SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Item No: 4.B.4
A.C. Date:

Autonomy Syllabus Scheme III (2023-24)

(As per NEP 2020 Guidelines)

for

Four Year Multidisciplinary

Bachelors of Technology (B.Tech.)

Artificial Intelligence and Data Science

with

Multiple Entry and Multiple Exit Options

Levels 4.5 - 6

(First Year Effective from A.Y. 2023-24,
Second Year Effective from A.Y. 2024-25,
Third Year Effective from A.Y. 2025-26,
Last Year Effective from A.Y. 2026-27)

From the Principal's Desk:

To address the changing demands of the digital era, it is required to create a future-ready workforce that can navigate the complexities of an interconnected world, drive innovation, and contribute to the nation's growth. The **National Educational Policy 2020 (NEP 2020)** framed by the Government of India recommends a holistic, inclusive, and flexible approach to ensure equitable access to quality education across all levels, promote multidisciplinary research, and impart skill-based education with integration of technology. As per guidelines by the Department of Higher and Technical Education, Government of Maharashtra, the salient features of NEP 2020 aligned curriculum should include:

- Major (Core) Mandatory and Elective Courses
- Open Elective Courses
- Vocational and Skill Enhancement Courses
- Ability Enhancement Courses, Indian Knowledge System, and Value Education Courses
- Co-curricular Courses and Field Projects / Community Engagement Projects / Internship
- Multidisciplinary Minor Courses
- Option for Bachelor's Degree with Honours (based on Additional Credits)
- Option for Bachelor's Degree – Honours with Research (based on Additional Credits)
- Option for Bachelor's Degree with Double Minors (based on Additional Credits)
- Multiple Entry and Multiple Exit Options

Being an **autonomous institute** since the Academic Year 2021-22, **K. J. Somaiya Institute of Technology (KJSIT)**, has well-adapted newer approaches to reach higher levels of excellence in engineering education. Ahead of its time, the academic reforms at KJSIT have already addressed majority of these NEP 2020 aspects through its existing **Syllabus Scheme I, II, and II B** implemented under the academic autonomy. For a complete alignment with NEP 2020, the **KJSIT Autonomy Syllabus Scheme III** is introduced, to be effective from Academic Year 2023-24 across all the branches, progressively from First Year Engineering.

Specifically, the existing curriculum already comprise state-of-the-art **Major (Core) courses** in theory and practical. With an ideology that the root of innovation is 'interest', the curriculum offers wide range of Elective courses — grouped into **Major-related Electives** and **Inter-disciplinary / Open Electives**. At par with international engineering education, it follows a learner-centric approach as well as promotes MOOCs, where the students can choose to study courses concerning areas of their interests, and the same is continued in Scheme III.

Further, under the theme of "Learning by Doing", the existing curriculum includes Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses — that assure X factor in all the students of the institute. The SAT courses are practiced across the first three years of engineering, focusing on responsibilities towards society, problem-solving abilities, communication skills, ethics, leadership and teamwork, motivation for life-long learning, skills on emerging areas of technology, skills on different languages, etc. In the Syllabus Scheme III, these SAT courses are now aligned and offered as **Vocational Skill - SAT (VS - SAT) courses**, **Skill Enhancement - SAT (SE - SAT) courses**, **Ability Enhancement - SAT (AE - SAT) courses**, and **Value Education - SAT (VE - SAT) courses**.

Further, **Indian Knowledge System - SAT (IKS - SAT) course** is newly introduced in Scheme III that emphasizes on drawing insights from ancient wisdom to address modern challenges. Also, as an extension to the induction program for the First Year students, the introduced **Co-curricular - SAT (CC - SAT) course** aims to induct incumbents with the institutional practices, culture, and values, as well as encourage participation in co-curricular activities.

The component of **Project-Based Learning (PBL)** included in the Syllabus Scheme II is carried forward to Scheme III, wherein the students develop **Community Engagement / Field Projects** in Second, Third, and Last Year as Mini, Minor, and Major Projects respectively. Scheme III also retains the **Internship** component, offered with credits, to equip graduates with the industry trends, practices, and skills required at national and global level. The duality of PBL and Internship enables student involvement in research, innovation, and entrepreneurship, which are the fulcrums of higher education.

As a new introduction in line with NEP 2020, the Syllabus Scheme III incorporates mandatory **Multidisciplinary Minor courses** in Innovation and Entrepreneurship, Biotechnology, IoT and Cloud Computing, Geographical Information System, Very Large Scale Integration (VLSI) and Artificial Intelligence. These courses promote interdisciplinary thinking and broaden the career prospects, enabling students to develop solutions to real-world problems by combining expertise from multiple domains.

Aligned with NEP 2020, the Scheme III retains the initiative taken through Scheme II / II B of offering **Honours courses** for students who are desirous of pursuing focused interest in 06 emerging areas of technology recognized by AICTE: Internet of Things, Artificial Intelligence & Machine Learning, Cyber Security, Virtual and Augmented Reality, Data Science, and Blockchain. These Honours courses correspond to high-end industry standards and offer multi-fold opportunities of specialization.

As per NEP 2020, the above curricular aspects of Four Years UG Engineering Programme shall be offered with **Multiple Entry and Multiple Exit options**, leading to the conferment of:

- **One Year UG Certificate in Technology:** Awarded after completing First Year of Engineering and acquiring additional 08 credits immediately after First Year.
- **Two Years UG Diploma in Technology:** Awarded after completing Second Year of Engineering and acquiring additional 08 credits immediately after Second Year.
- **Three Years Bachelor's Degree in Vocation (B.Voc.):** Awarded after completing Third Year of Engineering and acquiring additional 08 credits immediately after Third Year.
- **Four Years Bachelor's Degree in Technology (B.Tech.) with Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through Honours courses in respective major discipline over Third & Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Research and Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through a research project in respective major discipline during Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) with Double Minors (Multidisciplinary & Specialization):** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through additional courses in another Engg. / Tech. discipline during Second to Fourth Year of Engineering.

Through the implementation of Autonomy Syllabus Scheme III (as per NEP 2020 Guidelines), strategic planning, and joint efforts of all stakeholders, KJSIT is endeavouring to enhance the quality of engineering education and set a benchmark for all the autonomous institutes nationwide.

Dr. Vivek Sunnapwar
Principal and Chairman - Academic Council

Preface by Board of Studies in Artificial Intelligence and Data Science:

We, the members of Board of Studies of B. Tech in Artificial Intelligence and Data Science (AI-DS) are very happy to present Autonomy Syllabus Scheme-III of Second Year Semester III of B. Tech in Artificial Intelligence with effect from the Academic Year 2024-25. We are assured that you will discover this syllabus interesting and challenging, we have implemented The National Educational Policy 2020 (NEP 2020) framed by the Government of India. As per guidelines by the Department of Higher and Technical Education, Government of Maharashtra, additionally comparing to Autonomy Scheme-I, II and II-B, we have introduced Multidisciplinary Minor Courses, Option for Bachelor's Degree with Honours, Honours with Research, Bachelor's Degree with Double Minors and Multiple Entry and Multiple Exit Options based on additional credits. Further, Indian Knowledge System - SAT (IKS - SAT) course is newly introduced in Scheme III that emphasizes on drawing insights from ancient wisdom to address modern challenges. Scheme III also have the Internship component for a complete semester, offered with credits, to equip graduates with the industry trends, practices, and skills required at national and global level.

The mandatory Multidisciplinary Minor courses such as Innovation and Entrepreneurship, Biotechnology, IoT and Cloud Computing, Geographical Information System, Very Large Scale Integration (VLSI) and Artificial Intelligence introduced for minor degree.

Under Multiple entry and multiple exit options, students awarding One Year UG Certificate in Technology after completing First Year of Engineering and acquiring additional 08 credits immediately after First Year, Two Years UG Diploma in Technology after completing Second Year of Engineering and acquiring additional 08 credits immediately after Second Year, Three Years Bachelor's Degree in Vocation (B.Voc.) after completing Third Year of Engineering and acquiring additional 08 credits immediately after Third Year, Four Years Bachelor's Degree in Technology (B.Tech.) with Multidisciplinary Minor after completing Fourth Year of Engineering. Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Multidisciplinary Minor after completing Fourth Year of Engineering and acquiring additional 18 credits through Honours courses in respective major discipline over Third & Fourth Year of Engineering, Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Research and Multidisciplinary Minor after completing Fourth Year of Engineering and acquiring additional 18 credits through a research project in respective major discipline during Fourth Year of Engineering and Four Years Bachelor's Degree in Technology (B.Tech.) with Double Minors (Multidisciplinary & Specialization) after completing Fourth Year of Engineering and acquiring additional 18 credits through additional courses in another Engg. / Tech. discipline during Second to Fourth Year of Engineering.

In this course, the students may have career opportunities in healthcare, business, e-Commerce, social networking companies, biotechnology, genetics and other areas. We have mapped course outcomes, PBL outcomes, Skills outcomes, Activity outcomes and TBL outcomes module wise throughout the syllabus. Faculty in this program adopted collaborative, co-operative and online teaching learning techniques during coverage of the course; this will help students to understand each course in depth. The designed syllabus promises to achieve the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

We would like to show our appreciation to the faculties, students, industry experts and stakeholders assisting us in the design of this syllabus.

Board of Studies in Artificial Intelligence and Data Science are,

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. Milind U. Nemade	Head of the Department concerned (Chairman)	10	Prof. Sejal Shah	Member
2	Dr. Michel Mistry	Experts from outside parent university nominated by Academic council	11	Prof. G. R. Phadke	Member
3	Dr. Sanjay Shitole		12	Prof. Sarika Mane	Member

4	Dr. Madhav Chandane	One expert to be nominated by the Vice-Chancellor	13	Prof. Sheetal Jagtap	Member
5	Mr. Akhil Hada	One Representative from Industry /Corporate Sector/ Allied area relating to Placement	14	Prof. Devanand Bathe	Member
6	Dr. Vaishali Wadhe	Member	15	Prof. Ganesh Wadmare	Member
7	Prof. Pankaj Deshmukh	Member	16	Dr. Radhika Kotecha	Other member
8	Prof. Medha Asurlekar	Member	17	Dr. Namrata Gharat	Other member
9	Prof. Vidya Sagvekar	Member	18	Dr. Hariram Chavan	Other Member

Dr. Milind Nemade

HoD and Chairman, Board of Studies

Nomenclature and Alignment of Verticals and Components

Verticals as per NEP 2020 Guidelines	Components Aligning with KJSIT Autonomy Syllabus Scheme I / II / II B	Nomenclature for KJSIT Autonomy Syllabus Scheme III Aligned with NEP 2020 Guidelines
Basic and Engineering Science Courses	Basic Science (BS) Course	Basic Science (BS) Courses
	Engineering Science (ES) Course	Engineering Science (ES) Courses
Major Courses	Professional Core (PC) Courses	Major / Professional Core (PC) Courses
	Professional Elective - Department-level (PE-DLC) Courses	Major / Professional Elective - Department-level (PE-DLC) Courses
Generic / Open Elective Courses	Open Elective - Institute-level (OE-ILC) Courses	Open Elective - Institute-level (OE-ILC) Courses
Multidisciplinary Minor Courses	-	Multidisciplinary Minor (MM) Courses
Vocational Skill Courses	Workshop I; Workshop II; SAT Courses – TBL	Vocational Skill - SAT (VS-SAT) Courses
Skill Enhancement Courses	SAT Courses – SBL (Program Specific)	Skill Enhancement - SAT (SE-SAT) Courses
Ability Enhancement Courses	Professional Communication Skills; SAT Course – SBL (Foreign and/or Indian Modern Languages)	Ability Enhancement - SAT (AE - SAT) Courses
Indian Knowledge System Courses	-	Indian Knowledge System - SAT (IKS - SAT) Courses
Value Education Courses	SAT Course – ABL (National, Global, Societal and Environmental Aspects); Business Communication & Ethics	Value Education - SAT (VE - SAT) Courses
Field Projects / Community Engagement Projects	PBL – Mini, Minor, Major	Community Engagement – Project-Based Learning (PBL)
Internship / Apprenticeship	Internship	Internship (INT)
Co-curricular Courses	Student Induction Program	Co-curricular - SAT (CC - SAT) Courses

Other Abbreviations:

- SAT – Skill/Activity/Technology-Based Learning (Exposure Courses)
- TH – Theory
- P – Practical
- TUT – Tutorial
- T1 – Test 1
- T2 – Test 2
- CA – Continuous Assessment Test (T = T1 + T2)
- ESE – End Semester Exam
- TW – Term Work
- O – Oral Exam
- P – Practical Exam
- P&O – Practical & Oral Exam

Programs Offered with Multiple Entry Multiple Exit Options

Level 4.5: UG Certificate in Technology

Disciplines:	• Information Technology • Computer Engineering • Artificial Intelligence & Data Science • Electronics and Telecommunication
Years of Study:	01 Year
Semesters:	1 and 2
Credits:	42
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 1st Year

Level 5: UG Diploma in Technology

Disciplines:	• Information Technology • Computer Engineering • Artificial Intelligence & Data Science • Electronics and Telecommunication
Years of Study:	02 Years
Semesters:	1, 2, 3, 4
Credits:	85
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 2nd Year

Level 5.5: Bachelor's Degree in Vocation (B. Voc.)

