous systems, and computational design.
5	WK8	Engagement with selected knowledge in the current literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.	Computational theory provides the vocabulary necessary to understand and analyse contemporary, fast-paced literature in computer science and data science. Computational theory fosters critical thinking by forcing a shift from simply using tools to understanding the underlying mechanics, capabilities, and limitations of machines. Computational theory encourages creative problem-solving by emphasizing abstraction; the ability to identify recurring patterns and ignore irrelevant details to focus on the core issue.

14.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Introduction to Automata Theory Language and Computation	3 rd	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman	Pearson Education	2008
T2	Theory of Computation	3 rd	Michael Sipser	Cengage learning	2013
T3	Theory of Computation	-	Vivek Kulkarni	Oxford University Press	2013

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Introduction to Languages and the Theory of Computation	6 th	J. C. Martin	Tata McGraw Hill Publication	2013
R2	Theory of Computation: A Problem-Solving Approach	-	Kavi Mahesh	Wiley-India	2011

Online Resources

SN	Title	Description
O1	YouTube : https://youtube.com/playlist?list=PLyqSpQzTE6M9-v4V62bCygAVYGluijyo&si=PJazlO1atch-HQnR	NPTEL -NOC IITM COURSE

Chapter 15:

Subject- Database Management System (Sem IV)

Overview			
Course code:	CAPC242	Course Category:	Program Core
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

15.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	3	-	2	-	3	8
Hours/Sem	45	-	30	-	45	120
Credits	3	-	1	-	-	4

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

15.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	3
Labs	50%	50%	100%	1

15.3 Course Objectives

Pre-requisite Course / Knowledge	Data Structures
Course Overview: The Database Management System course is intended to deliver the basic concepts of a database management system to students. In today's data-driven world, DBMS are essential for efficiently storing, managing, and analyzing the data. This course equips students with foundational concepts and practical skills to design and implement robust data-driven solutions across diverse domains.	
Course Objectives: 1. To learn the basics and understand the need of a database management system. 2. To construct ER/EER data model for real world applications 3. To develop a Relational Model from ER/EER. 4. To elaborate the concept of SQL to store and retrieve data efficiently. 5. To demonstrate notions of normalization for database design. 6. To understand the concepts of transaction, concurrency control recovery procedures.	

15.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPC242.1	Learn fundamentals and understand need of DBMS, data models, and architecture	Understand(L2)
CAPC242.2	Articulate ER/EER models for real-world applications	Apply(L3)
CAPC242.3	Transform ER/EER models into relational schemas	Apply(L3)
CAPC242.4	Apply SQL queries for data creation and retrieval	Apply(L3)
CAPC242.5	Analyze and apply normalization techniques	Analyze(L4)
CAPC242.6	Discuss transaction, concurrency, and recovery concepts	Understand(L2)

15.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs
1	Title	Introduction to Database Systems	CO1	L2	T1,T4, R1,R4	5
	1.1	Introduction, Characteristics of databases				
	1.2	Filesystem V/s Database system, Users of a Database system				
	1.3	DBMS system architecture				
	1.4	Data Models, Data Independence				
	1.5	Database Administrator (DBA), Role of a DBA & database languages.				
2	Title	The Entity- Relationship Model	CO2	L3	T1,R2,R3	8
	2.1	Types of data Models, The Entity-Relationship (ER) Model				
	2.2	Entity Sets, Entity Types, Attributes and Keys				
	2.3	Relationship Sets, Relationship Types, Weak Entity Types,				
	2.4	Mapping Cardinality & Participation. Extended Entity-Relationship (EER) Model, Generalization, Specialization and Aggregation.				
3	Title	Relational Model & Relational Algebra	CO3	L3	T2, R2,R4	10
	3.1	Introduction to Relational Model, Relational Model and Relational Algebra				
	3.2	Relational Model Constraints and Relational Database Schemas				
	3.3	Concept and types of Keys, Mapping the ER and EER to relational model.				

	3.4	Introduction to Relational Algebra: Selection, Projection, Union, Cartesian Product, Joins, Intersection, Rename					
	3.5	Relational Algebra Queries.					
4	Title	Structured Query Language (SQL)	CO4	L3	T2, T3, R1,R3	5	
	4.1	Overview of SQL, Data Definition Commands, Set operations, Aggregate function, Null values					
	4.2	Data Manipulation commands, Data Control commands,Views in SQL					
	4.3	Complex Queries using Group By, Joins , Nested queries, Integrity constraints in SQL					
	4.4	Security and authorization: Grant & Revoke in SQL, Aggregate functions, Hierarchical retrieval of data Functions and Procedures in SQL					
	4.5	Cursors, Trigger and its types, Recursive Queries, Nested Queries , Referential integrity in SQL.					
5	Title	Relational Database Design	CO5	L4	T1,T4, R2,R3	8	
	5.1	Design guidelines for relational schema, Decomposition, Functional Dependencies & types					
	5.2	Database tables and normalization. Introduction to multi valued dependency					
	5.3	Need for normalization. Definition of Normal Forms- 1NF, 2NF, 3NF & BCNF.					
	5.4	Converting Relational Schema to higher normal forms					
6	Title	Transaction Management, Concurrency & Recovery	CO6	L2	T2, T4, R2,R4	3	
	6.1	Transaction concepts, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions.					3hrs /wK
	6.2	Serializability – Conflict and View. Concurrency Control: Lock-based-protocols and Timestamp based protocols.					
	6.3	Deadlock handling, Recovery Concepts and Recovery System					
Self Study	SS.1	Need & Applications of databases (banking, e-commerce, airlines, education etc)					

	SS.2	Common ER Modeling Mistakes & Best Practices	
	SS.3	Introduction to Relational Calculus	
	SS.4	LeetCode (SQL practice problems), HackerRank (SQL challenges)	
	SS.5	Anomalies in Database Design	
	SS.6	Log based recovery methods.	

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs
1	Study of Database Fundamentals and DBMS Architecture	CO1	2
2	Identify the case study and detailed statement of the problem. Design an Entity Relationship (ER) / Extended Entity-Relationship (EER) Model.	CO2	2
3	Mapping ER/EER to Relational schema model.	CO3	2
4	Create a database using DDL and apply integrity constraints.	CO4	2
5	Perform data manipulations (DML) operations on populated databases.	CO4	2
6	Perform Simple, Nested queries and Complex queries using Join operation.	CO4	2
7	Perform DCL commands (Grant & Revoke)	CO4	2
8	Perform TCL command (Start, commit, rollback & savepoint)	CO4	2
9	Implementation of procedure and functions in SQL.	CO4	2
10	Implementation of Views and Triggers.	CO4	2
11	Study of Database Normalization and Normal Forms (1NF, 2NF, 3NF, BCNF)	CO5	2
12	Demonstration & implementation of Transaction and Concurrency control techniques using locks.	CO6	2
13	Mini project (Design simple GUI and Backend Connectivity)	CO6	2

Sr. No.	Guidelines for Mini project / Case Study takeaway (Suggested)	Hours
Part A	Identify a real-world application (e.g., hospital management, online shopping, college admission, banking system or any similar applications) and perform the following: 1. Formulate a clear problem statement. 2. Design the ER / EER diagram showing entities, attributes, relationships, and constraints. 3. Convert the ER/EER model into a relational schema with primary keys, foreign keys, and cardinality constraints. Expected Output: 1. ER/EER diagram 2. Relational schema 3. Entity descriptions	2 Hours
Part B	Using the relational schema created in Part A: 1. Create all tables using DDL commands with appropriate integrity constraints (PK, FK, CHECK, UNIQUE, NOT NULL). 2. Populate tables with sample data (minimum 10–15 records per table). 3. Perform DML operations (INSERT, UPDATE, DELETE). 4. Execute basic and complex SQL queries, including: a. JOINS b. Subqueries c. Aggregate functions d. Group By / Having e. Set operations Expected Output: 1. DDL scripts 2. DML scripts SQL query results (screenshots or printouts)	2 Hours

15.6 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA-1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
2	IA-2	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr
3	FA	2	CAT	Teachers Choice*	Teachers Choice*	10	10	-
4	ESE	1	ESE	Paper- Pen	In Class-End Sem Exam	60	60	2.5 Hrs

***IA** = Internal Assessment; **FA** = Formative Assessment;

IA 1 will be conducted after completion of 3 Modules; IA 2 will be conducted after completion of 3 modules

*Assessment Instruments → **What** Tools and instruments are used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed.

