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: 05/07/2024

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 III

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
AIC301	Applications of Mathematics in Engineering-I	3 – 0 – 1	04	3 – 0 – 1	04	BS
AIC302	Data Structure and Algorithms	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC303	Design and Analysis of Algorithms	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC304	Object Oriented Programming with Java	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC305	Discrete Structure for Data Science	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIL302	Data Structure and Algorithms Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL303	Design and Analysis of Algorithms Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL304	Object Oriented Programming with Java Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIPR31	Community Engagement PBL – Mini Project I	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
AIXS37	Web Design and Development (Skill Enhancement - SAT VII: Skill Based Learning)	0 – 2[*] – 0	02	0 – 1 – 0	01	SE-SAT
Total		**15 – 10 – 1**	**26**	**15 – 5 – 1**	**21**	

*SAT can be conducted as TH or P or both as required.

[$]Load of learner, not the faculty.

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	
AIC301	Applications of Mathematics in Engineering-I	20	20	40	60	2.5	25	-	-	-	125
AIC302	Data Structure and Algorithms	20	20	40	60	2.5	-	-	-	-	100
AIC303	Design and Analysis of Algorithms	20	20	40	60	2.5	-	-	-	-	100
AIC304	Object Oriented Programming with Java	20	20	40	60	2.5	-	-	-	-	100
AIC305	Discrete Structure for Data Science	20	20	40	60	2.5	-	-	-	-	100
AIL302	Data Structure and Algorithms Lab	-	-	-	-	-	25	-	-	25	50
AIL303	Design and Analysis of Algorithms Lab	-	-	-	-	-	25	-	-	25	50
AIL304	Object Oriented Programming with Java Lab	-	-	-	-	-	25	-	-	-	25
AIPR31	Community Engagement PBL – Mini Project I	-	-	-	-	-	25	-	-	25	50
AIXS37	Web Design and Development (Skill Enhancement - SAT VII: Skill Based Learning)	-	-	-	-	-	25	-	-	-	25
Total		**100**	**100**	**200**	**300**	**-**	**150**	**-**	**-**	**75**	**725**

SEMESTER IV
TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
AIC401	Mathematics for Data Science	3 – 0 – 1	04	3 – 0 – 1	04	BS
AIC402	Database Management System	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC403	Operating System	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC404	AI Algorithms and Ethics	3 – 0 – 0	03	3 – 0 – 0	03	PC
MMC405	Multidisciplinary Minor Course	3 – 0 – 0	03	3 – 0 – 0	03	MM
AIL402	Database Management System Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL403	Operating System Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
MML405	Multidisciplinary Minor Lab	0 – 2 – 0	02	0 – 1 – 0	01	MM
AIPR42	Community Engagement PBL – Mini Project II	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
AIXS48	Python Programming (Basics to Advanced) Skill Enhancement – SAT VIII: Skill-Based Learning	0 – 2[*] – 0	02	0 – 1 – 0	01	SE-SAT
AIXS49	Indian and Foreign Modern Languages (Ability Enhancement – SAT IX: Skill-Based Learning)	0 – 2[*] – 0	02	0 – 1 – 0	01	AE-SAT
Total		**15 – 12 – 1**	**28**	**15 – 6 – 1**	**22**	

[*]SAT can be conducted as TH or P or both as required.
[$]Load of learner, not the faculty.

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	
AIC401	Mathematics for Data Science	20	20	40	60	2.5	25	-	-	-	125
AIC402	Database Management System	20	20	40	60	2.5	-	-	-	-	100
AIC403	Operating System	20	20	40	60	2.5	-	-	-	-	100
AIC404	AI Algorithms and Ethics	20	20	40	60	2.5	-	-	-	-	100
MMC405	Multidisciplinary Minor Course	-	-	-	-	-	50	50	-	-	100
AIL402	Database Management System Lab	-	-	-	-	-	25	-	-	25	50
AIL403	Operating System Lab	-	-	-	-	-	25	-	25	-	50
MML405	Multidisciplinary Minor Lab	-	-	-	-	-	25	-	-	-	25
AIPR42	Community Engagement PBL -Mini Project II	-	-	-	-	-	25	-	-	25	50
AIXS48	Python Programming (Basics to Advanced) Skill Enhancement – SAT VIII: Skill-Based Learning	-	-	-	-	-	25	-	-	-	25
AIXS49	Indian and Foreign Modern Languages (Ability Enhancement – SAT IX: Skill-Based Learning)	-	-	-	-	-	25	-	-	-	25
Total		**80**	**80**	**160**	**240**	-	**225**	**50**	**25**	**50**	**750**