Disciplines:	• Information Technology • Computer Engineering • Artificial Intelligence & Data Science • Electronics and Telecommunication
Years of Study:	03 Years
Semesters:	1, 2, 3, 4, 5, 6
Credits:	130
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 3rd Year

Level 6: B.Tech. in Technology with Multidisciplinary Minor

<table>
<tr><td>Major Disciplines with Offered Multidisciplinary Minors:</td><td>
<table>
<tr><th>Minor / Major</th><th>Innovation and Entrepreneurship</th><th>Biotechnology</th><th>IoT and Cloud Computing</th><th>Geographical Information System</th><th>VLSI</th></tr>
<tr><td>Information Technology</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Computer Engineering</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Artificial Intelligence & Data Science</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Electronics & Telecommunication</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
</table>
</td></tr>
<tr><td>Years of Study:</td><td>04 Years</td></tr>
<tr><td>Semesters:</td><td>Major – 1, 2, 3, 4, 5, 6, 7, 8
Multidisciplinary Minors – 4, 5, 6</td></tr>
<tr><td>Credits:</td><td>174</td></tr>
</table>

Level 6: B.Tech. in Technology - Honors and Multidisciplinary Minor

<table>
<tr><td>Major Disciplines with Offered Honors and Multidisciplinary Minors:</td><td>
<table>
<tr><th>Honors / Major</th><th>Internet of Things*</th><th>Artificial Intelligence & Machine Learning</th><th>Cyber Security</th><th>Virtual and Augmented Reality</th><th>Data Science</th><th>Blockchain</th></tr>
<tr><td>Information Technology</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Computer Engineering</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Artificial Intelligence & Data Science</td><td>√</td><td></td><td>√</td><td>√</td><td></td><td>√</td></tr>
<tr><td>Electronics and Telecommunication</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
</table>
<table>
<tr><th>Minor / Major</th><th>Innovation and Entrepreneurship</th><th>Biotechnology</th><th>IoT and Cloud Computing*</th><th>Geographical Information System</th><th>VLSI</th></tr>
<tr><td>Information Technology</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Computer Engineering</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Artificial Intelligence & Data Science</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Electronics & Telecommunication</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
</table>
* Can be chosen for either Honors or Minors, not both
</td></tr>
<tr><td>Years of Study:</td><td>04 Years</td></tr>
<tr><td>Semesters:</td><td>Major – 1, 2, 3, 4, 5, 6, 7, 8
Multidisciplinary Minors – 4, 5, 6
Honors – 5, 6, 7, 8</td></tr>
<tr><td>Credits:</td><td>192 (= Major with Multidisciplinary Minors: 174 + Honors: 18)</td></tr>
</table>

Level 6: B.Tech. in Technology - Honors with Research and Multidisciplinary Minor

Major Disciplines with Offered Honors and Multidisciplinary Minors:

Major	Honors with Research
Information Technology	√
Computer Engineering	√
Artificial Intelligence & Data Science	√
Electronics and Telecommunication	√

Major \ Minor	Innovation and Entrepreneurship	Biotechnology	IoT and Cloud Computing*	Geographical Information System	VLSI
Information Technology	√	√	√	√	√
Computer Engineering	√	√	√	√	√
Artificial Intelligence & Data Science	√	√	√	√	√
Electronics & Telecommunication	√	√	√	√	√

Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Honors with Research** – 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Honors with Research: 18)

Level 6: B.Tech. in Technology with Double Minors (Multidisciplinary & Specialization)

Major Disciplines with Multidisciplinary Minors and Specialization Minors:

Multidisciplinary Minors:

Major \ Minor	Innovation and Entrepreneurship	Biotechnology	IoT and Cloud Computing*	Geographical Information System	VLSI
Information Technology	√	√	√	√	√
Computer Engineering	√	√	√	√	√
Artificial Intelligence & Data Science	√	√	√	√	√
Electronics & Telecommunication	√	√	√	√	√

Specialization Minors:

06 additional courses (of minimum 12 week each), in another Engg. / Tech. discipline / Emerging Areas through MOOC – SWAYAM

Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Specialization Minors** – 3, 4, 5, 6, 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Specialization Minors: 18)

Credit Distribution Structure for Four Year Multidisciplinary B.Tech. Degree Program with Multiple Entry Multiple Exit Options

Level	Semester	Faculty: Science and Technology					Faculty: Any	Vocational Skills (VS) & Skill Enhancement (SE) Courses		Ability Enhancement (AE), Indian Knowledge System (IKS), Value Education (VE) Courses			Field Projects / Community Engagement (CE) Projects, Internship (INT), and Co-curricular (CC) Courses			Credits	Cumulative Credits
		Basic Science (BS) Courses	Engineering Science (ES) Courses	Major / Professional Core (PC) Courses	Major / Professional Elective - Department-level (PE-DLC) Courses	Multi-disciplinary Minor (MM) Courses	Open Elective - Institute-level (OE-ILC) Courses	VS - SAT Courses	SE - SAT Courses	AE - SAT Courses	IKS - SAT Courses	VE - SAT Courses	CE - Project-Based Learning (PBL)	INT	CC - SAT Courses		
Level 4.5	I	9	8					1				1			2	21	42
	II	9	8					1		2	1					21	
Exit Option with UG Certificate in Technology with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 5.0	III	4		15					1				1			21	85
	IV	4		11		4			1	1			1			22	
Exit Option with UG Diploma in Technology with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 5.5	V			11	4	3			1			2	1			22	130
	VI			8	4	3	3	2					3			23	
Exit Option with Bachelor's Degree in Vocation (B. Voc.) with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 6.0	VII			8	7		3						6			24	174
	VIII			8										12		20	
Total		**26**	**16**	**61**	**15**	**10**	**6**	**4**	**3**	**3**	**1**	**3**	**12**	**12**	**2**	**174**	

SEMESTER V

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
AIC501	Machine Learning	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC502	Data Warehousing and Mining	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC503	Information Theory and Coding	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIDLC50X	(Major / Professional Elective-Department Level Course-I)	3 – 0 – 0	03	3 – 0 – 0	03	PC-DLC
MMC505	(Multidisciplinary Minor Course-III)	3 – 0 – 0	03	3 – 0 – 0	03	MM
MML505	(Multidisciplinary Minor Course Lab II)	0 – 2 – 0	02	0 – 1 – 0	01	MM
AIL501	Machine Learning Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL502	Data Warehousing and Mining Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIDLL50X	(Major / Professional Elective-Department Level Course-I)	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
AIPR53	Project Based Learning - Minor Project-I	0 – 2 - 0	02[$]	0 – 1 – 0	01	PBL
AIXS511	Aptitude/ Logic building and Competitive Engg. [Skill Enhancement- SAT XI Skill Based Learning	0 – 2* – 0	02[$]	0 – 1 – 0	01	SE-SAT
AIXA512	SAT XII: Activity Based Learning (Business Communication and Ethics)	0 – 4** – 0	04[$]	0 – 2 – 0	02	AE-SAT
Total		**15 – 16 – 0**	**31**	**15 – 8 – 0**	**23**	

*SAT can be conducted as TH or P or both as required.
[$]Load of learner, not the faculty. **02 Hours class-wise and 02 Hours batch-wise.

Professional Electives - Department Level Elective Courses and Labs (PE-DLC – I)

Group A:	Group B:	Group C:	Group D:
(AIDLC5041)	(AIDLC5042)	(AIDLC5043)	(AIDLC5044)
AI in Computer Networks	Image and Video Processing	Embedded System and Design	AI for Bioinformatics
(AIDLL5041)	(AIDLL5042)	(AIDLL5043)	(AIDLL5044)
AI in Computer Networks Lab	Image and Video Processing Lab	Embedded System and Design Lab	AI for Bioinformatics Lab

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P&O	
AIC501	Machine Learning	20	20	40	60	2.5	25	-	-	-	100
AIC502	Data Warehousing and Mining	20	20	40	60	2.5	-	-	-	-	100
AIC503	Information Theory and Coding	20	20	40	60	2.5	-	-	-	-	100
AIDLC50X	(Major / Professional Elective-Department Level Course-I)	20	20	40	60	2.5	-	-	-	-	100
MMC505	(Multidisciplinary Minor Course-III)	20	20	40	60	2.5	-	-	-	-	100
MML505	(Multidisciplinary Minor Course Lab II)	-	-	-	-	-	25	-	-	-	25
AIL501	Machine Learning Lab	-	-	-	-	-	25	-	-	25	50
AIL502	Data Warehousing and Mining Lab	-	-	-	-	-	25	-	-	25	50
AIDLL50X	(Major / Professional Elective-Department Level Course-I)						25	-	-	-	25
AIPR53	Project Based Learning - Minor Project-I						25	-	-	25	50
AIXS511	Aptitude/ Logic building and Competitive Engg. [Skill Enhancement- SAT XI Skill Based Learning	-	-	-	-	-	25	-	-	-	25
AIXS512	SAT XII: Activity Based Learning (Business Communication and Ethics)	-	-	-	-	-	25	25	-	-	25
Total		**100**	**100**	**200**	**300**	**-**	**175**	**25**	**-**	**75**	**775**

Honors with Research

Semester	Course Code	Course Name	Credits
VII	HRC701	Research-based Learning – Project A	8
VIII	HRC801	Research-based Learning – Project B with Dissertation Report	10
Total			18

General Guidelines for Semester VII:

- Students should pursue an online course on Research Methodology offered through the SWAYAM or other platform.
- Students should select a research topic that aligns with their interests, academic goals, and the availability of resources. Students are required to define the objectives and goals of your research project.
- Students should conduct a comprehensive literature review to understand the existing knowledge and research related to their topic. Accordingly, gaps or areas that require further investigation should be identified.
- Students should create a detailed research plan outlining the methodologies, experiments, data collection methods, and analysis techniques that they shall employ with ethical considerations.
- It is expected that the students complete 40% implementation of research in this semester.
- Evaluation of research shall be done through 03 presentations (viva-voce) during the entire semester.

General Guidelines for Semester VIII:

- Students are required to complete the remaining implementation of research, as carried forward from Semester VII.
- Students should analyze their findings and present them in a clear and concise manner. It is expected to discuss the implications of results and compare them with existing research. The research outcome should be interpreted in light of your research questions and objectives.
- Students should prepare a comprehensive research report that includes an introduction, literature review, methodology, results, discussion, and conclusion.
- Students should consider publishing their work in a suitable academic journal to contribute to the scholarly community or present the research findings to peers, faculty, and potentially at conferences or symposiums.
- Evaluation of research shall be done through 03 presentations (viva-voce) during the entire semester and the dissertation report submitted.

Baskets for Verticals – All Programs

Basic Science (BS) Courses Basket
Engineering Mathematics I
Engineering Physics
Engineering Chemistry
Engineering Mathematics II
Physics and Nanotechnology
Materials Chemistry
Applications of Mathematics in Engineering – I
Applications of Mathematics in Engineering – II

Engineering Science (ES) Courses Basket
Engineering Mechanics
Basics of Electrical Engineering
Engineering Graphics
Computer Programming

Open Elective - Institute-level (OE-ILC) Courses Basket	
Product Lifecycle Management	Project Management
Reliability Engineering	Finance Management
Management Information System	Entrepreneurship Development and Management
Design of Experiments	Human Resource Management
Operations Research	Professional Ethics and CSR
Cyber Security and Laws	Research Methodology
Disaster Management & Mitigation Measures	IPR and Patenting
Energy Audit and Management	Digital Business Management
Development Engineering	Environmental Management

Multidisciplinary Minor (MM) Courses Basket					
MM1: Innovation and Entrepreneurship Basket	**MM2: Biotechnology Basket**	**MM3: IoT and Cloud Computing Basket**	**MM4: Geographical Information System Basket**	**MM5: Very-Large-Scale Integration (VLSI) Basket**	**MM6: Artificial Intelligence (AI) Basket**
MMIEC405 Design Thinking and Ideation **MMIEL405** Design Thinking and Ideation Lab	**MMBTC405** Introduction to Biotechnology & Bioinformatics **MMBTL405** Bio-Informatics Lab	**MMICCC405** Foundations of IoT **MMICCL405** Internet of Things Lab	**MMGISC405** Spatial Computing Technologies **MMGISL405** Geographical Information System (GIS)	**MMVLSIC405** Digital System Design **MMVLSIL405** Digital System Design Lab	**MMAI405** Fundamentals of Data Science **MMAIL405** Fundamentals of Data Science

MMIEC505 Business Model Development and Prototyping	**MMBTC505** Genetic Engineering & Omics	**MMICCC505** Cloud Computing for IoT	**MMGISC505** Remote Sensing and Technology	**MMVLSIC505** Analog and mixed-signal IP Design	**MMAIC505** Machine Learning
MMIEC604 Strategic Management and IPR for Start-ups	**MMBTC604** Industrial Biotechnology	**MMICCC604** Advanced IoT & Capstone Project	**MMGISC604** Geomatics	**MMVLSIC604** VLSI for Digital Signal Processing	**MMAIC604** Artificial Intelligence

Vocational and Skill Enhancement Courses	
Vocational Skill - SAT Course (VS-SAT) Basket	**Skill Enhancement - SAT Course (SE-SAT) Basket**
Skill-Based Learning - Workshop I (Fitting, Electro-mechanical Work, Carpentry)	Skill-Based Learning - *Major Specific*
Skill-Based Learning - Workshop II (Computer Hardware, Networking, Electrical Work)	Skill-Based Learning - Aptitude / Logic Building & Competitive Programming
Technology-Based Learning - *Major Specific*	

Ability Enhancement, Indian Knowledge System, Value Education Courses		
Ability Enhancement – SAT Course (AE - SAT) Basket	**Indian Knowledge System - SAT Course (IKS - SAT) Basket**	**Value Education – SAT Course (VE - SAT) Basket**
Skill-Based Learning – Professional Communication Skills	Activity-Based Learning – Topics of Interest from IKS	Activity-Based Learning – National, Global, Societal and Environmental Aspects
Skill-Based Learning – Foreign and/or Indian Modern Languages		Activity-Based Learning – Business Communication & Ethics

Community Engagement Project and Co-curricular Courses	
Community Engagement – Project-Based Learning (PBL) Basket	**Induction and Co-curricular – SAT Course (CC - SAT) Basket**
Mini Project I	Universal Human Values
Mini Project II	Proficiency Modules
Minor Project	Yoga and Meditation
Innovation-Based - Major Project A	Creative Arts, Cultural and Literary Activities
Innovation-Based - Major Project B	NSS Activities
	Sports

Multiple Exit Courses*		
UG Certificate Exit Basket (04 Credits Each)	**UG Diploma Exit Basket (04 Credits Each)**	**Bachelor's in Vocation Exit Basket (04 Credits Each)**
1.Flutter App Development Course with Dart (2 credits)	1.Full Stack Developer Course (SQL, HTML, CCS, JavaScript, React, Redux, Node, Express, MongoDB, GIT (2 Credits)	1. Generative AI course (2 credits)
2.Python Programming (2 credits)	2.Software Testing (2 credits)	2. Conversational AI and NLP using JavaScript (2 credits)
3.Digital Marketing (2 credits)	3.AWS Artificial Intelligence (2 credits)	3. Tableau and Power BI Certification (2 credits)
4.Network Administration (2 credits)	4.AR/VR Certification (2 credits)	4. AI with DevOps Course (2 credits)
Internship of 4 weeks (4 credits)	Internship of 4 weeks (4 credits)	Internship of 4 weeks (4 credits)
OR 06-08 Week Internship		

**To pursue 02 Courses of 04 Credits each OR 01 course of 04 Credits and 04 Week's Internship of 04 Credits OR 06-08 Week's Internship of 08 Credits.*

Baskets for Honors Courses

Honors Domain 1: Artificial Intelligence and Machine Learning Basket
Mathematics for AI & ML
Game Theory using AI & ML
AI & ML in Healthcare
Text, Web and Social Media Analytics

Honors Domain 2: Blockchain Basket
Bit Coins and Crypto Currency
Blockchain Platform
Blockchain Development
Decentralized Finance (DeFi)

Honors Domain 3: Cyber Security Basket
Ethical Hacking
Digital Forensic
Security Information Management
Application Security

Honors Domain 4: Data Science Basket
Mathematics for Data Science
Statistical Learning for Data Science
Data Science for Health and Social Care
Text, Web and Social Media Analytics

Honors Domain 5: Augmented and Virtual Reality Basket
Virtual Reality
AR and Mix Reality
ARVR Application
Game Development with VR

Honors Domain 6: Internet of Things Basket
IoT Sensor Technologies
IoT System Design
Dynamic Paradigm in IoT
Industrial IoT

**** Some Major / Minor / SAT / Honors Courses will be offered as learning from MOOCs.***

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Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC501	Machine Learning	03	0	0	03
Prerequisites:	1. Linear algebra, multivariate calculus, and probability theory 2. Knowledge of a programming language (PYTHON/C/C ++/ MATLAB recommended).				
Course Objectives (COBs):	1. Apply Machine Learning techniques in real life applications. 2. Understanding the nature of problems solved with Machine Learning. 3. Understand learning process by human and Machine learning algorithms.				
Course Outcomes (COs):	**After successful completion of the course students will be able to:** 1. Explain Machine Learning Techniques which can be used in real world scenarios. 2. Comprehend regression concept used in machine learning. 3. Explain different classification methods in machine learning 4. Apply different clustering methods that are used in machine learning. 5. Apply different optimization techniques for applications 6. Apply Dimensionality reduction techniques.				