*refer section 3.8

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiments	10	CAT	Practical	Journal (Rubrics Based)	10	20	2 hours
2	Classroom Participation	-	CAT	Attendance	Record and Rubrics	5	10	-
3	Mini Project	1	CAT	Mini Project /Online Certification (MOOCs)	Rubrics Based	10	20	-
4	ESE	1	ESE	Oral and Practical	Rubrics based	25	50	-

Note:

1. CAT Activity will be part of Term Work.

2. Learners will perform lab 10 experiments & cover all modules

3. The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the Term Work.

4. An oral /Practical viva examination will be held based on the above syllabus.

15.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPC242.1	3	2	-	-	-	-	-	3	2	-	3	3	-
CAPC242.2	3	3	3	-	2	-	-	3	2	-	3	3	-
CAPC242.3	3	3	3	-	3	-	-	3	3	-	3	3	-
CAPC242.4	3	3	-	-	3	-	-	3	3	-	3	3	-
CAPC242.5	3	3	-	-	3	-	-	3	3	-	3	3	3
CAPC242.6	3	2	2	-	-	-	-	3	2	-	3	3	-

15.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	Apply knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	Students begin with fundamental knowledge (definitions, architecture) and develop basic understanding. This builds awareness and interest in database systems.
2	WK 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	Requires understanding of concepts and applying them to design models. Often done in groups, encouraging teamwork and structured problem-solving.
3	WK3	Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health, safety, cultural, societal, and environmental factors.	Focuses on practical implementation and solving real database queries, promoting logical thinking and problem-solving attitude.
4	WK4	It provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline.;	Focus on understanding & usage of tools
5	WK5	Knowledge, including efficient resource use, to support engineering design and operations in a practice area	Students create solutions for engineering problems and design/develop outcomes to meet identified needs.

6	WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve engineering problems.
7	Wk8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.	conduct investigations of engineering problems including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. Students will be able to recognize the need and ability for independent and life-long learning, adaptability to new and emerging technologies and critical thinking.

15.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Database System Concepts	7 th	Korth & Silberchatz, Sudarshan	McGraw Hill	2023
T2	Fundamentals of Database Systems	7 th	Elmasri and Navathe	Pearson education	2017
T3	SQL and PL/SQL for Oracle 10g Black Book	1 st	Dr. P.S. Deshpande	Dreamtech Press	2011
T4	Database Management systems	1 st	G.K gupta	McGraw Hill	2011

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Database Management Systems	3 rd	R.Ramakrishnan, Johannes Gehrke	McGraw Hill	2014
R2	An Introduction to Database Systems	8 th	C.J. Date	Pearson education	2006
R3	Database Systems: A practical Approach to Design, Implementation and Management.	5 th	Thomas Connolly, Carlyn Begg	Pearson/ Addison-Wesley	2014

Online Resources

SN	Title	Description
O1	Introduction to Database Systems	NPTEL link
O2	https://www.postgresql.org/	Advanced Open-source relational database
O3	Draw.io	Software: ER Diagram & Data Modelling Tool

Chapter 16:

Subject- Computer Networks (Sem IV)

Overview			
Course code:	CAPC243	Course Category:	Program Core
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

16.2 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	3	--	2	-	3	8
Hours/Sem	45	-	30	-	45	120
Credits	3	-	1	-	-	4

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

16.3 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	40%	60%	100%	3
Labs	50%	50%	100%	1

16.4 Course Objectives

Pre-requisite Course / Knowledge	Knowledge of any programming or algorithms is desirable
Course Overview: This course provides a comprehensive overview of how digital devices communicate, covering the fundamentals of network architectures, protocols, and technologies. Knowledge of Computer networking is required to understand communication between browsers, web servers, routers, Hubs, Layer 2, 3 switches. This is going to help to understand cloud computing, machine learning, and AI engineering.	
Course Objectives: 1. To introduce basic concepts of computer networking and layered architecture. 2. To investigate the complexities and challenges in Data Link Layer. 3. To understand IP primitives and routing algorithms. 4. To elaborate connection oriented and connection-less protocols. 5. To demonstrate notions of application layers protocols. 6. To create and simulate practical network-based applications.	

16.5 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPC243.1	Explain the basics of computer network components.	Understand (L2)
CAPC243.2	Explore the different services and design challenges of the data link layer.	Understand (L2)
CAPC243.3	Classify IP addressing with subnetting and super netting techniques.	Understand (L2)
CAPC243.4	To learn and apply concepts of connection management and flow control.	Apply (L3)
CAPC243.5	To learn and apply protocols concepts at the application layer.	Apply (L3)
CAPC243.6	To design and develop network applications using simulation tools and socket programming.	Create (L6)

16.6 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Introduction to Networking	CO1	L2	T1, R1, R5	5
	1.1	Introduction to computer network, Network Devices				
	1.2	Network topology				
	1.3	Switching: Circuit-Switched Networks, Packet Switching				
	1.4	Network Types: LAN, MAN, WAN, Layered architecture				
	1.5	TCP/IP model, Difference between OSI and TCP/IP.				
2	Title	Physical and Data Link Layer	CO2	L2	T1, T2, R2, R5	8
	2.1	Physical Layer: Communication mechanisms and Electromagnetic Spectrum,				
	2.2	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics				
	2.3	DLL Design Issues (Services, Framing, Error Control, Flow Control),				
	2.4	Error Detection and Correction (Hamming Code, CRC, Checksum)				
	2.5	Elementary Data Link protocols, Stop and Wait,				
	2.6	Sliding Window (Go-Back-N, Selective Repeat),				
	2.7	Medium Access Control Sublayer Channel Allocation problem, Multiple Access Protocol (ALOHA)				
	2.8	Carrier Sense Multiple Access, (CSMA/CD)				
3	Title	Network Layer	CO3	L2	T1, R1, R2	7
	3.1	Network Layer: Communication Primitives, IPv4 Addressing: classful and classless				
	3.2	Subnetting, Introduction to IPv4 Protocol,				
	3.3	IPv4 Header format, Network Address Translation (NAT)				
	3.4	IPv6 addressing, IPv4 vs IPv6 addressing				
	3.5	Routed vs Routing protocols, Classification of Routing algorithms.				
	3.6	Shortest Path algorithms (Dijkstra's), Link State Routing				
	3.7	Distance Vector Routing, ICMP.				