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1.Introduction to Machine Learning	1.1 Types of human learning, What is machine learning? Types of machine learning– supervised, unsupervised, semi-supervised and reinforcement learning.	CO1	02	08
	1.2 Machine learning activities, applications of machine learning. Steps in Developing a Machine Learning Application.		03	
	1.3 Model Evaluation and Validation, Feature types, Feature Construction and Transformation, Feature Selection.		03	
2.Supervised Learning-Regression	2.1 Introduction of regression, Regression algorithms: Simple linear regression, Multiple linear regressions, Polynomial regression model, Logistic regression, Maximum likelihood estimation, Regression Performance Metrics.	CO2	04	08
	2.2 Derivative based optimization-Optimization, Cost function, Gradient descent algorithm. Derivative free optimization- Random Search, Down-Hill Simplex.		04	
3.Supervised Learning-Classification	3.1 Classification: Rule based classification, Binary Classification, classification performance metrics, Multi-class Classification, classification by Bayesian Belief networks, Hidden Markov Models, Naive Bayes classifier, k-Nearest Neighbour (kNN).	CO3	06	09

	3.2 Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART).		03	
4. Support Vector Machine	4.1 Support Vector Machine: Maximum Margin Linear Separators, Quadratic solution to find maximum margin separators, Kernels for learning non-linear functions and examples.	CO4	04	04
5.Unsupervised Learning	5.1 Introduction of unsupervised learning, Unsupervised vs supervised learning, Application of unsupervised learning, Clustering and its types, Partitioning method: k-Means and K-Medoids, Hierarchical clustering.	CO5	04	06
	5.2 Case Studies: Credit card Fraud detection (anomaly detection), Customer Segmentation etc.		02	
6.Dimensionality Reduction:	Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis.	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total hours	**42**

Text Books:	1. Peter Flach: Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition. 2. Hastie, Tibshirani, Friedman: Introduction to Statistical Machine Learning with Applications in R, Springer, 2nd Edition-2012. 3. Peter Harrington "Machine Learning in Action", DreamTech Press.
Reference Books:	1. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition-2013 2. C. M. Bishop: Pattern Recognition and Machine Learning, Springer 1st Edition-2013.
Useful Links:	1. https://www.nptel.ac.in 2. https://swayam.gov.in 3. https://www.coursera.org/
Term Work (TW):	1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Machine Learning". 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and Minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.
Continuous Assessment (CA):	**Test-1 and Test-2** (**20 Marks**): • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIL501	Machine Learning Lab	01	00	01
Lab Prerequisite:	1. Linear algebra, multivariate calculus, and probability theory. 2. Neural Networks. 3.Knowledge of a programming language (PYTHON/C/C ++/ MATLAB recommended).			
Lab Objectives:	1. To acquire advanced Data Analysis skills. 2. Create ML solutions for various real life problems. 3. Understanding the nature of problems solved with Machine Learning.			
Lab Outcomes:	At end of successful completion of this course, student will be able to, 1. Identify machine learning tools suitable for a given problem. 2. Apply Regression Methods. 3. Implement Classification method to ML application. 4. Implement Clustering for ML application. 5. Apply the Dimensionality Reduction Techniques.			

Lab No.	Experiment Title	LO Mapped	Hrs./Lab
I.	Lab prerequisite (Study Python ecosystem for Machine learning: Python, SciPy, Scikit-learn).	---	02
1.	Study of Various ML tools in Python.	LO1	02
2.	Write a program to demonstrate the working of the linear regression algorithm. Use an appropriate data set for linear regression.	LO2	02
3	Write a program to implement Gradient Descent method to Minimize the loss function (Linear Regression) in machine learning	LO2	02
4.	Write a program to demonstrate the working of the logistic regression algorithm. Use an appropriate data set.	LO3	02
5.	Write a program to demonstrate the working of the decision tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	LO3	02
6.	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Compute the accuracy of the classifier, considering few test data sets.	LO3	02
7.	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.	LO3	02

8.	Write a program to implement SVM algorithm to classify the iris data set. Compute the accuracy of the classifier, considering few test data sets.	LO3	02
9.	Write a program to implement PCA for the dimensionality reduction technique using a suitable data set.	LO5	02
10.	Write a program to implement k-Means clustering algorithm for a sample training data set stored as a .CSV file.	LO4	02
Books:			
Text Books	1. Peter Harrington ―Machine Learning In Action‖, DreamTech Press. 2. Ethem Alpaydın, ―Introduction to Machine Learning‖, MIT Press. 3. Tom M.Mitchell ―Machine Learning‖ McGraw Hill.		
Reference Books	1.Stephen Marsland, ―Machine Learning An Algorithmic Perspective‖ CRC Press. 2. J.-S.R. Jang "Neuro-Fuzzy and Soft Computing" PHI 2003. 3. Samir Roy and Chakraborty, ―Introduction to soft computing‖, Pearson Edition. 4. Kevin P. Murphy, Machine Learning ― A Probabilistic Perspective.		
Virtual Lab Links:	1. www.ibm.com 2. https://www.coursera.org/learn/machine-learning 3. https://cedar.buffalo.edu/~srihari/CSE574/index.html		
Term work:	1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Machine Learning". 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.		

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC502	Data Warehousing, Mining & Visualization	03	0	0	03

Prerequisite:	Database Concepts
Course Objectives:	1. To identify the significance of Data Warehousing and Mining. 2. To analyze data, choose relevant models and algorithms and visualizations for respective applications. 3. To develop research interest towards advances in data mining.
Course Outcomes:	After the successful completion of this course, learners will be able to: 1. Understand Data Warehousing Fundamentals. 2. Apply Data Warehousing Schemas and Operations. 3. Apply Data Mining, Data Exploration, and Preprocessing Techniques. 4. Implement Frequent Pattern and Association Mining. 5. Implement Data Visualizations Using Various charts. 6. Implement Advanced Data Visualization and Interaction Techniques.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs /Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Data Warehousing Fundamentals	1.1.Introduction to unstructured data, No SQL, Document database features and queries	CO1	02	06
	1.2. Operational vs Decision support systems, why Data warehousing? Data warehouse concepts, defining features, data warehouse versus data marts, data warehouse architecture, Overview of the components, metadata in the data warehouse, E-R Modeling versus Dimensional Modeling.		04	
2. Data Warehousing: Schemas and Operations	2.1.Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Constellation Schema, Fact less Fact Table.		02	06
	2.2. Update to the dimension tables. Major steps in ETL overview, requirement, steps, summary OLTP versus OLAP, Data cube and OLAP, OLAP operations: Slice Dice, Rollup, Drilldown and Pivot.		04	
3. Introduction to Data Mining, Data Exploration and Data Pre processing	3.1.Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining,	CO2	02	06
	3.2.Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization,		02	
	3.3.Data Pre-processing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.		02	

4. Mining Frequent Patterns and Associations	4.1.Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining,	CO4	02	07
	4.2.Apriori Algorithm, Association Rule Generation, Mining Frequent Item sets without candidate generation		03	
	4.3.Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.		02	
5. Data Visualization	5.1 Introduction to Data Visualization Acquiring and Visualizing Data.	CO5	01	06
	5.2 Exploring the Visual Data Spectrum: Charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, and Area Charts).		02	
	5.3 Exploring advanced Visualizations (Bubble Charts, Surface Charts, Map Charts, Info graphics)		03	
6.Advanced Data Visualization	6.1 Creating HTML5 CANVAS Charts (HTML5 Canvas basics, Linear interpolations, A simple column Chart, Adding animations).	CO6	02	08
	6.2 Google charts (Google Charts API Basics, A Basic bar chart, A basic Pie chart, Working with Chart Animations), Create custom dynamic visualizations using d3js.		02	
	6.3 Making charts interactive and Animated: Data joins, updates and exits, interactive buttons, Updating charts, Adding transactions, using keys.		02	
	6.4 Adding a Play Button: wrapping the update phase in a function, Adding a Play button to the page, Making the Play button go, Allow the user to interrupt the play, sequence.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**
Books:				
Text Books	1. Han, Jiawei, Jian Pei, and Micheline Kamber. Data mining: concepts and techniques. Elsevier, 2011. 2. Ponniah, Paulraj. Data warehousing fundamentals for IT professionals. John Wiley & Sons, 2011.			

Reference Books	1. Dunham, Margaret H. Data mining: Introductory and advanced topics. Pearson Education India, 2006. 2. Reema Thareja, "Data warehousing", Oxford University Press 2009. 3. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson Publisher 2nd Edition. 4. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining", Morgan Kaufmann 3rd edition. 5. Kimball, Ralph, and Margy Ross. The data warehouse toolkit: the complete guide to dimensional modeling. John Wiley & Sons, 2011.Inmon, William H. Building thedata warehouse. John wiley & sons, 2005. 6. Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery, "JavaScript and Query for Data Analysis and Visualization", WROX. 7. Ritchie S. King, "Visual storytelling with D3", Pearson 8. Dr. Ossama Embarak, "Data Analysis and Visualization Using Python", APress.
Useful Links:	https://onlinecourses.nptel.ac.in/noc20_cs12/preview https://www.coursera.org/specializations/data-mining
Continuous Assessment (CA):	**Test-1 and Test-2** (**20 Marks**): • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE)(60 Marks):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIL502	**Data Warehousing and Mining Lab**	01	0	01
Lab Prerequisite:	Database Concepts			
Lab Objectives:	1. Design and implement data warehousing and OLAP operations. 2. Apply data pre-processing, classification, clustering, and association rule mining techniques. 3. Utilize data mining tools (WEKA/R) and document experimental results effectively.			
Lab Outcomes (Los):	After the completion of course , student will be able to 1. Design a data warehouse and conduct various OLAP operations. 2. Implementation of data pre-processing. 3. Implementation of Association Rule Mining and data mining tool (WEKA/R tool). 4. Implementation of data visualization. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.			

Suggested Practical List:

Lab No.	Experiment Title	LO Mapped	Hrs./Lab
1.	Write a detailed problem statement and design dimensional modelling for a data warehouse/data mart. case study (creation of star and snowflake schema)	LO1, LO5, LO6	02
2.	Based on the experiment 1 case study, implement all dimension tables and fact tables	LO1, LO5, LO6	02
3.	Based on the experiment 1 case study, implementation of OLAP operations: Slice, Dice, Rollup, Drilldown, and Pivot	LO1, LO5, LO6	02
4.	To perform data pre-processing.	LO2, LO5, LO6	02
5.	Implementation of Association Rule Mining (Apriori) and FP growth tree algorithm.	LO3, LO5, LO6	02
6.	Using a data mining tool (WEKA/R tool), do data pre-processing and illustrate the Classification, Clustering, and Association algorithms on data sets.	LO3, LO5, LO6	02
7.	To explore the advanced visual data spectrum for bubble chart using R/Python.	LO4, LO5, LO6	02
8.	To explore HTML5 canvas charts.	LO4, LO5, LO6	02
9.	To implement advanced data visualization	LO4, LO5, LO6	02

Term work (TW):	1. Term work should consist of a minimum of 8 experiments 2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Warehousing and Mining Lab". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).
Oral/Practical/ P&O:	**Oral/Practical /P&O examination** will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC503	Information Theory and Coding	03	0	0	03

Prerequisite:	Applications of Mathematics in Engineering-I
Course Objectives:	1. To introduce to students the concept of information, entropy and coding. 2. Students will study different source coding techniques of data compression. 3. Students will study different image, audio and video compression techniques. 4. Students will study different channel coding techniques of data compression.
Course Outcomes:	Students will be able to 1. Apply information rate, entropy and channel capacity parameters to solve data compression problems. 2. Apply Huffman and Arithmetic coding methods to solve data compression problems. 3. Apply Dictionary methods to text compression. 4. Explain image and video compression techniques for different signal processing applications. 5. Explain Audio compression Techniques. 6. Apply block codes, cyclic codes and convolutional codes to solve error control coding problems.