4	Title	Transport Layer	CO4	L3	T3, R2, R3	7
	4.1	Transport Layer: Service primitives				
	4.2	Sockets				
	4.3	Connection management (Handshake), UDP				
	4.4	TCP, TCP state transition,				
	4.5	TCP timers, TCP Flow control (sliding Window),				
	4.6	TCP congestion control.				
5	Title	Application Layer	CO5	L3	T1, R1, R2	6
	5.1	HTTP, HTTPS				
	5.2	SMTP, Telnet,				
	5.3	FTP, DHCP				
	5.4	DNS types, DNS name server				
6	Title	Socket Programming and Simulation	CO6	L6	T2, R4,R5	6
	6.1	Introduction to Socket Programming				
	6.2	Types of Sockets, Socket API basics				
	6.3	Socket Life Cycle				
	6.4	TCP client server, UDP client server,				
	6.5	Introduction to Wireshark Packet capturing tool,				
	6.6	Simulation using ns3.				
Self - Study	SS.1	OSI Model, Basic Networking Commands.				2hr/ wk
	SS.2	Modulation Techniques, Byte stuffing vs Bit stuffing, ARQ Mechanism, CISCO Packet tracer.				
	SS.3	Advanced IP Addressing and Subnetting, Packet Structure and Analysis. ICMP in real life, IP spoofing (basic idea), Firewalls				
	SS.4	UDP vs TCP (Real Applications), TCP Congestion control algorithms, Performance Metrics, Network troubleshooting tools(Netstat, Telnet)				
	SS.5	Cookies and sessions, Digital Certificates, SSH, Telnet Vs SSH, Command Line tools				
	SS.6	Advanced socket concepts, Real applications using Sockets. Open ports and vulnerabilities Basic idea of: Port scanning, Denial of Service (DoS)				

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs
1	Identify computer networking like Switches, Hub, Router, Cables. Design Straight and Cross connection UTP cable using crimping tool and test wiring of connection using Network tester	CO1	2
2	Execute Networking related commands on Windows platform a) ping www.google.com b) netstat -r c) ipconfig d) arp	CO1	2
3	Implement GO-BACK-N Algorithm using C.	CO2	2
4	Run Wireshark packet capturing software and run in promiscuous mode, check header details of MAC header to find the 48-bit address of ethernet.	CO2	2
5	Design a Implement Stop and Wait Algorithm.	CO2	2
6	Implement Dijkstra's Algorithm for routing.	CO3	2

7	Design a small computer network using 5 client server switches of 8 ports. Check speed transmission from client to server using Cisco Packet tracer.	CO3	2
8	Implement UDP client Server application. Use suitable port numbers and IP address as per requirement.	CO4	2
9	Run Wireshark packet capturing software and capture UDP, TCP, HTTP, DNS, ethernet packet and analyse its header.	CO4	2
10	Capture and analyse SMTP packets. (On the background of the system you should open your email to capture details of these packets. Find out source email ID, Source IP address, destination IP address.	CO5	2
11	Implement Telnet/FTP protocol for file transfer.	CO5	2
12	Implement TCP layer Sliding window protocol in C language.	CO6	2
13	Implement TCP Client -Server application. two windows on the same computer while implementing this experiment.	CO6	2

16.7 Assessment Methodologies and Tools

Theory Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	IA 1	1	CAT	Paper – Pen	Classroom Test	15	15	1 Hr.
2	IA2	1	CAT	Paper-Pen	Classroom Test	15	15	1 Hr.
3	FA	2	CAT	Teacher Choice*	Teacher Choice*	10	10	-
4	ESE	1	ESE	Paper- Pen	Classroom Test	60	60	2.5 Hrs.

*IA = Internal Assessment; FA = Formative Assessment;

IA 1 will be conducted after completion of 3 Modules; IA 2 will be conducted after completion of 3 modules

*Assessment Instruments → **What** Tools and instruments are used for the assessment.

*Assessment Methods → **How** Are assessments evaluated and/or executed.

*refer section 3.8

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiment	10	CAT	Practical	Rubrics Based	20	40	2 Hrs.
2	Class Participation	-	CAT	Attendance	Record and Observation	05	10	-
3	ESE	-	ESE	Oral and Practical	-	25	50	2.5 Hrs.

Note:

1. CAT Activity will be part of Term Work

2. Learners will perform lab 10 experiments at least 1 experiment from each module for 2 hrs.

3. ESE will be a combination of executing any program followed by Oral by external.

16.8 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPC206.01	3	2	2	-	-	-	-	-	-	-	-	3	-
CAPC206.02	2	3	2	-	-	-	-	-	-	-	-	3	-
CAPC206.03	3	2	2	-	-	-	-	-	-	-	-	3	-
CAPC206.04	3	2	-	-	-	-	-	-	-	-	-	3	-
CAPC206.05	3	2	-	-	-	-	-	-	-	2	-	3	-
CAPC206.06	2	2	3	2	3	-	-	-	2	2	2	3	-

16.9 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	Apply knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	Course covers fundamental concepts such as network components, IP addressing, protocols, and flow control.
2	WK 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	Students analyze networking problems, such as data link layer challenges, subnetting logic, and protocol behavior.
3	WK3	Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health, safety, cultural, societal, and environmental factors.	Involves designing network applications and understanding protocol design aspects.
4	WK4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	Students perform testing, debugging, simulation, and result analysis using tools.
5	WK5	Create, select, and apply appropriate modern computing tools and technologies (e.g., simulators, programming languages, networking tools, packet analyzers) with an understanding of their limitations.	Use of simulation tools (NS2/NS3), socket programming, packet analyzers

16.10 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	<i>Computer Networking: A Top-Down Approach</i>	8 th	Kurose, J. F., & Ross, K. W.	Pearson	2021
T2	<i>Data Communications and Networking</i>	5 th	Behrouz A. Forouzan	Mc Graw Hill education	2013
T3	Illustrated TCP/IP	Volume 1, 2	W. Richard Stevens	Prentice Hall	2015

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Computer Networks: Principles, Technologies & Protocols for Network Design.	1 st	Natalia Olifer & Victor Olifer	Wiley India	2011
R2	Computer Networks: A Systems Approach	2 nd	Larry L. Peterson, Bruce S. Davie	Morgan Kaufmann (an imprint of Elsevier)	2000
R3	An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network	1 st	Srinivasan Keshav	Pearson Education (India)	2002
R4	ns-3 Tutorial Release ns-3-dev			ns-3 Project	2025
R5	Computer networking for beginners		Bansod, Dr Patil	Shroff Publisher	2024

Online Resources

SN	Title	Description
O1	NPTEL: https://nptel.ac.in/courses/106105183	Computer Networks And Internet Protocol, IIT Kharagpur Prof. Soumya Kanti Ghosh Prof. Sandip Chakraborty
O2	https://www.coursera.org/specializations/computer-communications	Understand fundamental network architecture concepts and their impacts on cyber security, to develop skills and techniques required for network protocol design
O3	https://www.coursera.org/learn/tcpip?action=enroll	Introduction to TCP/IP, you will learn the operational functions of Internet technologies (which

		include IPv4, IPv6, TCP, UDP, addressing, routing, domain names, etc.)
--	--	--

Chapter 17:

Subject- Design Thinking (Sem IV)

Overview			
Course code:	IGEM241	Course Category:	Vocational and Skill Enhancement Course
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

17.1 Teaching & Learning Scheme

Components	Classroom Instruction		Lab instructions		Teamwork/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-	2	2	-	4
Hours/Sem	-	-	30	30	-	60
Credits	-	-	2		-	2

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

17.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	-	-	-	-
Lab & Term Work	100%	-	100%	2

17.3 Course Objectives

Pre-requisite Course / Knowledge	Nil
Course Overview: This course introduces students to the principles, process, and practical application of design thinking as a human-centered approach to problem-solving. It focuses on understanding user needs, redefining problems, and creating innovative solutions through iterative design.	
Course Objectives: 1. To introduce learners to the fundamental concepts of Design Thinking. 2. To make learners understand the different stages involved in the Design Thinking process. 3. To acquaint learners with various tools used in Design Thinking. 4. To study techniques used for generating solutions to problems. 5. To provide exposure to different case studies related to Design Thinking. 6. To design, develop, and evaluate a prototype.	