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs./ Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Information Entropy and Coding Fundamentals	1.1. Introduction to Information Theory, Uncertainty and Information, self-information, Entropy, properties, Information rate, Types of Entropy, Mutual Information.	CO1	03	08
	1.2 Need of data compression, Compression techniques, Measure of performance, Variable size codes, Prefix codes, The Kraft-MacMillan Inequality Criteria, Source Coding Theorem, Channel Capacity, Types of channels, Channel coding Theorem (Shannon's Second Theorem), Channel Capacity Theorem (Shannon's Third Theorem), Binary Symmetric Channels.		05	
2. Huffman and Arithmetic Coding	2.1.Shannon Fano Coding, Huffman Code and Huffman Tree construction, Huffman Decoding, Minimum Variance Huffman Code, Extended Huffman Codes, Adaptive Huffman Code, Tunstall Codes.	CO2	05	08
	2.2. Difficulties in Huffman Coding, Arithmetic Coding using Tag generation methods.		03	
3. Text Compression	Run Length Encoding for Text and Image, Move to Front Coding.	CO3	02	05
	Static Dictionary, Digram coding, Adaptive Dictionary: LZ77 (Sliding Window), LZ78, LZW.		03	
4. Image and	4.1.Approaches to Image compression, Types of images, GIF, JPEG, Gray codes, Differential Lossless	CO4	04	07

Video Compression	4.2.Video Compression principle, video compression techniques, types of frames, H.261standard, MPEG 4 Encoding and Decoding.		03	
5. Audio Compression	The Human Auditory System, μLaw and A-Law Companding, Audio compression, MPEG Audio coding-Layer 1, 2 and 3 (MP3 Format).	CO5	03	03
6. Error Control Coding	6.1. Linear Block Codes: Hamming Code, Error Detection and Correction Capability of Hamming Code, Encoder of (7,4) Hamming Code, Syndrome Decoding.	CO6	02	06
	6.2. Cyclic Codes: Cyclic property, Generator and Parity Check Matrices, Encoder and Decoder, Syndrome decoding.		03	
	6.3.Convolutional Codes: Transform Domain Analysis of Convolutional Encoder, Code Tree, Trellis and State Diagram,		01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:	
Text Books	1. David Salomon, Data Compression: The Complete Reference, Springer, Third Edition, 2005. 2. Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann Publishers, Second Edition, 2006. 3. Ranjan Bose, Information Theory, Coding and Cryptography, Tata McGraw Hill, Second Edition. 4. R. Avudaiammal, Information Coding Techniques, Tata McGraw Hill, Second Edition. 5. Jorge Castineira Moreirra, Essentials of Error Control Coding, Wiley-India, First Edition. 6. K.S. Shivaprakasha, Murlidhar Kulkarni, Information Theory and Coding, Wiley,
Reference Books	1. Mark Nelson, Jean-Loup Gailly, the Data Compression Book, BPB Publications, Second Edition, 1995. 2. Drozdek, Elements of Data Compression, Cengage Learning, First Edition, 2001. Thomas Cover wiley, Element of Information Theory, Second Edition.
Useful Links:	1. http://www.nptelvideos.com/video.php?id=989 2. https://www.coursera.org/lecture/algorithms-part2/introduction-to-data-compression-OtmHU 3. https://nptel.ac.in/courses/106102064/19
Continuous Assessment(CA):	**Test-1 and Test-2** (**20 Marks**): • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC501	AI in Computer Networks	03	0	0	03

Prerequisite:	Computer Networks
Course Objectives:	1. Introduce networking architecture like OSI and TCP/IP model and its protocols. 2. Understand the various layers and protocols TCP/IP in the model. 3. Recognize different addressing schemes, connecting devices and routing protocols. 4. Select the required protocol from the application layer protocols.
Course Outcomes:	On successful completion of the course the students will be able to: 1. Differentiate the working of layers in OSI model and TCP/IP model. 2. Categorize physical layer services and systems. 3. Classify the various multiple access methods. 4. Analyze various routing protocols in the Network layer. 5. Explain the various protocols in the Transport layer and Application layer. 6. Explain the importance of AI in computer networks.

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs./ Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1.Introduction to Network Architectures, Protocol Layers, and Service models	1.1 **Introduction to Computer Networks** ● Definition and applications of computer networks. ● Types of networks: LAN, MAN, WAN. ● Network topologies and their characteristics.	CO1	02	06
	1.2 **Addressing & Protocols** ● Addressing types: Physical, Logical, and Port addressing. ● Networking protocols and industry standards.		02	
	1.3 **Network Protocol Architectures** ● Importance of layered architectures. ● **OSI Model**: Layers and functionalities.		02	
2. Physical Layer	2.1 **Transmission Media** ● Wired Media: Coaxial, Twisted Pair, Optical Fiber ● Wireless Media: RF communication, Infrared, Microwave. ● Transmission impairments and their effects. ● Multiplexing techniques: FDM, TDM, and CDM. ● Spread Spectrum Techniques. ● Fiber-to-the-X (FTTX) networks.	CO2	03	08
	1.2 **Network Interconnecting Devices** • Hub, Bridge, Switch, Router, Gateway. • Characteristics and functionality in network communication.		02	

	1.3 **Switching Techniques** • Circuit Switching • Packet Switching		03	
3. Data Link Layer	3.1 **Data Link Control (DLC)** ● DLC services and protocols • High-Level Data Link Control (HDLC)	CO3	02	08
	3.2 **Media Access Control (MAC)** ● Channel access methods: Random Access, Controlled Access, Channelization ● **Wired LANs (Ethernet Protocols)**: • Standard Ethernet, Fast Ethernet, Gigabit Ethernet, 10-Gigabit Ethernet CSMA/CD mechanism.		03	
	3.3 Wireless LANs (IEEE 802.11 Standards) • System and protocol architecture. • 802.11 variants: 802.11a/b/g/n/ac/ax . • CSMA/CA mechanism.		03	
4. Network Layer	**4.1 Network layer services**, packet switching, network layer performance, forwarding of IP packets, Internet Protocol,IPv4 header format	CO4	02	08
	4.2 IPv4 Addressing (classful and classless), Subnetting, Supernetting design problems IPv4 Protocol, IP-v6 addressing, transition from IPv4 to IPv6.		02	
	4.3 Routing algorithms: Shortest Path (Dijkastra's), Link state routing, Distance Vector Routing, Bellman Ford's Algorithm, OSPF and RIP.		02	
	4.4 Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms.		02	
5. Transport Layer & Application Layer	**5.1 Transport Layer Services** • Flow control and error control techniques • Protocols: Stop-and-Wait, Go-Back-N, Selective Repeat • Sliding Window protocol	CO5	02	06
	5.2 Transport Protocols • **Connection-Oriented:** TCP services, TCP header, Three-way Handshake • **Connectionless:** UDP services, UDP header format		02	
	5.3 Application Layer Protocols • Web and communication protocols: HTTP, DNS, SMTP, DHCP. • Secure communication: SSH, Telnet.		02	
6. AI in Computer Networks	**6.1 Software-Defined Networking (SDN)** • Introduction to SDN and its architecture. • SDN applications in modern networks.	CO6	02	04

	6.2 Artificial Intelligence in Networking • Role of AI in network management. • AI-based traffic analysis and optimization. • AI for network security and anomaly detection. • Reinforcement Learning for Network Optimization.		02	
	6.3 Future Trends in Networking • Next-generation network architectures. • 5G and beyond. • Quantum networking and its implications.			
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:	
Text Books	1. S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition. 2. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition. 3. Alberto Leon Garcia, "Communication Networks", McGraw Hill Education, Second Edition.
Reference Books	1. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition. 2. Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition. 3. Bhushan Trivedi, "Data Communication and Network", Oxford Publication Press, 1st edition.
Useful links:	1. https://www.nptel.ac.in 2. https://swayam.gov.in 3. https://www.coursera.org/
Continuous Assessment (CA):	**Test-1 and Test-2 (20 Marks)**: • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIDLL501	AI in Computer Networks Lab	01	0	01
Lab Prerequisite:	Computer Networks			
Lab Objectives:	1.To practically explore OSI layers and understand the usage of simulation tools. 2.To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure. 3.To identify the various issues of a packet transfer from source to destination.			
Lab Outcomes (Los):	**The student will be able to:** 1. Explain different hardware components and commands of computer networking. 2. Execute different IP networking commands. 3. Implement different algorithms in the C language 4. Simulate different protocols in NS2 software and cisco packet tracer with ML.			

Suggested Practical List:

Lab No.	Experiment Title	LO Mapped	Hrs./Lab
1.	Study of hardware components of computer communication and networking	LO1, LO5	02
2.	IP networking and network commands : ifconfig, ping, traceroute, netstat, arp, nslookup dig and route etc.	LO2, LO5	02
3.	Implementation for cyclic redundancy code	LO3, LO5	02
4.	Installation of ns2 and implementation for simple example of ns2	LO4, LO5	02
5.	Implementation of star topology in ns2.	LO4, LO5	02
6.	Simulation of connection of two LANs using Router on Cisco Packet Tracer	LO4,LO5	02
7.	Simulation of distance vector routing (bellman- ford algorithm)	LO3, LO5	02
8.	Study of wireshark and analyzing packet using wireshark	LO3, LO5	02
9.	Simulate a network with congestion and apply ML to predict congestion events.	LO4, LO5	02
10.	Use machine learning to detect anomalies in network traffic.	LO4, LO5	02

Term work (TW):	1.Term work should consist of minimum 8 experiments 2.Journal must include at least 2 assignments on content of theory and practical of the course "AI in Computer Networks". 3.The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance (Theory & Practical): 05-marks, Assignments: 05-marks).
Oral/Practical/ P&O:	**Oral/Practical /P&O examination** will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC502	Image and Video Processing	3	0	0	03

Prerequisite:	1.Engineering Mathematics
Course Objectives:	1. To learn the fundamental concepts of image and video processing. 2. To learn image compression, segmentation techniques with practical applications.
Course Outcomes:	1. Represent and interpret the image in its numeric and graphical form. 2. Perform different image enhancement approaches for improving image quality. 3. Elucidate the mathematical modelling of image segmentation. 4. Apply the concept of image compression. 5. Transform image from spatial to frequency domain using different transforms. 6. Explain the basics of video processing.

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs./ Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Digital Image Processing Fundamentals	1.1 Introduction: Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System.	CO1	01	04
	1.2 Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Image File Formats: BMP, TIFF and JPEG. RGB Color model.		03	
2. Enhancement in Spatial and Frequency Domain	2.1 Enhancement in the spatial domain: Negative Transformation, Power Law Transformation, Logarithmic Transformation, Gray Level Slicing (with and without background), Bit Plane Slicing, Histogram Processing, Arithmetic and logical operations on image (addition, subtraction, ANDing, ORing).	CO2	05	09
	2.2 Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter, Frequency domain image enhancement techniques.		04	
3. Image Segmentation and Morphological Operations	3.1 Relationship between pixels and connectivity, Detection of Discontinuities, Thresholding, Region based image segmentation, **Graph Theoretic Technique,** split and merge techniques. Roberts, Prewitts, Laplacian and Sobel operators, Image Representation- Chain Code	CO3	07	10
	3.2 Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Thinning and Thickening.		03	
4. Image Compression	4.1 Fundamentals: Coding Redundancy, Interpixel Redundancy, Psycho visual Redundancy Lossless Compression Techniques: Run Length Coding, Huffman Coding, Lossy Compression Techniques: Improved Gray Scale Quantization, Transform Coding, JPEG	CO4	06	06

5. Image Transforms	5.1 2D-DFT, DCT, Hadamard Transform, Haar Transform.	CO5	04	04
6. Basic Steps of Video Processing:	6.1 Analog video, Digital Video, Time varying Image Formation models: 3D motion models, Geometric Image formation, formation, sampling of video signals, motion-based video object detection and tracking.	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**
Books:				
Text Books	1**.** Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition. 2**.** S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009.			
Reference Books	1**.** Jain A K, "Fundamentals of Digital Image Processing". 2. William K Pratt, "Digital Image Processing"**.**			
Useful links:	1. https://www.coursera.org/learn/digital 2. https://onlinecourses.nptel.ac.in/noc22_ee86/preview			
Continuous Assessment (CA):	Test-1 and Test-2 (20 Marks): • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.			
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.			

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIDLL 502	Image and Video Processing Lab	01	0	01

Lab Prerequisite:	1**.** Knowledge of a programming language (OpenCV/ Python/ MATLAB).
Lab Objectives:	1.To learn basic programming skills like OpenCV, Python or Matlab. 2. To enhance, segment or compress a gray level image. 3.To develop a small DIP application.
Lab Outcomes (Los):	The students should be able to: 1. Enhance a given gray scale image. 2. Apply different spatial masks on the image. 3. Segment a given image. 4. Compress a given image. 5. Transform an image to frequency domain using transforms. 6. Use AI to process a given image.

Suggested Practical List:

Lab No.	Experiment Title	LO Mapped	Hrs./Lab
1.	Image Enhancement using point processing techniques	LO 1	2
2.	Image Enhancement with Histogram Equalization	LO 1	2
3.	Implementation of Averaging and Sharpening filters	LO 2	2
4.	Edge detection using Prewitt / Sobel / Robert operator/Laplacian of Gaussian	LO 3	2
5.	Digital Image Watermarking	LO 1	2
6.	Morphology Image Processing	LO 4	2
7.	Image Segmentation	LO 3	2
8.	Image Compression using Huffman	LO 4	2
9.	Image Transform 2D DFT	LO 5	2
10.	Video Capture	LO 1	2
11.	Image Processing using AI tools	LO 6	2

Virtual Lab Links:	1.https://cse19-iiith.vlabs.ac.in/
Term work (TW):	1. Term work should consist of a minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments: 10-marks.
Oral/Practical/ P&O:	**Oral/Practical /P&O examination** will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC503	Embedded System and Design	03	0	0	03

Prerequisite:	1. C programming. 2. Computer Networks.
Course Objectives:	1. To study concepts involved in Embedded Hardware and Software for System realisation. 2. To learn the concepts of modern microcontroller cores like the ARM-Cortex. 3. To learn Real-time programming to design time-constrained embedded systems.
Couse Outcomes:	After successful completion of the course students will be able to: 1. Understand Microprocessors and Microcontroller Fundamentals. 2. Select appropriate hardware and communication protocols for Embedded System implementation. 3. Compare GPOS and RTOS and investigate the concepts of RTOS. 4. Describe the features of Free RTOS. 5. Explain various tools for testing and debugging embedded systems 6. Design a system for different requirements based on life-cycle for an embedded system.

Module No & Name	Sub Topics	CO mapped	Hrs /Subtopic	Total Hrs/ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Microprocessors and Microcontroller Fundamentals	1.1Microprocessor, Microcontroller, Comparison between microprocessors and microcontrollers.	CO1	01	07
	1.2 Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes.		03	
	1.3 Instruction set of 8051, Simple Programs.		03	
2. Introduction to Embedded Systems & Embedded Hardware Elements	2.1 Definition, Block diagram, Characteristics, Classification, Design metrics of Embedded system and Challenges in optimization of metrics, Applications.	CO2	03	13
	2.2 Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. Types of memories.		02	
	2.3 Case Study: ARM Cortex-M3 Features, Architecture, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.		04	
	2.4 Communication Interfaces: Comparative study of Serial communication Interfaces -RS-232, RS-485, SPI, I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee.		04	
3. Embedded Software	3.1 Program Modelling concepts: DFG, CDFG, FSM.	CO3	02	08
	3.2 Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS. Task, Task states, Multi-tasking,		06	

	Task scheduling, and algorithms- SJF, Round-Robin, Priority, Earliest Deadline First, Inter-process communication.			
4. Introduction to FreeRTOS	FreeRTOS Task Management features, Resource Management features, Task Synchronization features, Event Management features, Calculation of CPU Utilization of an RTOS, Interrupt Management features, Time Management features.	CO4	03	03
5. Testing and Debugging Methodology	5.1 Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator.	CO5	01	02
	5.2 Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing.		01	
6. System Integration (Case Studies)	6.1 Embedded Product Design Life-Cycle (EDLC)- Waterfall Model, Hardware-Software Co-design.	CO6	03	06
	6.2 Case studies for Automatic Chocolate Vending Machine, Adaptive Cruise Control , Smart Card (highlighting i) Specification requirements (choice of components), ii) Hardware architecture iii) Software architecture).		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total Hours	**42**

Books:	
Text Books	1.Mazidi, Muhammad Ali. The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2/E. Pearson Education India, 2007. 2.Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014. 3.Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd. 4.SriramIyer, Pankaj Gupta," Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003. 5.Joseph Yiu,"The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
Reference Books	1.David Simon,"An Embedded Software Primer", Pearson, 2009. 2.Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd. 3.AndrewSloss, Domnic Symes, Chris Wright," ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004 4.FrankVahid, Tony Givargis,"Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002. 5.Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009.
Useful Links:	1. www.freertos.org
Continuous Assessment (CA):	**Test-1 and Test-2** (**20 Marks**): Test-1 and Test-2 consists of two class tests of 20 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.