17.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
IGEM241.1	Differentiate between traditional problem-solving methods and the Design Thinking approach and explain its core principles.	Analyze (L4)
IGEM241.2	Develop a user persona by applying empathy-based techniques.	Apply (L3)
IGEM241.3	Formulate a clear problem statement using appropriate Design Thinking tools.	Apply (L3)
IGEM241.4	Apply ideation methods to generate multiple solution options for a problem.	Apply (L3)
IGEM241.5	Build prototypes using a variety of techniques.	Create (L6)
IGEM241.6	Evaluate prototypes and collect feedback to improve and refine them.	Evaluate (L5)

17.5 Modules / Syllabus Content

Theory Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Introduction to Design Thinking	CO1	L4	T1, R1	5
	1.1	Definition, History and need of Design Thinking				
	1.2	Difference between Traditional Problem Solving and Design Thinking approach				
	1.3	Key tenets of Design Thinking				
2	Title	Empathize	CO2	L3	T1, T2, R1	5
	2.1	Foundation of Empathy and its purpose				
	2.2	Methods for understanding user needs: Interviews, observation and immersion				
	2.3	Empathy Mapping and persona development				
3	Title	Define – Problem Definition and Analysis	CO3	L3	T2, T3, R1	5
	3.1	Significance of defining a problem				
	3.2	Analyse research data to identify core problem				
	3.2	Crafting actionable Problem Statements (Point of View - POV)				
4	Title	Ideate – Generating solution	CO4	L3	T1, T2, R2	5
	4.1	Divergent vs Convergent thinking				
	4.2	Brainstorming techniques: Mind mapping, SCAMPER				
	4.3	Concept selection and feasibility assessment				
5	Title	Prototype - Making ideas tangible	CO5	L6	T1, T3, R1	3
	5.1	Low Fidelity to High Fidelity Prototype				
	5.2	Rapid Prototyping technique				
6	Title	Test – Iteration and Feedback	CO6	L5	T1, T2, R1	3
	6.1	Guidelines for conducting test				
	6.2	User validation and usability testing				
	6.3	Developing Feedback loops to refine the prototype based on testing				
Self-	SS.1	Self-Learning: Case Studies from various domains				

Study	SS.2	Self-Learning: Empathy and User Research	
	SS.3	Self-Learning: Creating a Persona – A Step-by-step guide with tips and examples	
	SS.4	Self-Learning: How to run an effective ideation workshop: A step-by-step guide	
	SS.5	Self-Learning: Various case studies related to prototyping	
	SS.6	Self-Learning: To find End Goals of test: Desirability, Feasibility and Viability	

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs.
1	Customer Journey Mapping – Visualize user interaction from discovery to usage and identify pain points	CO2	2
2	Stakeholder Mapping – Identify stakeholders and categorize them by influence and interest	CO2	2
3	How Might We Problem Framing – Convert insights into actionable problem statements	CO3	2
4	Brainstorming Session – Generate creative ideas using mind mapping and brainwriting techniques	CO4	2
5	Affinity Diagramming – Group ideas into themes to identify patterns and insights	CO3	2
6	Rapid Prototyping – Create quick, low-fidelity prototypes focusing on functionality	CO5	2
7	Wireframing – Design basic layouts for mobile/web interfaces	CO5	2
8	Role-Playing – Simulate user interactions with prototypes to gather feedback	CO6	2
9	Usability Testing – Test prototypes with users to identify issues and improvements	CO6	2
10	Feedback Loop and Iteration – Refine solutions based on user feedback and document improvements	CO6	2

Assignments (Suggested list of Assignments)

SN	List of Assignments
1	Create an empathy map for a specific target user group. Divide it into four sections: <i>Says, Thinks, Feels, and Does</i> . Gather insights by interviewing users or researching their experiences.
2	Based on research, develop user personas that include demographics, motivations, pain points, and goals. Present the persona to the class.
3	Select three real-life products with both good and bad design aspects. Analyse them and explain why you consider their design effective or ineffective.
4	Explore any open-source design thinking tool and write a short report about it. You may Also conduct a user survey to support your findings.

17.6 Assessment Methodologies and Tools

Lab Component

#	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiment	10	CAT	Practical Experiments	Journal (Rubrics Based)	25	50	2 Hr
2	Assignment	4	CAT	Teacher Choice	Teacher Choice	10	20	TBD
3	Report	1	CAT	Report Writing	Rubrics based	10	20	TBD
4	Class Participation	1	CAT	Attendance	Record based	5	10	-

Note:

1. CAT Activity will be part of Term Work.

The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.

2. Learners will perform minimum 10 experiments at least 1 experiment from each module.

17.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
IGHS241.01	3	3	-	-	2	-	-	2	2	-	-	2	2
IGHS241.02	2	3	3	2	2	-	-	2	2	-	-	3	2
IGHS241.03	3	3	3	2	2	-	-	2	2	-	-	3	2
IGHS241.04	2	2	2	2	2	-	-	2	2	-	-	3	2
IGHS241.05	2	2	2	2	2	-	-	2	2	-	-	3	2
IGHS241.06	2	2	2	3	2	-	-	2	2	-	-	3	2

17.8 Course to Knowledge and Attitude Profile (WK) Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK2	Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.	Design Thinking involves analytical and data-driven approaches for understanding user needs and evaluating solutions.

2	WK5	Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts.	The subject promotes sustainable and resource-efficient solution development for real-world problems.
3	WK7	Knowledge of the role of engineering in society and identified issues in engineering practice including public safety and sustainable development.	Design Thinking focuses on solving societal problems with user-centric and socially responsible approaches.
4	WK8	Engagement with current research literature, critical thinking, and creative approaches to evaluate emerging issues.	The subject develops innovation, creativity, critical thinking, and problem-solving abilities.

17.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-Solving	1 st	Pavan Soni	Penguin Random House India Pvt. Ltd.	2022
T2	Design Thinking: Methodology Book	1 st	Emrah Yayici	CRC Press	2016
T3	Handbook of Design Thinking	1 st	Christian Mueller Roterberg	Independently Published	2018

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School	2 nd	Idris Mootee	Wiley	2013
R2	Change by Design	Revised	Tim Brown	Harper Business	2009

Online Resources

SN	Title	Description
O1	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview	SWAYAM course covering fundamentals of Design Thinking, innovation processes, user-centred design, ideation techniques, and real-world applications.
O2	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr. Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview	SWAYAM course introducing Design Thinking concepts, problem-solving methodologies, empathy, ideation, prototyping, and testing techniques.
O3	Usability Testing	Online resource explaining usability testing

	https://www.interaction-design.org/literature/topics/usability-testing	principles, user evaluation methods, feedback collection techniques, and best practices for improving user experience and product design.
--	---	---

Chapter 18:

Subject- Engineering Fundamentals & Technical Skills (Sem IV)

Overview			
Course code:	IGVE241	Course Category:	Vocational and Skill Enhancement Course
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

18.1 Teaching & Learning Scheme

Components	Class room Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-		2	-	2
Hours/Sem	-	-		30	-	30
Credits	-	-		1	-	1

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

18.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	-	-	-	-
Labs/ Demo/ Activity	100%	-	100%	1

18.3 Course Objectives

Pre-requisite Course / Knowledge	Programming for Problem Solving, Engineering Mathematics.
Course Overview: The course series provides comprehensive training in programming, problem solving, database management, and competitive coding skills required for academic excellence and industry readiness. It covers Python and Java programming fundamentals, object-oriented programming, data structures, algorithms, SQL query writing, debugging techniques, and optimization methods. The courses also focus on logical reasoning, competitive programming strategies, advanced problem-solving techniques, graph and string algorithms, and number theory concepts. Through hands-on coding practice, placement-oriented challenges, mock tests, and real-world case studies, students develop strong analytical, technical, and interview preparation skills essential for software development, coding competitions, and career opportunities in the IT industry.	

Course Objectives:

1. To develop programming and logical problem-solving skills using Python fundamentals, data structures, object-oriented concepts, and placement-oriented coding techniques.
2. To apply Java programming concepts, object-oriented principles, and data structures for developing efficient solutions to coding and real-world programming problems.
3. To understand and implement SQL queries, joins, subqueries, indexing, and aggregate functions for effective database management and data retrieval.
4. To enhance algorithmic thinking and coding efficiency through optimization techniques, modular arithmetic, and competitive programming strategies.
5. To strengthen analytical reasoning, debugging abilities, and optimization skills for solving computational and logical problems efficiently.
6. To apply advanced algorithms, graph techniques, string algorithms, and number theory concepts in solving complex programming and real-world competitive coding challenges.

18.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
IGVS241.1	Apply Python programming concepts, data structures, object-oriented programming principles, and competitive coding techniques to solve logical and placement-oriented programming problems efficiently.	Apply (L3)
IGVS241.2	Develop Java-based solutions using programming fundamentals, object-oriented concepts, data structures, algorithms, and debugging techniques for software development and coding challenges.	Apply (L3)
IGVS241.3	Design and execute SQL queries using joins, subqueries, aggregate functions, indexing, and views for efficient database management and data retrieval applications.	Understand (L2)
IGVS241.4	Analyze and solve competitive programming problems using algorithmic techniques such as greedy methods, divide-and-conquer strategies, sliding window, prefix sums, and modular arithmetic.	Analyze (L4)
IGVS241.5	Demonstrate effective problem-solving abilities through optimization techniques, debugging strategies, test case validation, and analytical reasoning for computational problems.	Analyze (L4)
IGVS241.6	Apply advanced algorithms including graph algorithms, weighted pathfinding, string matching algorithms, and number theory concepts to solve complex real-world and competitive programming challenges.	Evaluate (L5)

18.5 Modules / Syllabus Content

Demo Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs.
1	Title	Python Programming and Problem Solving	CO1	Apply (L3)	T1, R1	5
	1.1	Python Programming Fundamentals 1. Variables, Data Types, and Operators 2. Conditional Statements and Loops 3. Functions, Lists, and String Handling				
	1.2	Data Structures using Python 1. Lists, Tuples, and Dictionaries 2. Stack and Queue Implementation 3. Searching and Sorting Techniques, Time Complexity and Optimization Techniques 2. Pattern Programming and Logical Problem Solving 3. Placement-Oriented Coding Challenges				
	1.3	Object-Oriented Programming in Python 1. Classes and Objects 2. Inheritance and Polymorphism 3. Constructors and Encapsulation				
	1.4	Activity: Develop Python programs to perform searching and sorting techniques such as Linear Search, Binary Search, Bubble Sort, and Selection Sort.				
	1.5	Activity: Analyze the time complexity of different algorithms and implement optimized coding solutions for placement-oriented problems.				
2	Title	Core Java Programming and Problem Solving	CO2	Apply (L3)	T2, R2	5
	2.1	Java Programming Fundamentals 1. Variables, Data Types, Operators, and Input/Output 2. Conditional Statements and Looping Constructs 3. Methods, Arrays, and String Handling				
	2.2	Data Structures using Java 1. Arrays, Array List, and LinkedList 2. Stack, Queue, and HashMap Implementation 3. Searching and Sorting Algorithms, Competitive Coding using Java 1. Time Complexity and Optimization Techniques 2. Pattern Programming and Logical Coding Problems 3. Placement-Oriented Coding Challenges				
	2.3	Object-Oriented Programming in Java 1. Classes, Objects, and Constructors 2. Inheritance, Polymorphism, and Abstraction 3. Encapsulation and Interface Concepts				
	2.4	Activity: Develop Java programs to perform searching and sorting algorithms such as Linear Search, Binary Search, Bubble Sort, and Merge Sort.				
	2.5	Activity: Create Java classes and objects to model real-world applications using constructors and methods.				
3	Title	SQL Basics and Intermediate	CO3	Apply (L3)	T3, R3	4
	3.1	Understanding SQL Syntax, Writing Complex Queries, Advanced Joins (INNER OUTER, CROSS)				
	3.2	Nested Subqueries, Indexing Techniques, Aggregate Functions (GROUP BY, HAVING) Using Views for Query Simplification				
	3.3	Activity: Develop SQL queries using nested subqueries for data analysis and conditional retrieval.				
4	Title	Competitive Programming Basics	CO4	Apply (L3)	T4, R4	4
	4.1	Greedy Algorithms in Practice, Divide and Conquer Techniques, Sliding Window and Two Pointers, Prefix Sums				
	4.2	Dynamic Array Usage in Problem Solving, Applying Modular Arithmetic in Coding Challenges				
	4.3	Activity: Implement prefix sum algorithms to perform efficient range sum and cumulative data analysis operations.				
	4.4	Activity: Solve competitive programming challenges involving modular arithmetic and large number computations efficiently.				
5	Title	Problem Solving Techniques	CO5	Apply (L3)	T5, R5	4
	5.1	Understanding Problem Statements, Optimizing Solutions (Time and Space Complexity)				
	5.2	Test Case Generation and Validation, Debugging Advanced Logical Errors				

	5.3	Activity: Analyze different programming problem statements and identify inputs, outputs, constraints, and expected solutions.				
	5.4	Activity: Develop automated test scenarios to verify the accuracy and reliability of coding solutions.				
	Title	Advanced Problem Solving	CO6	Analyze (L4)	T6, R6	4
6	6.1	Advanced Graph Problems (Dynamic Graph Queries), Pathfinding in Weighted Graphs), String Algorithms (KMP, Z Algorithm, Rabin- Karp)				
	6.2	Number Theory (Primality Testing, GCD, LCM, Chinese Remainder Theorem), Real- world Case Studies in Competitive Programming				
	6.3	Activity: Develop programs for dynamic graph queries and real-time pathfinding applications using graph data structures.				
	6.4	Activity: Design optimized coding solutions for industry-level problem statements using advanced algorithms and data structures.				