End Semester Examination (ESE)(60 Marks):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Course Code	Course Name	Credits		
		P	TUT	Total
AIDLL503	Embedded System and Design Lab	01	0	01
Lab Prerequisite:	1. C programming 2. Computer Networks			
Lab Objectives:	1.Understand Embedded IDE for practical. 2.Implementation of Embedded systems interfaces to sensors and actuators using embedded C. 3.Implementation of Free RTOS concepts 4.Demonstration of IoT based case study.			
Lab Outcomes (LOs):	After successful completion of the course students will be able to: 1. Implement embedded systems interfaces to sensors and actuators using embedded C. 2. Analyze the comparison between various serial communications interfaces used in Embedded Systems. 3. Execute Free RTOS concepts. 4. Demonstrate case study. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.			

Lab. No.	Experiment Title	LO mapped	Hrs/Lab
1.	Interfacing of LEDs /switches with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
2.	Interfacing of Temperature sensor with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
3.	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
4.	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
5.	Interfacing of a relay with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
6.	Interfacing of a DC motor (speed and Direction control) with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
7.	Interfacing of a stepper motor (to move by a particular angle) with any embedded core. (8051/ARM)	LO1, LO5, LO6	2
8.	Implement the I2C communication to connect to DS1307 RTC	LO 2, LO5, LO6	2
9.	Interfacing of I2C with ARM	LO 2, LO5, LO6	2
10.	Interfacing of SPI with ARM	LO 2, LO5, LO6	2
11.	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS (FreeRTOS).	LO3, LO5, LO6	2
12.	Simulation of multitasking using FreeRTOS	LO3, LO5, LO6	2

13.	Simulation of mutex using FreeRTOS	LO3, LO5, LO6	2
14.	Embedded Systems Case Study (IA)	LO4, LO5, LO6	4
Term work: (25 Marks)	1. Term work should consist of a minimum of 8 experiments 2. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. 3. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. 4. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. 5. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.		
Note: Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC504	AI for Bioinformatics	03	0	0	03

Prerequisite:	1. Mathematics & Statistics. 2. Basics of Artificial Intelligence & Machine Learning. 3.Fundamentals of Bioinformatics.
Course Objectives:	1. To unlock biological insights from data, drive innovation in healthcare, and improve our understanding of life at the molecular level using computational techniques.
Course Outcomes:	1. Understand the fundamentals of Bioinformatics. 2.Analyze and process biological sequences. 3. Apply AI & ML techniques to biological data. 4. Explore AI applications in drug discovery & genomics. 5. Develop practical skills in AI-powered bioinformatics tools. 6. Address ethical considerations in AI-driven healthcare.

Module No & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	--	02	02
1. Introduction to AI in Bioinformatics	1.1 Basics of Bioinformatics and Computational Biology, Role of AI in Bioinformatics.	CO1	02	06
	1.2 Biological Databases (GenBank, PDB, UniProt, etc.).	CO1	02	
	1.3Machine Learning vs. Deep Learning in Bioinformatics.	CO1	01	
	1.4 Challenges in AI for Bioinformatics	CO1	01	
2. Biological Data & Preprocessing	2.1 Types of Biological Data (Genomic, Proteomic, Clinical).	CO2	02	08
	2.2 Data Collection, Storage, and Formats (FASTA, Gen Bank, PDB), Data Cleaning and Normalization Techniques.	CO2	03	
	2.3Feature Engineering in Biological Data, Dimensionality Reduction Methods (PCA, t-SNE, UMAP).	CO2	03	
3. Machine Learning in Bioinformatics	3.1 Supervised Learning (Classification & Regression) in Bioinformatics, Disease Prediction Models, and Protein Structure Classification.	CO3	02	06
	3.2 Unsupervised Learning for Clustering ,Gene Expression Clustering (K-means, Hierarchical), Dimensionality Reduction for Genomics.		02	
	3.3 Evaluation Metrics (Accuracy, Precision, Recall, F1-score, ROC curves).		02	

4. AI in Genomics and Proteomics	4.1 Genome Sequencing and Next-Generation Sequencing (NGS).	CO4	02	08
	4.2 AI for Gene Expression Analysis.		02	
	4.3 Protein Structure Prediction using AI.		02	
	4.4 Drug Discovery and Personalized Medicine.		02	
5. AI in Biomedical Image Analysis	5.1 Fundamentals of Biomedical Imaging (X-ray, MRI, CT, Microscopy).	CO5	01	06
	5.2 Image Segmentation using AI (U-Net, Mask R-CNN).		02	
	5.3 Feature Extraction and Classification in Biomedical Images.		02	
	5.4 AI Applications in Retinal and Cancer Imaging.		01	
6. AI-driven Bioinformatics Applications and Ethics	6.1 AI in Drug Discovery and Pharmacogenomics, AI for Pandemic Prediction and Vaccine Development	CO6	02	06
	6.2 AI in Disease Risk Prediction and Personalized Healthcare, Ethical Concerns in AI-driven Bioinformatics.		02	
	6.3 Future Trends and Research Opportunities.		02	
			Total hours	**42**
Books:				
Text Books	1.” Basics of Bioinformatics”-Rui Jiang Xuegong Zhang Michael Q. Zhang. 2."Artificial Intelligence in Bioinformatics" – Kalidas Yeturu. 3."Bioinformatics: Sequence and Genome Analysis" – David W. Mount, 2nd Edition , CBS Publishers and Distributors. 4."Bioinformatics, The Machine Learning Approach" – Pierre Baldi & Søren Brunak, 2nd Edition.			
Reference Books	1."Bioinformatics Algorithms: An Active Learning Approach" – Phillip Compeau and Pavel Pevzner. 2."Computational Intelligence Techniques in Bioinformatics" – Gary B. Fogel.			
Continuous Assessment (CA):	**Test-1 and Test-2** (**20 Marks**): • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.			
End Semester Examination (ESE)(60 Marks):	Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum. Duration of ESE is 2.5 hours.			

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIDLL504	AI for Bioinformatics Lab	01	0	01

Lab Prerequisite:	1. Programming Languages: Python (NumPy, Pandas, Scikit-learn, TensorFlow, PyTorch). 2. R (for statistical analysis). 3. Bioinformatics Tools: BLAST, Biopython, Bioconductor, FASTA/FASTQ file handling.
Lab Objectives:	1. To equip students with practical skills in data processing, machine learning models to solve real-world bioinformatics problems.
Lab Outcomes (LOs):	1. Understand AI applications in genomics, proteomics, and drug discovery. 2. Preprocess biological data and extract meaningful features. 3. Develop ML models for analyzing biological datasets. 4. Implement real-world applications of AI in genomics, drug discovery, and healthcare. 5. Apply AI to real-world problems in personalized medicine.

Lab. No.	Experiment Title	LO mapped	Hrs/Lab
1	Introduction to Biological Databases & Retrieving Data using Python (Biopython)	LO1	2
2	Sequence Processing and Feature Extraction using Python	LO2	2
3	Applying ML Models for Gene Expression Analysis	LO3	2
4	Implementing CNN for Bioimage Classification (Using TensorFlow/PyTorch)	LO3	2
5	AI for Drug Discovery – Predicting Drug-Protein Interactions	LO4	2
6	Case Study: Disease Prediction using ML	LO5	2
7	Case Study: AI-driven Genomic Data Analysis	LO5	2
8	Case Study: Diabetic Retinopathy Classification using AI	LO5	2

Virtual Lab Links:

1. Bioinformatics Virtual Lab I : Biotechnology and Biomedical Engineering : Amrita Vishwa Vidyapeetham Virtual Lab

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. The experiments should be students' centric and attempts should be made to make experiments more meaningful, interesting and innovative.
3. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time.
4. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged.
5. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

Note:

Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be

explored to give greater clarity to the students and they can be motivated to think differently.
Oral/Practical/P&O : **Oral/Practical /P&O examination** will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIPR53	Community Engagement PBL (Project Based Learning): Minor Project Lab-I	01	0	01

Objectives:	1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To inculcate the process of applying fundamental engineering concepts to develop solutions. 4. To encourage self-learning, research, and innovation while addressing real-world challenges.
Outcomes:	After successful completion of this course learner will be able to… 1. Identify problems based on societal/research needs, considering United Nations Sustainable Development Goals (SDGs). 2. Design solutions or system components that meet real-world needs and can be practically deployed. 3. Select appropriate tools to implement the project. 4. Develop interpersonal skills to work as a member of a group or leader 5. Excel in written and oral communication. 6. Demonstrate project management principles during project work. 7. Demonstrate capabilities of investigation and self-learning by oneself or as a team gaining life skills.

Guidelines for Minor Project	
1	Project based learning Minor Project Lab-1 should be implemented using Java/Python programming.
2	Students shall form a group of 2 to 3 students, while forming a group shall not be allowed less than two or more than three students, as it is a group activity.
3	Students should do survey and identify societal or industry needs, converting them into statement aligned with relevant SDGs for minor project in consultation with faculty supervisor/internal committee of faculties.
4	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of Minor project.
5	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisor may give inputs to students during minor project activity; however, focus shall be on self-learning.
7	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
8	The best solution should be implemented as a working model, considering feasibility in terms of real-world deployment.
9	The solution to be validated with proper justification and report to be compiled in standard format of the college.
10	Projects should be designed to allow potential **conversion from Minor Project to Major Project** in future semesters by integrating **multidisciplinary technologies.**

11	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Minor Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Minor Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work:

The review/ progress monitoring committee shall be constituted by senior faculty members. The progress of minor project to be evaluated on continuous basis, minimum two reviews in each semester. Assessment also considers peer review and ethics observed by faculties and participation involvement.

Distribution of Term work marks for both semesters shall be as below	**Practical Marks**
Marks awarded by guide/supervisor based on implementation. (Minimum 2 modules implementation is expected) *Modules- Operations, Functions as per the requirement of project)	10
Peer assessment by team members	5
Marks awarded by review committee	5
Quality of Project report	5

Review / progress monitoring committee may consider following points for assessment based on project as mentioned in general guidelines

1.	Students group shall complete project in all aspects including, a. Identification of need/problem b. Proposed final solution c. Procurement of components/system d. Building prototype and testing
2.	Continuous assessment will be weekly based on logbook. Two presentations will be conducted for review before a panel. a. First shall be for finalization of problem and proposed solution b. Second shall be for implementation and testing of solution.

Assessment criteria of Minor Project:

Minor Project shall be assessed based on following criteria;

1	Quality of survey and identification of problem statement.
2	Innovativeness in solutions
3	Implementation
4	Teamwork
5	Project Report

Guidelines for Assessment of Minor Project Practical/Oral Examination:

1.	Report should be prepared as per the guidelines.
2.	Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners
3.	Students shall be motivated to participate in poster, project competition on the work in students' competitions.

Minor Project shall be assessed based on following points.

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets

6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication
P&O	P&O examination will be based on Minor project implementation.

Exposure Course Code	Exposure Course Name	Credits		
		P	TUT	Total
AIXS511	Skill-Based Learning Aptitude/Logic Building and Competitive Programming skills	01	0	01

SBL Prerequisite:	1. Knowledge of elementary mathematics HSC level. 2. Knowledge of basic English grammar. 3. Knowledge of Basic programming languages.
SBL Objectives (SOBs):	1. To have the basic awareness about how to prepare for recruitment process. 2. To introduce the students to computational skills required to appear for recruitment tests. 3. To introduce the students to coding skills required to appear for recruitment tests.
SBL Outcomes (SOs):	1. Discuss the basic concepts of quantitative ability. 2. Discuss the basic concepts of logical reasoning skills. 3. Acquire satisfactory competency in use of verbal reasoning. 4. Use the most common algorithms for competitive programming. 5. Analyse data structures for competitive up solving. 6. Analyse weak areas to focus on.

Module No.	Module Title	SO Mapped	Hrs./ Module
1.**Basics of Quantitative Abilities**	1.1 Problems on Number System, Problems on HCF and LCM, Problems on Average.	SO1,	03
	1.2 Problems on Ratio and Proportion, Problems on Percentage.		
2.Arithmetic Quantitative Abilities	2.1 Problems on Ages, Problems on Profit and Loss		03
	2.2 Problems on Simple and Compound Interest, Problems on Time and Distance.		
3.Logical Reasoning	3.1 Number Series, Alpha Numerical, Letter & Symbol Series.	SO2, SO3	02
	3.2 Numerical and Alphabet Puzzles, Seating Arrangement.		
4.Programming Techniques	4.1 What is Competitive Programming? Programming Contests, Language Features.	SO4	04
	4.2 Recursive Algorithms, Bit Manipulation		
5. Sorting and Searching	5.1 Sorting Algorithms, Solving Problems by sorting, 5.2 Binary Search.	SO5	04
6. Mock Interviews	6.1 Mock interviews by industrial experts or alumni	SO6	04
		Total hours	**20**

Books:

Text Books:	1. Quantitative abilities by Arun Sharma. 2. Quantitative Aptitude for Competitive Examinations by R S Agrawal. 3. Verbal and Non-Verbal reasoning by R S Agrawal. 4. Guide to Competitive Programming Learning and Improving Algorithms Through Contests Antti Laaksonen, Department of Computer Science, University of Helsinki, Finland.

Reference Books:	1. Algorithms Illuminated by Tim Roughgarden. 2. Algorithm Design, Jon Kleinberg and Éva Tardos. 3. Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein. 4. Competitive Programming 4: The Lower Bound of Programming Contests in the 2020s by Steven Halim and Felix Halim. 5. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests Antti Laaksonen.
Useful Links:	1.https://doi.org/10.1007/978-3-319-72547-5 2. Algorithms by Jeff Erickson (freely available online) 3. https://onlinecourses.nptel.ac.in/noc21_cs99/preview 4. https://unacademy.com/a/i-p-c-beginner-track
Term Work:	1.Term work shall be awarded based on 2. Student active participation in skill-based learning. 3. Term work total 25 marks. (Solving aptitude and technical papers :15 Marks, Mock Interview: 10 Marks)

Course Code	Lab Name	Credits		
		TH	P	TUT
AIXA512	Business Communication & Ethics	0	4**	0
****2 hours class wise and 2 hours batch wise**				
Hardware Requirements:	PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 4 GB RAM 3. Minimum 40 GB Hard disk			
Software Requirements:	1. Microsoft Windows 10 Desktop OS 2. Language Laboratory Software: ODLL (Orell Digital Language Laboratory)			
Prerequisite:	Fundamental knowledge of Professional Communication Skills as acquired in Semester II			
Lab Rationale:	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.			
Lab Objectives:	1. To discern and develop an effective style of writing important technical/business documents. 2. To investigate possible resources and plan a successful job campaign. 3. To comprehend the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. 4. To develop creative and impactful presentation skills. 5. To ehavio personal traits, interests, values, aptitudes and skills. 6. To understand the importance of integrity and develop a personal code of ethics.			
Lab Outcomes:	1. Plan and prepare effective business/ technical documents which will in turn provide a solid foundation for their future managerial roles. 2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry. 3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. 4. Deliver persuasive and professional presentations. 5. Develop creative thinking and interpersonal skills required for effective professional communication 6. Apply codes of ethical conduct, personal integrity and norms of organizational behaviour			

Module No. & Name	Sub Topics	LO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	--	02	02
1.Advanced Technical Writing: Project/	1.1 Classification of Reports: Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.) Time Interval (Periodic, One-time, Special) Function (Informational, Analytical, etc.)	LO1, 6	01	06

Problem Based Learning	Physical Factors (Memorandum, Letter, Short & Long)			
	1.2 Parts of a Long Formal Report: Prefatory Parts (Front Matter) Report Proper (Main Body) Appended Parts (Back Matter)		01	
	1.3 Language and Style of Reports Tense, Person & Voice of Reports Numbering Style of Chapters, Sections, Figures, Tables and Equations Proofreading through Plagiarism Checkers		01	
	1.4 Definition, Purpose & Types of Proposals Solicited (in conformance with RFP) & Unsolicited Proposals Types (Short and Long proposals)		01	
	1.5 Parts of a Proposal Elements Scope and Limitations Conclusion		01	
	1.6 Technical Paper Writing Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) Language and Formatting Referencing in IEEE Format		01	
2. Employment Skills	2.1. Cover Letter & Resume Parts and Content of a Cover Letter Difference between Bio-data, Resume & CV Essential Parts of a Resume Types of Resume (Chronological, Functional & Combination)	LO2, 4	01	06
	2.2 Verbal Aptitude Test Modelled on CAT, GRE, GMAT exams		01	
	2.3 Group Discussions Purpose of a GD Parameters of Evaluating a GD		01	
	Types of GDs (Normal, Case-based & Role Plays)		01	
	GD Etiquettes		01	
	2.4 Personal Interviews Planning and Preparation Types of Questions Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual		01	
3. Business Meetings	3.1 Conducting Business Meetings Types of Meetings Meeting etiquettes	LO3, 6	01	02

	3.2 Documentation Notice Agenda Minutes		01	
4. Technical/ Business Presentations	4.1Effective Presentation Strategies Defining Purpose Analyzing Audience, Location and Event Gathering, Selecting & Arranging Material	LO2, 4	01	02
	4.2 Structuring a Presentation Making Effective Slides Types of Presentations Aids Closing a Presentation		01	
5.Interpersonal Skills	5.1 Emotional Intelligence	LO5, 6	01	08
	Motivation		01	
	Assertiveness		01	
	Time Management		02	
	Stress Management		02	
	5.2 Start-up Skills Financial Literacy Risk Assessment Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	LO2, 5	01	
6. Corporate Ethics	6.1 Intellectual Property Rights Copyrights Trademarks Patents	LO6	01	02
	6.2 Case Studies Cases related to Business/ Corporate Ethics	LO1 to 6	01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**28**

Books:	
Text Books	1. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press. 2. Bovée, C. L., & Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
Reference Books	1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill. 2. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning. 3. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning. 4. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson. 5. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication,Principles

	and Practice. Oxford University Press 6. Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press

Useful Video links:

Sr. No	Topic	Links
1	TOEFL listening Skill	https://www.youtube.com/watch?v=jSUh0Civuv4
2	MBA Interview	https://www.youtube.com/watch?v=cwW9QBNuwCw
3	How to write a successful CV	https://www.youtube.com/watch?v=U0JAfqEak2c
4	Interview techniques (How to answer tell me about yourself)	https://www.youtube.com/watch?v=m5kR7TPAkSw
5	The 4 types of team members you can hire	https://www.youtube.com/watch?v=5bYYFfpbSqc
6	Every Meeting Ever	https://www.youtube.com/watch?v=K7agjXFFQJU

Assessment:	
Term Work (25 Marks)	• **Term work of 25 Marks shall consist of a minimum 8 Assignments.** • **The distribution of marks for term work shall be as follows:** • **Assignment : 15 Marks** • **Book Report (hard copy) : 10 Marks** • **Note:** The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Oral (25 Marks)	**Oral Examination will be based on a GD & the Project/Book Report presentation.**
1	**Group Discussion : 10 Marks**
2	**Project Presentation : 15 Marks**

Note:

1. The Main Body of the project/book report should contain a minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Activity. No	Activity/ AssignmentTitle (In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)	Hrs/Lab
1.	**Test of English as Foreign Language (TOEFL)**	2hrs
2.	Group discussion (Practice session)-I	2hrs
3.	Group discussion (Practice session)-II	2hrs
4.	Final Group discussion-I	2hrs
5.	Final Group discussion-II	2hrs
6.	English Aptitude Test	2hrs
7.	Resume Writing	2hrs
8.	Mock interview	2hrs
9.	Role play techniques for interpersonal skills	2hrs
10.	Project Report Presentation-I	2hrs
11.	Project Report Presentation -II	2hrs
12.	Technical proposal	2hrs

13.	Corporate Ethics/role play/case studies	2hrs
14.	Business Meetings: case studies/role play	2hrs

SOMAIYA
VIDYAVIHAR
.K J Somaiya Institute of Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Autonomy Syllabus Scheme III (2023-24)

(As per NEP 2020 Guidelines) for

Four Year Multidisciplinary Bachelors of Technology

(B.Tech.) Program

Minors in

VLSI
Bio-technology (BT)
Geographical Information System (GIS)
Innovation and Entrepreneurship (IE)
IoT and Cloud Computing (ICC)

w.e.f. Academic Year: 2024-25

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMVLSIC505	Analog and mixed-signal IP Design	03	0	0	03

Prerequisite:	1. Semiconductor physics. 2. Electronic Devices and Circuits.
Course Objectives:	1. Learn CMOS design style. 2. Understand the fundamentals of physical design. 3. Learn Analog IP design. 4. Learn advanced analog IC design.
Course Outcomes:	After successful completion of the course students will be able to: 1. Analyze behavior of CMOS circuits in various operating conditions. 2. Analyze nuances of NMOS and PMOS devices. 3. Design both analog and digital circuits using CMOS technology. 4. Draw IC layouts incorporating concepts likeEuler's path and stick diagrams to optimize circuit performance. 5. Develop Analog systems such as Phase-Locked Loops. 6. Design for stability and precision in integrated circuits using BGR designs.

Module No. & Name	Detailed Content	CO Mapped	Hrs/ Subtopic	Hrs /Mod
I. Prerequisite and Course	Prerequisite Concepts and Course Introduction	---	**02**	**02**
1 : Fundamentals of MOSFETs	MOSFET fundamentals; n-channel and p-channel MOSFETs; MOSFET characteristics and regions of operation. MOSFET Applications: MOSFET based digital circuits. MOSFET as a switch and its role in digital systems.	**CO1**	**04**	**04**
2: CMOS circuits design	CMOS circuit design, focusing on the intricacies of NMOS and PMOS devices under various conditions. Study the drain current behavior in response to changes in drain-to-source voltage, emphasizing the critical roles of velocity saturation and the voltage transfer characteristics (VTC).	**CO2**	**06**	**06**
3: Evaluation of CMOS circuits	3.1 CMOS design: dynamic and static behaviors of CMOS inverters.	**CO3**	**03**	**08**
	3.2 Evaluation of CMOS inverters under different loading and input conditions		**02**	
	3.3 The switching thresholds and robustness against electrical parameter variations		**02**	
	3.4 Designing reliable CMOS logic circuits.		**01**	
4: Physical design	4.1 Transition to custom IC layout design, introducing concepts	**CO4**	**02**	**06**
	4.2 Layout techniques to optimize circuit performance and minimize errors in the final IC fabrication.		**02**	
	4.3 Techniques to create efficient and effective semiconductor layouts		**02**	
5: Analog circuit design	Phase-Locked Loop (PLL) and Bandgap Reference (BGR) designs. PLL components, such as phase frequency detectors and charge pumps Signal integrity using PLL.	**CO5**	**08**	**08**
6: Advanced	6.1 Design of BGR circuits	**CO6**	**03**	**08**

Analog circuit design	6.2 Stable voltage references across temperature variations		**03**	
	6.3 high-precision applications in integrated circuits.		**02**	
Books:				
Text Books	1."CMOS: Circuit Design, Layout, and Simulation" by R. Jacob Baker. 2."Design of Analog CMOS Integrated Circuits" by Behzad Razavi. 3."CMOS VLSI Design: A Circuits and Systems Perspective" by Neil Weste and David Harris.			
Reference Books	1."CMOS VLSI Design: A Circuits and Systems Perspective" by Neil Weste and David Harris. 2."Digital Integrated Circuits: A Design Perspective" by Jan Rabaey, Anantha Chandrakasan, Borivoje Nikolic.			
Useful Links:				
NPTEL: https://archive.nptel.ac.in/courses/108/106/108106105/				
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.			
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMBTC505	Genetic Engineering & Omics	03	00	00	03

Prerequisites:	Biology till 10th standard and Fundamentals from earlier semester
Course Objectives (COBs):	1. To make learners aware of the structure and properties of nucleic acids. 2. To familiarize with the enzymes, stages and significance of DNA replication, transcription and translation. 3. To introduce tools, techniques and applications of genetic engineering.
Course Outcomes (COs):	After the successful completion of this course, learner will be able to: 1. Summarize enzymes and stages of DNA replication. 2. Describe components, stages and significance of transcription and translation. 3. Use different tools and techniques for genetic engineering. 4. Appraise applications of genetic engineering. 5. Explore different protein structure prediction algorithms. 6. Discuss multi-omics data, employing appropriate bioinformatics tools and techniques to derive meaningful biological insights.

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction.	--	02	02
1. DNA Replication	Features of DNA replication, Enzymes involved in DNA replication	CO1	02	07
	Process of DNA replication in bacteria.		02	
	Overview differences between bacterial and eukaryotic DNA replication.		02	
	Introduction to mutations.		01	
2. Transcription and Translation	Introduction to gene expression, RNA polymerase	CO 2	01	06
	Stages and significance of transcription		03	
	Stages and significance of translation		02	
3. Tools and Technique of Genetic Engineering	Introduction, mode of action Restriction enzymes, DNA polymerase, reverse transcriptase, and DNA liga	CO 3	02	06
	Plasmid as vectors.		01	
	Principle of Gene cloning,		01	
	Polymerase chain reaction,		01	
	Sangers DNA Sequencing method.		01	
4. Applications of Genetic Engineering	Production of recombinant proteins and vaccines, Applications in forensics,	CO 4	02	06
	Gene therapy,		01	

	Diagnosis of diseases		**01**	
	Introduction and applications of transgenic organisms.		**02**	
5. Structural Bioinformatics	Protein Structure Basics: Primary, secondary, tertiary, and quaternary structures.	**CO 5**	**02**	**08**
	Protein Data Bank (PDB): Accessing and using structural data.		**01**	
	Protein structure prediction: Secondary structure prediction- Chao Fasman rules, GOR method and other third generation methods. Tertiary structure prediction: Homology Modeling, Structure comparison based methods, Ab-initio folding methods.		**03**	
	Protein/protein and protein/ligand Interactions: Docking algorithms, Structure-Based Drug Design: Principles and methods.		**02**	
6. Omics	Overview of Omics Technologies and Analysis Genomics: Techniques and applications.	**CO6**	**01**	**07**
	Transcriptomics: RNA sequencing and data analysis.		**01**	
	Proteomics: Mass spectrometry and protein quantification.		**01**	
	Metabolomics: Techniques and analysis approaches.		**01**	
	Epigenomics: DNA methylation and histone modification studies.		**01**	
	Integrative Omics: Combining omics data for comprehensive analysis		**02**	
II. Course conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	**01**	**01**
			Total Hours	**42**

Books:

Text Books:	1. Strachan and Read (2011). Human molecular genetics, 4th edition, Garland Science 2. T.A. Brown (2006), Genomes 3, 3rd edition, Garland Science 3. Omics Books
Reference Books:	1. Watson- (2004), Molecular biology of the Gene, 5th edition, Pearson education 2. P.J. Russell (2010), iGenetics, 3rd edition, Pearsons 3. Primrose, S.B. and Twyman, R.(2006). Principles of Gene manipulations and Genomics, 7th edition, Blackwell publishing 4. Glick, B.R. and Pasternack, J.J. (2017). Molecular biotechnology, 5th edition, ASM press 5. Brown, T.A. (2010). Gene cloning and DNA analysis, 6th edition, Willey-Blackwell 6. Rastogi, S. and Pathak, N. (2011). Genetic engineering, First edition, Oxford press

Useful Links:

	1. https://youtu.be/JeoegQaF8ig?si=Ku7aA5cR3edVfi7I 2. https://youtu.be/MhJT9yjnl88?si=wtG8kaEC2iYUto2C

	3. https://youtu.be/qw2ZaUXgWHU?si=wLO6jc6ljzZTU-Ak 4. https://youtu.be/fQo4bqV29Gs?si=iAWhctcJzJkDIJWK 5. https://youtu.be/0Ha9nppnwOc?si=Ie1pY-MH-lAeBjrW 6. https://youtu.be/nJK-l7ByQAs?si=lEUsUhkHUBMCZVAM 7. https://youtu.be/7cn10wayDug?si=rPyc8Vq11b5LGo0i 8. https://youtu.be/iWpGjeGz_r8?si=UN0csOLEyeE9N1F_ 9. https://youtu.be/Kx5qMjh-izA?si=mrRVGdn0ue78nfYz 10. https://youtu.be/-QIMkQ4E_wE?si=TYLIl90dZ0XJzAeN
Term Work (TW):	● Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. ● Term work evaluation shall be for Total 50 Marks based on performance.
End Semester Examination (ESE):	● End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMGISC505	Remote Sensing and Technology	03	0	0	03