18.6 Assessment Methodologies and Tools

Lab Component

	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Activity	12	CAT	Activity	Journal (Rubrics Based)	20	80	2 Hrs.
2	Class Participation	-	CAT	Teachers Observation	Record	5	20	-

CAT Activity will be part of Term Work

18.7 Suggested CO-PO/PSO/PEO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
IGVS241.1	-	-	-	-	-	2	-	2	3	3	-	2	-
IGVS241.2	2	2	-	-	2	-	-	-	3	3	-	-	2
IGVS241.3	-	-	2	2	-	-	-	-	-	-	-	-	2
IGVS241.4	2	2	-	-	-	2	-	2	3	-	-	3	-
IGVS241.5	-	2	-	-	2	-	-	3	-	3	2	-	-
IGVS241.6	2	3	2	-	2	2	-	-	2	3	2	3	2

18.8 Course to Knowledge and Attitude Profile (WK)

#	WK#	WK Statement	Justification of Mapping
1	WK1	A systematic, theory-based understanding of the natural sciences applicable to engineering fundamentals.	Students develop foundational knowledge of Python programming, Java programming, SQL, algorithms, and computational problem-solving

			concepts essential for engineering and software applications.
2	WK2	Conceptually based mathematics, numerical analysis, statistics, and formal aspects of computer and information science to support engineering analysis and modeling.	Competitive programming, time complexity analysis, modular arithmetic, graph algorithms, and optimization techniques strengthen analytical, mathematical, and logical reasoning abilities.
3	WK3	A systematic, theory-based formulation of engineering fundamentals required in engineering specialization.	The course develops core understanding of data structures, object-oriented programming, database systems, searching and sorting techniques, and advanced computational methods required for computer engineering specialization.
4	WK5	Engineering practice is supported by techniques, resources, and modern engineering and IT tools necessary for engineering activities.	Practical implementation using Python, Java, SQL platforms, coding environments, debugging tools, GitHub, and online coding platforms enhances modern software engineering practices.
5	WK6	Engineering practice is informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to professional engineering practice.	Real-world case studies, debugging practices, and placement-oriented coding activities improve professional decision-making and responsible software development skills.

18.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Python Programming: An Introduction to Computer Science	3 rd	John Zelle	Franklin, Beedle & Associates	2016
T2	Java: The Complete Reference	11 th	Herbert Schildt	McGraw Hill	2019
T3	Learning SQL	3 rd	Alan Beaulieu	O'Reilly Media	2020
T4	Database System Concepts	7 th	Abraham Silberschatz, Henry F. Korth, S. Sudarshan	McGraw Hill	2019
T5	<i>Problem Solving with Algorithms and Data Structures using Python</i>	3 rd	Bradley N. Miller, David L. Ranum	Franklin, Beedle & Associates	2011
T6	<i>Algorithm Design</i>	1 st	Jon Kleinberg, Éva Tardos	Pearson	2005

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Automate the Boring Stuff with Python	2 nd	Al Sweigart	No Starch Press	2019

R2	Introduction to Programming in Java	2 nd	Robert Sedgewick, Kevin Wayne	Addison-Wesley	2017
R3	SQL Practice Problems	1 st	Sylvia Moestl Vasilik	Manning Publications	2017
R4	Database Management Systems	3 rd	Raghu Ramakrishnan,	McGraw Hill	2002
R5	Guide to Competitive Programming	1 st	Antti Laaksonen	Springer	2017
R6	Algorithms Unlocked	1 st	Thomas H. Cormen	MIT Press	2013

Online Resources

SN	Title	Description
O1	https://leetcode.com	A student-friendly platform to practice coding problems, data structures, and algorithms for improving programming skills and preparing for placements.
O2	https://docs.oracle.com/en/java/javase/26/	Official Java learning resource for students to understand core Java concepts, syntax, libraries, and programming fundamentals.
O3	https://sqlzoo.net/wiki/SQL_Tutorial	Interactive SQL practice website designed for students to learn and apply database queries step-by-step.
O4	https://codeforces.com/	Competitive programming platform for students to practice coding challenges and improve problem-solving speed and accuracy.
O5	https://www.interviewbit.com/	Structured learning platform for students to prepare for technical interviews through coding practice and conceptual learning.

Chapter 19:

Subject - AI Tools (SEM IV)

Overview			
Course code:	CAVS241	Course Category:	Vocational and Skill Enhancement Course
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R25-Y2

19.1 Teaching & Learning Scheme

Components	Class room Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-	2	2	-	4
Hours/Sem	-	-	30	30	-	60
Credits	-	-	2		-	2

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

19.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Theory	-	-	-	-
Labs	50%	50%	100%	2

19.3 Course Objectives

Pre-requisite Course / Knowledge	Knowledge of any programming or algorithms is desirable
Course Overview: This course provides hands-on exposure to modern AI-powered tools across writing, image generation, coding, research, and workflow automation. Students will learn to effectively integrate these tools into real-world academic, research, and industrial applications.	
Course Objectives: 1 To introduce students to the landscape and capabilities of modern AI tools used in various domains. 2 To familiarize students with the use of AI tools for enhancing productivity in writing, coding, research, and design tasks. 3 To provide exposure to AI-based systems for generating and processing text, images, and code. 4 To impart knowledge of integrating multiple AI tools for building automated workflows.	

- | | |
|---|--|
| 5 | To create awareness about ethical considerations, limitations, and responsible use of AI technologies. |
|---|--|

19.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAVS242.1	Use AI tools effectively for content creation and communication	Apply (L3)
CAVS242.2	Generate and evaluate AI-based visual outputs	Evaluate (L5)
CAVS242.3	Apply AI-assisted coding in software development	Apply (L3)
CAVS242.4	Conduct efficient AI-supported research	Analyze (L4)
CAVS242.5	Design automated workflows integrating multiple AI tools	Create (L6)

19.5 Modules / Syllabus Content

Demonstration Component

Module	Unit	Topic	CO	Blooms Level	Reference	Hrs
1	Title	AI for Writing & Content Creation	CO1	L3	T1, R2	7
	1.1	AI-assisted writing fundamentals				
	1.2	Prompt engineering for content generation				
	1.3	Blog writing, reports, technical documentation				
	1.4	Summarization and paraphrasing techniques				
	1.5	Tone adaptation and multilingual writing				
2	Title	Image Generation Tools	CO2	L5	T3	5
	2.1	Basics of generative AI in image synthesis				
	2.2	Prompt design for image creation				
	2.3	Style transfer and artistic rendering				
3	Title	AI Code Assistants	CO3	L3	T3, T5, R3	5
	3.1	AI-assisted programming concepts				
	3.2	Code generation, debugging, and optimization				
	3.3	Auto-completion and documentation generation				
	3.4	Limitations and risks in AI-generated code				
4	Title	Research & Knowledge Tools	CO4	L4	T4, R2	4
	4.1	AI in academic research				
	4.2	Literature review automation				
	4.3	Citation generation and validation				
	4.4	Knowledge extraction and summarization				
5	Title	Workflow Automation	CO5	L6	T4, T2, R4	5
	5.1	Introduction to no-code/low-code automation				
	5.2	Integrating AI tools into workflows				
	5.3	Event-based automation and triggers				
	5.4	Building Intelligence pipelines				
Self - Study	SS.1	Explore AI tools for grammar correction and plagiarism detection such as Grammarly and Turnitin.				2 hrs. /wk
	SS.2	Explore AI video generation tools like Runway ML and Synthesia.				