Prerequisites:	
Course Objectives (COBs):	1. 1. To understand the fundamental concepts of Remote Sensing 2. To acquire knowledge of various types of Remote Sensing and its application potential 3. To understand the characteristics of different satellites and sensors 4. To gain knowledge on the interaction of EMR with earth's surface and atmosphere 5. To explore the potential of remote sensing in environmental and geological applications
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Gain fundamental skills in applying different satellite sensors for earth observation 2. Utilize satellite sensors effectively for various earth-related studies 3. Acquire knowledge about the evolution of remote sensing technology and its recent trends 4.Analyse the interaction of electromagnetic radiation with earth's surface and atmosphere 5. Apply remote sensing techniques in environmental and resource management studies 6. Know your land and the area with the different classification levels

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	01
1. Principles of Remote Sensing	1.1 Definition, History & Concepts,	CO1	02	10
	1.2 Electromagnetic Radiation (Source)		02	
	1.3 Mode of Energy transfer, Radiation Principles		02	
	1.4 Blackbody radiation, Radiation laws)		04	
2. Electro Magnetic Radiation (EMR)	2.1 EM spectrum, EMR interaction with atmosphere (absorption, scattering, atmospheric windows)	CO2	05	10
	2.2 EMR interaction with earth surface (absorption & reflection)		02	
	2.3 Spectral Response pattern		02	
	2.4 Energy budgeting in Remote Sensing		01	
3. Sensors and Platforms	3.1 Resolutions (Spatial, Spectral, Temporal, Radiometric), Platforms, Sensors	CO3	01	05
	3.2 Scanning & Orbiting Mechanism of Satellites, Data Acquisition		02	
	3.3 Optical Remote Sensing (Basic concepts, Optical sensors and scanners)		02	
4. Thermal and Hyperspectral Remote Sensing	4.1 Thermal Remote Sensing: Emissivity, Kinetic and Radiant temperature	CO4	02	05
	4.2 Thermal sensors & scanners, Thermal conductivity		01	
	4.3 Thermal capacity, Thermal Inertia		01	
	4.4 Hyperspectral Remote Sensing: basic concepts		01	

5. Remote Sensing Satellites	LANDSAT and SPOT program, ESA program, Copernicus program, Sentinel series, IRS program, Resources at & Cartosat series, RISAT series, Chandrayaan and Mangalyaan programs, Meteorological Satellites, Shuttle Mission, Future Remote Sensing Missions.	CO5	05	05
6.Module Name	Interpretation key and visualisation pattern	CO6	01	05
	Pre- Processing and the classification techniques		03	
	Accuracy assessment and Change Detection		01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total Hours	**42**

BOOKS:	
Text Books:	1. Curran, P.J. (1985). Principles of Remote Sensing, Longman. 2. George Joseph and Jeganathan, C. (2018). Fundamentals of Remote Sensing, 3rd ed., Universities Press. 3. Lillesand, T.M. and Kiefer, P.W. (2007). Remote Sensing and Image Interpretation, 3rd ed., John Wiley & Sons. 4. Sabins, F.F. (1996). Remote Sensing: Principles and Interpretations, 3rd ed., W.H. Freeman & Co Ltd.
Reference Books:	1. Burney, S.S. Application of Thermal Imaging, Adam Hilger Publications, 1988. 2. Drury, S.A. (1990). A Guide to Remote Sensing - Interpreting Images of Earth, Oxford Science Publications. 3. Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2008). Remote Sensing and Image Interpretation, 6th ed., John Wiley & Sons. 4. Skou, N. and le Vine, D. (2006). Microwave Radiometer Systems: Design and Analysis, 2nd ed. 5. Woodhouse, I.H. (2005). Introduction to Microwave Remote Sensing, Taylor & Francis Ltd. 6. Kuenzer, C. and Dech, S. (Eds.) (2013). Thermal Infrared Remote Sensing: Sensors, Methods, Applications, Springer.
Useful Online Resource Links:	1. https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/remote-sensing 2. https://oceanservice.noaa.gov/facts/remotesensing.html 3. https://www.nasa.gov/directorates/somd/space-communications-navigation-program/remote-sensing/
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMIEC505	Business Model Development and Prototyping	03	0	0	03
Note: Hands-on activities shall be conducted during Theory Classes.					
Prerequisites:	Design Thinking and Ideation				
Course Objectives (COBs):	1. To familiarize learners with business model fundamentals. 2. To introduce learners to minimum viable products (MVPs) and iterative prototyping. 3. To transition from MVP to a scalable product by identifying product-market fit. 4. To teach basic financial literacy for early-stage start-ups. 5. To provide an understanding of the incubation process and resources available to start-ups. 6. To deepen learning through start-up case studies and practical examples.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Design and develop a basic business model for a start-up. 2. Create and refine a minimum viable product (MVP) for a business concept 3. Create strategies to scale the MVP while managing risks. 4. Develop simple revenue and cost projections for a business. 5. Evaluate and assess the impact of incubation on start-up success. 6. Critique start-up strategies and propose improvements.				

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Business Models	Business Model Canvas (BMC): Key Components, Types of Business Model	CO1	02	06
	Value Proposition and Customer Segments		01	
	Examples of Real-World Business Models		01	
	Exercises on Building BMC		02	
2. Prototyping and MVP Development	Testing and Refining Prototypes, Iterative Prototyping	CO2	02	08
	Concept of MVP and Rapid Prototyping		02	
	Steps to Develop an MVP		02	
	Hands-on: Creating and Iterating MVPs		02	
3. Scaling from MVP to Product-Market Fit	User-Centered Design	CO3	02	06
	Defining and Measuring Product-Market Fit, Pivoting Strategies, Scaling MVP into Products		02	
	Case Studies of Start-ups Scaled from MVP		01	
	Go-To-Market (GTM) Strategy for Start-ups		01	
4. Financial Planning for Start-ups	Costing, Pricing, and Revenue Projections	CO4	01	06
	Understanding Taxation and Unit Economics		02	
	Introduction to Funding Stages: Angel Investors, VCs		02	

	Case Studies of Financial Successes and Challenges		01	
5. Pre-incubation and Incubation	Stages of Pre-incubation and Incubation	**CO5**	**01**	**06**
	Resources and Support Mechanisms		**01**	
	Case Studies of Start-ups in Incubation		**02**	
	Group Activities: Pitching for Incubation		**02**	
6. Case Studies of Start-ups	Case Studies of Start-ups in India / abroad	**CO6**	**02**	**07**
	Case Studies of Start-ups using BMC and MVPs		**02**	
	Lessons from Real-World Start-up Failures		**01**	
	Group Presentations and Feedback Sessions		**02**	
II. Course Conclusio	Recap of Modules, Outcomes, Applications, and Summarization	**-**	**01**	**01**
			Total Hours	**42**

BOOKS:	
Text Books:	1. A. Osterwalder and Y. Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers", Wiley, 2010. 2. E. Ries. "The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses." Crown Business, 2011.
Reference Books:	1. K. Berman and J. Knight, "Financial Intelligence for Entrepreneurs: What You Really Need to Know About the Numbers", Harvard Business Review Press, 2008. 2. S. Daniel, "How to Start a Business in India", Clever Fox Publishing, 2020.
Useful Online Resource Links:	1. https://onlinecourses.nptel.ac.in/noc25_ge11/preview 2. https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview 3. https://onlinecourses.swayam2.ac.in/ntr24_ed51 4. https://www.udemy.com/topic/minimum-viable product
Term Work (TW):	• Term work will consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMICCC505	Cloud Computing for IoT	03	0	0	03

Prerequisite:	C Programming
Course Objectives:	1. To Understand the fundamentals of cloud computing and differentiate between IaaS, PaaS, and SaaS models. 2. To understand virtualization and containerization, VMs and containers and edge computing architecture. 3. To explore key services from leading cloud providers and compare pricing models and features. 4. To understand cloud-based IoT platforms and integrate sensors and devices with cloud for real-time control and data logging. 5. To explore cloud data storage types and services and understand visualization tools and dashboards. 6. To develop IoT-to-cloud pipelines and automate actions based on real-time data triggers.
Course Outcomes:	Upon completion of this course, students will be able to: 1. Explain cloud computing fundamentals and distinguish between IaaS, PaaS, and SaaS models. 2. Demonstrate understanding of virtualization, containers, and edge computing concepts. 3. Identify and compare core services and pricing models of AWS, Azure, and GCP. 4. Integrate IoT devices with cloud platforms for real-time data logging and control. 5. Utilize cloud storage options and apply visualization tools for data

Module Number & Name	Sub Topics	CO mapped	Hrs/ Subtopics	Total Hrs Module
1. Introduction to Cloud Computing: Concepts, Service Models(IaaS, PaaS, SaaS)	Introduction, Historical developments, Building Cloud Computing Environments	CO1	03	06
	IaaS – AWS EC2, Google Compute Engine, **PaaS** – Heroku, Google App Engine, **SaaS** – Google Workspace, Salesforce		03	
2. Virtualization and Cloud Architecture (VMs, Containers, Edge Computin)	Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Virtualization: Hypervisors (Type I and II),	CO2	03	06
	VM lifecycle, Containers vs VMs: Docker Introduction, Container Orchestration (Kubernetes Basics), Edge vs Cloud Computing, Microservices and Serverless Concepts.		03	
3.Public Cloud Platforms: AWS, Azure,GCP (overview)	AWS Services: EC2, S3, Lambda, IAM, CloudWatch, Azure Services: VM, Blob Storage, Functions, Azure Monitor,	CO3	03	06

	GCP Services: Compute Engine, Cloud Storage, Pub/Sub, Free tiers, trial usage and billing overview, Hands-on: Deploying a static website on AWS S3.		03	
4. IoTCloud Integration Firebase,Blynk, IFTTT	Overview of IoT & cloud convergence, visualizations, Firebase: Realtime database, Firestore, Authentication.	CO4	04	08
	Blynk IoT: Mobile dashboards and GPIO controls, IFTTT: Event-driven automation between cloud apps, MQTT, REST APIs for device-cloud communication		04	
5.Data Storage & Visualization in Cloud	Object, Block, File Storage Concepts, Storage Services: AWS S3, Azure Blob, Google Cloud Storage, Cloud-native databases: Firebase, DynamoDB	CO5	04	08
	Visualization tools: Grafana, Power BI (cloud-based), ThingSpeak charts, Data lifecycle management and retention		04	
6.Hands-on: Real-time data logging, Cloud triggers, Mobile alerts	Reading data from sensors (DHT11, LDR, etc.), Sending data to cloud (ThingSpeak, Firebase), Creating cloud triggers using thresholds, Using IFTTT/Blynk for alerts and mobile UI,	CO6	04	08
	Final Project: Build a real-time weather monitoring system with alert system		04	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total Hours	**42**

Text Books:	1.The Internet of Things in the Cloud A Middleware Perspective, Honbo Zhou – CRC Publication. 2.Internet of Things- Hands on Approach, Arshdeep Bagha, Vijay Medisetti, Published by Arshdeep Bagha and Vijay Medisetti,2014
Reference Books:	1. Dernd Scholz-Reiter, Florian Michahelles, Architecting the Internet of Things, Springer 2016, ISBN.' 978- 3-642-1915 7- 2 2. Learning AWS IoT- Effectively Manage Connected Devices on the AWS Cloud Using Services Such as AWS Greengrass, AWS Button, Predictive Analytics and Machine Learning, Agus Kurniawan, Packt Publication,2018 3. Platform-specific tutorials (Firebase, Blynk, ThingSpeak Docs)
Useful Links :	**https://www.grovator.com/**
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.

Course Code	Course Name	Credits			
		T	P	TUT	Total
MMVLSIC604	VLSI for Digital Signal Processing	03	0	0	03

Prerequisite:	1. Digital System Design 2. Signals & Systems 3. Discrete Time Signal Processing 4. Digital VLSI Design 5. Mini Project 2B- FPGA based Project
Course Objectives:	1. To describe the characteristics of computationally intensive algorithms 2. To identify the bottlenecks of intensive computations. 3. To learn various techniques to map DSP algorithms on hardware to improve performance.
Course Outcomes:	After successful completion of the course students will be able to 1. Apply DSP algorithms, graphical representations (SFG, DFG, DG), and critical path analysis to design efficient systems. 2. Apply efficient algorithm-to-architecture mapping techniques to enhance circuit performance. 3. Design optimized adder architectures for performance improvement. 4. Apply efficient multiplier architectures, for DSP system design.

Module No. & Name	Detailed Content	CO Mapped	Hrs/ Subtopic	Hrs /Module
I. Prerequisite and Course	Prerequisite Concepts and Course Introduction	---	**02**	**02**
1. Introduction to DSP Systems	1.1 Typical DSP Algorithms, Graphical representation of DSP Algorithms.	**CO1**	**03**	**06**
	1.2 Signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), high level transformation, critical path.		**03**	
2. Efficient Algorithm to Architecture Mapping	2.1 Design of N-bit incrementer, decrementer,complimenter.	**C02**	**03**	**07**
	2.2 Techniques to enhance circuit performance, pipelining and parallel processing, circuit design for N bit natural numbers, optimized circuit design for different functions.		**04**	
3. Efficient Adder Architecture	3.1 Introduction to Adder design, Variable Block Adder circuit design, Delay optimized Carry Look Ahead Adder.	**CO3**	**02**	**07**
	3.2 Carry Select Sum Adder, Conditional Sum Adder, Ling's Adder.		**03**	
	3.3 Prefix and Parallel prefix adders, Running Average Circuit		**02**	
4.DSP Architecture Design	4.1 Array Multiplier ,Signed and Unsigned Multiplier ,Booths Multiplier , Bough-Wooley Multiplier.	**CO4**	**03**	**06**
	4.2 Architecture of Squaring Circuit, Reconfigurable Constant Multiplier Design		**03**	
DSP Architecture Design	5.1Floating point representation IEE754, floating point operations-2's compliment representation, adder, subtractor, multiplier.	**CO5**	**03**	**06**
	5.2 CORDIC Architecture, FFT Architecture, FIR filter		**03**	

6. Efficient Design of Machine Learning Hardware	6.1 Artificial Intelligence and Machine Learning, Software and Co-design Optimizations, Pruning, Systolic array convolution.	**C06**	**03**	**06**
	6.2 Hardware-Level Techniques, RTL design of sum of differences, Energy efficient hardware accelerator design methodology for Neural Networks.		**03**	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	**---**	**01**	**01**
			Total hours	**42**
Books:				
Text Books	1. "VLSI Digital Signal Processing Systems Design and Implementation", Khesab Parhi 2. "COMPUTER ARITHMETIC - Algorithms and Hardware Designs",Behrooz Parhami 3. "Machine Learning in VLSI" -Ibrahim (Abe) M. Elfadel, Duane S. Boning, Xin Li Computer-Aided Design.			
Reference Books	1.``Digital Signal Processing for Multimedia Systems", Keshab K. Parhi and Takao Nishitani, Marcel Dekker. 2. ``Pipelined Lattice and Wave Digital Recursive Filters", J. G. Chung and Keshab K. Parhi, Kluwer.			
Useful Links:				
	1. https://nptel.ac.in/courses/108105118 2. https://nptel.ac.in/courses/108106149 3. https://nptel.ac.in/courses/108105157			
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.			
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMBTC604	Industrial Biotechnology	03	0	0	03

Prerequisites:	---
Course Objectives (COBs):	1. Discuss the applications of biotechnology in the food industry. 2. Understand the role of biotechnology methods and tools in drug development and other applications in the pharmaceutical Industry. 3. Understand the basics of food, nutrition and health.
Course Outcomes (COs):	After the successful completion of this course, learner will be able to: 1. Discuss the various aspects of dairy food process technology. 2. Comprehend the relation between food , nutrition and health 3. Importance of modern food products- nutraceuticals, functional food, Probiotics, prebiotics and synbiotics 4. Discuss application of biotechnology in pharmaceutical Industry. 5. Understand the application of biotechnology in preclinical studies. 6. Comprehend the steps of a clinical study and clinical data management.