	SS.3	Study AI testing/debugging tools and DevOps assistants such as Tabnine and Replit.	
	SS.4	Explore academic reference management tools such as Mendeley and Zotero.	
	SS.5	Explore AI agent platforms and autonomous workflow systems such as AutoGPT and LangChain.	

Laboratory Component (Suggested List of Experiments)

SN	Title of the experiment	CO	Hrs.
1	Generate blog/article using Claude, ChatGPT, and Jasper; compare quality and accuracy; create technical documentation using Copy.ai	CO1	2
2	Design zero-shot, few-shot, and chain-of-thought prompts; generate summaries and paraphrased outputs; experiment with tone adaptation and multilingual writing	CO1	2
3	Generate images using Midjourney, DALL-E, and Stable Diffusion; compare realism vs creativity; apply negative prompts and style keywords	CO2	2
4	Define a poster theme; generate visual elements using AI image tools; assemble poster using Canva; present final poster with prompt explanation	CO2	2
5	Set up GitHub Copilot/Cursor; build a simple app (to-do list, calculator, or API app); use AI for code generation; validate and test	CO3	2
6	Load buggy code into AI-assisted IDE; fix errors using AI suggestions; request optimization; generate inline comments and docstrings automatically	CO3	2
7	Use Perplexity AI for topic exploration; use Elicit to discover research papers; use NotebookLM to extract insights;	CO4	2
8	Perform manual literature review (30 min); repeat using AI tools; compare time, sources, depth, and accuracy; identify hallucinations; prepare comparison report	CO4	2
9	Generate Citation and annotated bibliography and cross-check citations	CO4	2
10	Build an automated workflow to generate AI-based content from form submissions.	CO5	2
11	Design an end-to-end workflow for AI-generated content delivery through email.	CO5	2
12	Create a complete automation pipeline	CO5	2

19.6 Assessment Methodologies and Tools

Lab Component

#	Assessment	How Many	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
1	Experiments	10	CAT	Practical / Experiments/Tutorials	Journal (Rubrics Based)	15	30	2 Hrs.
2	Presentation	1	CAT	Presentation	Rubrics Based	5	10	-
3	Class Participation		CAT	Attendance	Record Based	5	10	-
4	ESE	1	ESE	Oral and Practical	Rubrics based	25	50	2 Hrs.

Note:

1. CAT Activity will be part of Term Work.
2. The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.
3. Learners will perform minimum 10 experiment at least 1 experiment from each module.
4. Presentation topics strictly based on Application of Analysis of Algorithms in various domains.

19.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAVS242.1	3	2	2	3	2	-	3	-	-	-	-	3	3
CAVS242.2	2	2	3	3	3	2	2	-	-	-	-	3	3
CAVS242.3	3	3	3	3	2	-	3	-	-	-	-	3	3
CAVS242.4	3	3	2	3	2	2	3	-	-	-	-	3	3
CAVS242.5	2	3	3	3	3	3	3	-	-	-	-	3	3

19.8 Course to Knowledge and Attitude Profile (WK)

Mapping

#	WK#	WK Statement	Justification of Mapping
1	WK1	Theory based understanding of the natural science applicable to the discipline	Applies scientific principles of data processing and computational intelligence that form the basis of modern AI tools.
2	WK3	Theory based formulation of engineering fundamentals	The course develops engineering fundamentals through prompt design and automation workflows.
3	WK4	Engineering specialist Knowledge	AI-assisted development, research automation, and intelligent workflow systems.
4	WK6	Knowledge of engineering practice	Practical implementation of AI tools for solving real-world engineering and productivity challenges.

5	Wk9	Professional ethics and responsibilities	ethical awareness regarding responsible AI usage, privacy, plagiarism
----------	------------	--	---

19.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Prompt Engineering for Generative AI	-	James Phoenix, Mike Taylor	O'Reilly Media,	2024
T2	Generative AI for Software Developers	-	Saurabh Shrivastava et al.	Packt Publishing,	2025
T3	Generative AI: Techniques, Models and Applications	-	Rajan Gupta, Sanju Tiwari, Poonam Chaudhary	Springer	2025
T4	AI Tools for Everyone: Your Guide to Artificial Intelligence	-	Aditya Basu		2025
T5	AI Prompt Engineering Absolute Beginner's Guide	-	Michael Miller	Pearson	2025

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	Co-Intelligence: Living and Working with AI	-	Ethan Mollick	Portfolio/Penguin	2024
R2	Generative AI: How ChatGPT and Other AI Tools Will Revolutionize Business	-	Tom Taulli	Apress(ISBN: 978-1-484-29922-3)	2023
R3	Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play	2 nd	David Foster	O'Reilly Media ISBN: 978-1-098-13418-1	2019
R4	Modern Generative AI with ChatGPT and OpenAI Models	-	Valentina Alto	Packt Publishing ISBN: 978-1-805-12366-0	2023

Online Resources

SN	Title	Description
O1	https://docs.anthropic.com	Anthropic Claude documentation and prompt engineering guides
O2	https://www.promptingguide.ai	Comprehensive prompt engineering techniques guide
O3	https://platform.openai.com/docs	OpenAI API documentation for ChatGPT and DALL·E
O4	https://huggingface.co	Open-source AI models, datasets, and image generation spaces
O5	https://zapier.com/learn	Zapier learning hub for workflow automation tutorials
O6	https://docs.n8n.io	n8n workflow automation platform documentation

O7	https://elicit.com	AI research assistant for literature discovery and synthesis
O8	https://learnprompting.org	Free open-source course on prompt engineering

Chapter 20:

Subject- Mini Project (Sem IV)

Overview			
Course code:	CAPR241	Course Category:	PROJECT (PR)
Sem:	IV	Syllabus & Version:	SIGCE-NEP-R2025-Y2

20.1 Teaching & Learning Scheme

Components	Class room Instruction		Lab instructions		Team work/ Self learning	Total
	L	T	P	D	SL	
Hours/Week	-	-	2	-	-	2
Hours/Sem	-	-	15	-	15	30
Credits	-	-	1	-	-	1

* L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning

20.2 Examination Scheme

Component	CAT	ESE	TOTAL	CREDITS
Mini Project	50%	50%	100%	2

20.3 Course Objectives

Pre-requisites.	Students should possess fundamental knowledge of engineering sciences, discipline-specific core subjects, problem-solving techniques, programming/tools relevant to the domain, and basic communication and teamwork skills to undertake a mini project successfully.
Course Overview: The Mini Project course provides students with hands-on experience in solving real-world engineering problems by applying technical knowledge and engineering principles. It promotes innovation, teamwork, problem-solving, project planning, and communication skills. Students design, develop, test, and present solutions while gaining practical exposure to modern engineering tools and practices.	
Course Objectives: 1. To familiarize oneself with the process of recognizing demands and transforming them into a problem. 2. To acclimate to the process of collaboratively resolving the issue. 3. To familiarize oneself with the use of fundamental engineering principles in addressing challenges. 4. To instill the practice of self-directed learning and inquiry	

20.4 Course Outcomes

Course Outcomes (CO): At the End of the course students will be able to		
CO #	CO Detail	Bloom's level
CAPR241.1	Recognize issues stemming from social or research demands and utilize knowledge and skills to address these difficulties together.	Understand (L2)
CAPR241.2	Build interpersonal skills to function effectively as a group member or leader, and derive appropriate conclusions from available data using theoretical, experimental, or simulation methods.	Apply (L3)
CAPR241.3	Evaluate the effects of solutions within the societal and environmental frameworks for sustainable development.	Evaluate (L5)
CAPR241.4	Employ established engineering standards and excel in both written and verbal communication.	Analyze (L4)
CAPR241.5	Demonstrate self-directed learning ability within a group, fostering lifelong education.	Apply (L3)
CAPR241.6	Present exemplary project management concepts during project execution.	Apply (L3)

20.5 Modules / Syllabus Content

Laboratory Component (Suggested List of Experiments)

SN	Title of the Activity	CO	Hrs
1	Conduct surveys and identify needs. These needs will be transformed into a problem statement for mini projects. comprehend problems, propose multiple solutions, and select the most suitable solution in consultation with their guide or supervisor.	CO1	5
2	Submission Short Description of Mini project and implementation plan in the form of a Gantt/PERT/CPM chart that outlines the weekly activities of the mini project	CO2	5
3	Transform the optimal solution into a functional model by utilizing a variety of components from their respective domains and presenting it. Acquiring components/systems, creating a functioning prototype, and validating outcomes and Mid-term review	CO3	5
4	Evaluation /Troubleshooting /testing of the readiness of a functional prototype	CO4	5
5	Validation of the solution with appropriate justification and compilation of a Project report	CO5	5
6	Final review and presentation of the prototype implemented and submission of Project report and logbook	CO6	5

20.6 Assessment Methodologies and Tools

Lab Component

SN	Assessment	Nos	Category	Assessment Instrument	Assessment Method	Marks	% Wt	Duration
01	Activities	1-6	CAT	Group Discussion/ Presentation/ Project Based Activity	Synopsis / Project Report (Rubrics Based)	15	30	-
03	Logbook	01	CAT	Rubrics based	Rubrics based	5	10	-
04	Classroom Participation	-	CAT	Attendance	Record based	5	10	-
05	Oral/ Viva	01	ESE	Oral/ Presentation	Rubrics based	25	50	-

20.7 Suggested CO-PO/PSO Correlation Matrix

CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAPR241.1	-	-	-	-	2	-	-	-	2	2	2	2	-
CAPR241.1	-	-	2	2	3	-	-	2	2	2	2	2	-
CAPR241.1	-	-	2	2	3	-	-	2	2	2	2	2	2
CAPR241.1	-	-	2	-	2	-	-	3	2	2	3	2	3
CAPR241.1	-	-	2	3	3	-	-	2	3	3	3	2	3
CAPR241.1	-	-	2	2	2	-	-	2	2	3	3	2	3

20.8 Course to Knowledge and Attitude Profile (WK) Mapping

PO#	WK	WK Statement	Justification of Mapping
PO3	WK5	Engineering design practice for solving complex engineering problems.	Students design and develop systems, software, models, prototypes, or processes to meet specified requirements
PO5, PO10	WK6	Engineering practice is supported by technology, techniques, resources, and modern engineering tools.	Students utilize software tools, programming platforms, simulation packages, laboratory equipment, and project management tools.
PO4.PO11	WK8	Research literature, investigation methods, experimentation, data analysis, and interpretation.	Students conduct experiments, surveys, simulations, testing, validation, and performance evaluation of developed solutions

PO9, PO10, PO11	WK9	Ethics, professionalism, communication, teamwork, project management, and lifelong learning.	Students work effectively as individuals and team members, sharing responsibilities and achieving project objectives
--------------------------------	-----	--	--

20.9 Resources

Textbooks

SN	Title	Edition	Authors	Publisher	Year
T1	Project Management for Engineering, Business and Technology	6th Edition	John M. Nicholas, Herman Steyn	Routledge	2020
T2	Engineering Design: A Project-Based Introduction	5th Edition	Clive L. Dym, Patrick Little, Elizabeth J. Orwin, R. E. Spjut	Wiley	2019

Reference Books

SN	Title	Edition	Authors	Publisher	Year
R1	The Design of Everyday Things	Revised & Expanded Edition	Don Norman	Basic Books	2013
R2	Successful Project Management	7th Edition	Jack Gido, Joseph Clements, James Cogswell	Cengage Learning	2021

Online Resources

SN	Title	Description
O1	NPTEL – Project Management for Engineers	Comprehensive online courses covering project planning, scheduling, resource allocation, risk management, teamwork, and project execution in engineering applications.
O2	IEEE Xplore Digital Library	Online repository of research papers, technical articles, standards, and project ideas that help students conduct literature surveys and develop innovative engineering project

20.10 General Guidelines for Mini Project

1. Students are required to create a group of three to four students. It is prohibited to form a group with fewer than three or more than four students, as this is a group activity.
2. In consultation with the faculty supervisor, Head of department, or internal committee of faculties, students should conduct surveys and identify needs. These needs will be transformed into a problem statement for micro projects.
3. Students are required to submit an implementation plan in the form of a Gantt/PERT/CPM chart that outlines the weekly activities of the micro project.
4. Each group is required to create a logbook in which they can document their weekly work progress, and the guide/supervisor can corroborate and record any notes or comments.
5. While faculty supervisors may provide students with feedback during the micro project activity, the primary objective is to encourage self-directed learning.
6. Students in a group should be able to effectively comprehend problems, propose multiple solutions, and select the most suitable solution in consultation with their guide or supervisor.
7. Students are required to transform the optimal solution into a functional model by utilizing a variety of components from their respective domains and presenting it.
8. Validation of the solution with appropriate justification and compilation of a report in the standard format provided by Dept.
9. Given the emphasis on self-learning, innovation, addressing societal issues, and the development of entrepreneurship quality within the students through the Mini Projects, it is advisable for all student groups to implement a single project of a suitable quality over the course of two semesters. i.e. Mini Project 1 in semesters III/IV and Mini Project 2 in semesters V/VI.
10. Nevertheless, providing that the proposed Mini Project adheres to the qualitative aspects mentioned above and is completed in the odd semester, the group may be permitted to work on the extension of the Mini Project with appropriate improvements/modifications or a completely new project idea in the even semester, based on the individual students or group capability and the mentor's recommendations. This policy may be implemented on an individual basis.

20.11 Mini Project Assessment Criteria

Mini Project will be evaluated based on the following criteria:

- a. Survey quality and need identification.

- b. Clearly define the problem based on necessity.
- c. Innovative solutions.
- d. Assessing the feasibility of offered issue solutions and selecting the best answer.
- e. Cost effectiveness.
- f. Social effects.
- g. Innovativeness.
- h. Cost-effectiveness and social impact.
- i. The functional model fully meets the given requirements.
- j. Effectively applying skill sets.
- k. Effective use of engineering standards.
- l. Individual contributions as members or leaders.
- m. Clear written and verbal communication.

20.12 Recommended Self Learning Resources for AIML Mini Project

SN	Resource	Description
1	Kaggle Learn	Hands-on tutorials, datasets, notebooks, and competitions for AI, ML, and Data Science projects.
2	Google Colab	Cloud-based Python environment for developing and testing AI and ML models without local installation.
3	TensorFlow Documentation	Official tutorials and guides for building deep learning applications.
4	Scikit-Learn Documentation	Comprehensive resource for implementing machine learning algorithms and evaluation techniques.
5	GitHub Open-Source Projects	Repository of AI and Data Science projects for learning implementation and best practices.

20.13 Recommended Courses for Mini Project

1. Python for Data Science
2. Machine Learning
3. Data Analytics with Python
4. Deep Learning
5. Natural Language Processing
6. Design Thinking and Innovation