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	--	01	01
1. Dairy	Milk composition	CO1	01	06
	Purity checking of milk,Thermal processing of milk – Pasteurization.		01	
	Low-temperature long time (LTLT), High temperature short time (HTST), Sterilization and Ultra high temperature (UHT).		03	
	Packaging of milk		01	
2. Dairy	Microbiology of milk & milk products - butter, cheese, ice-cream.	CO1	02	07
	Fermentation of milk– Cheese, yogurt, probiotic dairy products.		01	
	Processing of evaporated and dried milk products.		02	
	By-products of dairy processing – Lactose production from whey protein.		02	
3. Food	**Food and nutrition** Basic terms used in study of food and nutrition, BMI, Nutritional Status and RDA.	CO2	02	07
	Understanding the relationship between food, nutrition, and health.		02	
	Concept of Balanced Diet, Food (Carbohydrates, lipids, proteins and vitamins), Groups, Food Pyramid.		02	
	Disorders of Nutrition.		01	
4. Food	**Nutraceuticals and functional foods** Definition, history, types and sources of nutraceuticals.	CO3	02	07

	Dietary supplements, fortified foods, and functional foods.		**02**	
	Future prospects of functional foods and nutraceuticals and their potential for use in improving health.		**02**	
	Concept of probiotics, prebiotics and symbiotic.		**01**	
5. Pharma	Concept of Biopharmaceuticals, Applications of recombinant DNA technology in producing drugs-	**CO4**	**02**	**06**
	Hybridoma technology, animal cell culture and plant tissue culture for producing biopharmaceutics.		**02**	
	Bioprospecting of drugs from natural sources. Screening of Natural products for lead identification.		**02**	
6. Pharma	Understanding the role of Biotechnology in Preclinical Studies.	**CO5, CO6**	**02**	**06**
	Evaluation of Pharmacokinetics and Pharmacodynamics properties of the drug based on Cell culture and Animal Based experiments.		**01**	
	Understanding the role of Biotechnology in different phases of Clinical trials and Clinical Data Management.		**01**	
	Phase 1: Evaluating Safety and dosing. Phase 2 and 3: Safety and efficacy.		**01**	
	Introduction to steps of effective Clinical Data Management.		**01**	
II. Course conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	**01**	**01**
			Total Hours	**42**

Books:	
Text Books:	1.Handbook of Pharmaceutical Biotechnology Editor(s): Shayne Cox Gad Ph.D., D.A.B.T.First published: 24 August 2006 Print SBN: 9780471213864 |Online ISBN: 9780470117118 |DOI:10.1002/0470117117. 2.Fundamentals of Clinical Trials. Lawrence M. Friedman, Curt D. Furberg, David L. DeMets, David M. Reboussin, Christopher B. Granger. Springer, 27 Aug 2015.
Reference Books:	1. Introduction to Pharmaceutical Biotechnology, Volume 1: Basic Techniques and Concepts. Saurabh Bhatia, Divakar Goli, IOP Publishing Limited, 23 May 2018 - Science. 2. Wildman, R. E. (2016). Handbook of Nutraceuticals and Functional Foods. CRC Press. 3. John Shi (2016), Functional Food Ingredients and Nutraceuticals: Processing Technologies, Second edition, CRC Press.
Useful Links:	
	1.https://pharmacentral.com/learning-hub/technical-guides/drug-discovery-and-development-a-step- by-step-guide/. 2. Tuda, F. *et al.* (2022). Pharmaceutical Biotechnology: The Role of Biotechnology in the Drug Discovery and Development. In: Anwar, M., Ahmad Rather, R., Farooq, Z. (eds) Fundamentals and Advances in Medical Biotechnology. Springer, Cham. https://doi.org/10.1007/978-3-030- 98554-7_9.
Term Work (TW):	● Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. ● Term work evaluation shall be for Total 50 Marks based on performance.

End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.

Course Code	Course Name	Credits			
		T	P	TUT	Total
MMGISC604	Geomatics	03	0	0	03

Prerequisites:	**Course 1**
Course Objectives (COBs):	1. To introduce the relevance of Geoinformatics to Urban Planning and Management. 2. To expose recent developments in Geoinformatics for Urban Planning and Management. 3. To sensitize the importance of inclusive urban planning towards sustainable development. 4. Urban Planning and Change Detection 5. Urban Structuring and population estimation.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Understand the basics of urban mapping and plan preparation. 2. Apply remote sensing techniques in urban mapping. 3. Utilize remote sensing in the preparation of urban plans. 4. Change detection analysis and urban sprawl. 5. E – Governance and Urban structure.

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	**-**	**02**	**02**
1. Introduction to Urban Planning	Concepts of Urbanization, Evolution of City Building, Urban Growth, Human Settlement Planning	**CO1**	**08**	**08**
2. Urban Ecology and Environment	Components of natural and built environment, impact of urbanization on ecosystems	**CO1**	**08**	**08**
3. Remote Sensing for Urban Studies	Planning of Transport, Energy, Water Supply, Solid Waste, and Social Infrastructure	**CO2, CO3**	**09**	**09**
4. Urban Infrastructure Planning	Planning of Transport, Energy, Water Supply, Solid Waste, and Social Infrastructure	**CO1, CO4**	**07**	**07**
5. Urban Information System	Classification of information, Digital Surface Models, Population Estimation	**CO1, CO5**	**04**	**04**
6. Climate Models	Urban climate Analysis, Land Surface Temperature and Urban Heat Island	**CO1, CO5**	**03**	**03**
II.Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	**-**	**01**	**01**
			Total Hours	**42**

Books	

Text Books:	1.Netzband, M., Stefanov, W. L., & Redman, C. (Eds.). *Applied Remote Sensing for Urban Planning, Governance and Sustainability*. Springer, 1st Edition, 2007. Rashed, T., & Jürgens, C. (Eds.). *Remote Sensing of Urban and Suburban Areas*. Springer, 1st Edition, 2010.
Reference Books:	1. Donnay, J. P., & Barnsley, M. J. *Remote Sensing and Urban Analysis*. 1st Edition, Taylor & Francis, 2005. 2. Weng, Q., & Quattrochi, D. A. (Eds.). *Urban Remote Sensing*. 1st Edition, CRC Press, 2006.
Useful Online Resource Links:	1. https://www.worldbank.org/en/topic/urbandevelopment/overview 2. https://geographycasestudy.com/urban-growth-and-urbanization/ 3. https://planningtank.com/urbanisation/urbanisation-urban-growth
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMIEC604	Strategic Management and IPR for Start-ups	03	0	0	03
	Note: Hands-on activities shall be conducted during Theory Classes.				

Prerequisites:	Design Thinking, Business Model Development and Prototyping
Course Objectives (COBs):	1. To understand the key legal elements of venture structuring, co-founder agreements, and conflict resolution. 2. To educate learners on the importance of IPR for start-ups. 3. To teach negotiation and leadership skills for funding, partnerships, and team scaling. 4. To explore strategies and metrics for scaling a start-up and expanding into new markets. 5. To explore sustainable and ethical business practices. 6. To synthesize learning into a comprehensive start-up plan.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Design legal framework and compliance requirements for start-ups. 2. Identify and outline Intellectual Property Rights (IPR) strategy for a start-up. 3. Apply negotiation techniques and leadership strategies to secure funding and build teams. 4. Identify growth opportunities and apply strategies for market expansion. 5. Propose strategies for creating ethical and sustainable business ventures. 6. Create and present a comprehensive start-up plan that includes scaling, funding, and IPR strategies.

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	**02**	**02**
1. Venture Structuring and Legal Aspects of Start-ups	Business Structures: LLP, Pvt. Ltd., etc.	**CO1**	**01**	**06**
	Venture Registration Processes		**02**	
	Co-founder and Shareholder Agreements		**01**	
	Conflict Resolution and Compliance		**01**	
	Risk Management		**01**	
2. Intellectual Property Rights (IPR)	Introduction to Intellectual Property Rights (IPR), Importance and Types of IPR: Patents, Trademarks, Copyrights	**CO2**	**02**	**08**
	IPR for Start-ups		**01**	
	IPR Filing Processes in India		**01**	
	IP Challenges and Solutions for Start-ups		**02**	
	IP Commercialization and Monetization		**02**	
3.Negotiation,	Crafting a Winning Pitch		**02**	
	Legal and Compliance Aspects in Funding		**02**	

Partnerships and Leadership in Start-ups	Negotiation Techniques for Partnerships, Funding, and Vendor Relationships Leadership and Team Building for Scaling, Motivating Teams in Startup	**CO3**	**02**	**08**
4.Growth and Strategic Scaling	Metrics for Scaling: Product-Market Fit, Traction	**CO4**	**02**	**05**
	Market Expansion Strategies, Growth Hacking Techniques		**02**	
	Case Studies of Scalable Start-ups		**01**	
5. Business Sustainability and Ethics	Sustaining a Business: Managing Cash Flows, Employee Retention	**CO5**	**02**	**06**
	Corporate Social Responsibility (CSR)		**01**	
	Ethical Dimensions in Start-ups		**01**	
	Case Studies of Sustainable Start-ups		**02**	
6. Capstone Project	Group Project: Comprehensive Start-up Plan	**CO6**	**02**	**06**
	Presentations: Funding Pitch, IPR Plan, and Growth Strategy		**02**	
	Feedback and Evaluation		**02**	
II. Course Conclusion	**Recap of Modules, Outcomes, Applications, and Summarization**	**-**	**01**	**01**
			Total Hours	**42**
Text Books:	1. V. Harnish, "Scaling Up: How a Few Companies Make It and Why the Rest Don't", Gazelles, Inc., 2014. **2.** D. Keeling, "Startup Guide to Intellectual Property: Early Stage Protection of IP", CreateSpace Independent Publishing Platform, 2014.			
Reference Books:	1. B. Feld and J. Mendelson, "Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist", Wiley, 2016. **2.** E. Ries. "The Lean Startup: How today's entrepreneurs use continuous innovation to create radically successful businesses", Crown Business, 2011.			
Useful Online Resource Links:	1. https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview 2. https://onlinecourses.nptel.ac.in/noc21_mg63/preview 3. https://www.udemy.com/course/sustainability-management-in-business 4. https://www.coursera.org/learn/intellectual-property-for-entrepreneurs			
Term Work (TW):	• Term work will consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.			
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMICCC604	Advanced IoT & Capstone Project	03	0	0	03

Prerequisite:	C Programming
Course Objectives:	1. To develop systems using IR sensors, cameras, and buzzers for motion detection and real-time alerting 2. To implement an energy-efficient lighting solution for homes and buildings using IoT sensors. 3. To create IoT solutions for monitoring vital signs (pulse, oxygen levels) and healthcare devices 4. To develop communication aids for people with disabilities using IoT- based systems. 5. To design and deploy a complete IoT solution to address a real-world problem.
Course Outcomes:	Upon completing this course, students will be able to: 1. Understand the security model of IOT 2. Understand the need of fog computing. 3. Design a IOT product with user experience 4. Analyze the product design. 5. Integrate the IOT embedded device with UX. 6. Design an IOT product as responsible IOT device.

Module No. & Name	Sub Topics	CO mapped	Hrs / Sub topics	Total Hrs/ Module
I. Prerequisites and Course	Prerequisite Concepts and Course Introduction.	-	02	02
1. IoT Security	IOT Reference Models, IOT Security Threats, IOT security Overview.	CO1	02	08
	IOT Security Overview-IoT Protocols, Network and Transport Layer Challenges, IoT Gateways and Security, IoT Routing Attacks, Bootstrapping and Authentication, Authorization Mechanisms, IoT OAS.		03	
	Security Frameworks for IoT-Light Weight Cryptography, Asymmetric LWC Algorithms Key Agreement, Distribution, and Bootstrapping.		02	
	Privacy in IoT Networks-Secure Data Aggregation, Enigma, Zero Knowledge Protocol Privacy in Beacons.		01	
2. Fog Computing: Principles, Architectures, and Applications	Introduction, Motivating scenario, Definition and characteristics, Applications- Healthcare, Augmented Reality, Caching & Preprocessing, Research Direction and Enablers, Commercial products.	CO2	05	05

3. User Experience Design for the Internet of Things?	How Is UX for IoT Different? A Design Model for IoT Things: The Technology of Connected Devices-Types of Connected Device, Multipurpose Computers, Bridging Physical and Digital: Sensors and Actuators, The Challenge of Powering Devices, Conserving Battery Life Networks: The Technology of Connectivity-Why Is Networking Relevant to IoT UX?,Networking Issues That Cause UX Challenges for IoT, The Architecture of the Internet of Things, Types of Network , Network Communication Patterns, Internet Service.	CO3	07	07
4. Product/Service Definition and Strategy	Making Good Products, From Innovation to Mass Market, Tools Versus Products, What Makes a Good Product?, Services in IoT,Business Models, The Role of Research in Connected Product Design, Initial Questions and Concepts, Techniques: from Asking to Watching to Making.	CO4	07	07
5. Embedded Device Design	An Introduction to Thinking About Physical Objects in IoT,Making Stuff: Differences to UX,Essentials of the Design Process, Three Faces of a Physical Product, Design of a 3D printer.	CO5	05	05
6.Responsible IoT Design	Security,Privacy,Environment,Social Engineering.	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	--	01	01
			Total Hours	**42**

Books	
Text Books:	1. Jake VanderPlas,“ Python Data Science Handbook”, O’Reilly publication,2016.
Reference Books:	1.Internet of Things, Principles and Paradigms by Rajkumar Buyya Designing Connected Products-UX for the Consumer Internet of Things by Claire Rowland, Elizabeth Goodman, Martin Charlier,Ann Light, and Alfred Lui.
Useful Online Resource Links:	1.https://spoken-tutorial.org/watch/Arduino/Introduction+to+Arduino/English/ 2.https://mqtt.org/ 3.https://github.com/microsoft/IoT-For-Beginners
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.