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: Block chain 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
AIC401	Mathematics for Data Science	03	0	01	04
Prerequisites:	1. Engineering Mathematics. 2. Basics of Applications of Mathematics in Engineering.				
Course Objectives (COBs):	1. To analyze characteristics of matrices like Eigenvalues and Eigen vectors. 2. To analyze characteristics of matrices like Nullity and factorization of matrices. 3. To study statistics for data science. 4. To introduce concepts of probability distributions. 5. To introduce concepts of sampling theory. 6. To use the theory of linear and Non-linear programming in engineering problems.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Determine eigenvalues, eigenvectors of matrices and study diagonalization. 2. Find nullity of the matrix as well as the factorization of the matrix. 3. Find the estimate of location, variability, covariance and correlation. 4. Evaluate probability distribution. 5. Use sampling theory in decision making problems. 6. Solve optimization problems using techniques of Linear and Non-Linear Programming.				

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.Linear Algebra: Theory of Matrices I	Characteristic Equation, Eigenvalues and Eigenvectors, and Properties (without proof).	CO1	02	06
	Cayley-Hamilton Theorem (without proof-state and verify), Verification and Reduction of Higher Degree Polynomials.		02	
	Similarity of Matrices, Diagonalizable and Non-Diagonalizable Matrices.		02	
2.Linear Algebra: Theory of Matrices II	(Recall: Trace, determinant of matrices, Rank of the matrix), Nullity of the matrices (upto 4×4 matrices).	CO2	02	07
	Matrix factorization: LU factorization- Cholesky factorization.		02	
	Singular Value Decomposition.		03	
3.Statistics for Data Analysis	Estimates of locations (Mean, Median, Mode, Quartiles (Q1, Q2, Q3)).	CO3	02	06
	Estimates of variability (Range, Inter quartile range, standard deviation, variance).		02	
	Covariance and Correlations (Kendall rank correlation).		02	
4.Probability Distribution	Discrete Probability Distribution: Binomial distribution, Poisson distribution.	CO4	02	07
	Continuous Probability Distribution: Normal Distribution, Exponential distributions, Webill		05	

	distribution.			
5.Sample Testing	Sampling Distribution, Test of Hypothesis, Level of Significance, Critical Region, One-tailed, and Two-tailed Test, Degree of Freedom.	CO5	02	07
	Students't-distribution (Small Sample), Test Significance of Mean and Difference between the Means of Two Samples, Chi-Square Test: Test of Goodness of Fit and Independence of Attributes, Contingency Table.		03	
	ANOVA test.		02	
6.Linear & Non Linear Programming Problems	Types of Solutions, Standard and Canonical of LPP, Basic and Feasible solutions, Slack Variables, Surplus Variables, Simplex Method.	CO6	03	06
	Unconstrained & constrained NLPP using Method of Lagrange's Multiplier (with one-equality constraint) with two and three variables).	CO5	03	
II.Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01

Text Books:	1. E. Kreyszig, Advanced Engineering Mathematics, Wiley. 2. R. Jain and S. Iyengar, Advanced Engineering Mathematics, Narosa Publication. 3. J. Brown and R. Churchill, Complex Variables and Applications, McGraw Hill.
Reference Books:	1. T. Veerarajan, Probability, Statistics and Random Processes, McGraw Hill. 2. H. Taha, Operations Research: An Introduction, Pearson. 3. S. Rao, Engineering Optimization: Theory and Practice, Wiley. 4. D. Hira and P. Gupta, Operations Research, S. Chand and Sons. 5. B. L. Agarwal, Basic Statistics, New Age International publishers. 6. H. K. Dass, Advance Engineering Mathematics, S. Chand and Company ltd .
Useful Links:	1. https://nptel.ac.in/courses/111/108/111108066/ 2. https://nptel.ac.in/courses/111/103/111103070/ 3. https://nptel.ac.in/courses/111/104/111104071/ 4. https://nptel.ac.in/courses/111/105/111105041/ 5. https://www.coursera.org/learn/complex-analysis 6. NPTEL :: Biotechnology - NOC:Data Analysis for Biologists 7. https://nptel.ac.in/courses/111101165 8. https://nptel.ac.in/courses/104106121
Term Work (TW):	1. Term work should consist of 6 batch wise tutorials. 2. Journal must include at least 2 assignments on content of theory of the course. The distribution of term work marks will be as follows. 1 | Tutorials | 20 2 | Assignment | 05
Continuous Assessment (CA):	The distribution of Continuous Assessment marks will be as follows – 1. Test 1 — 20 marks 2. Test 2 — 20 marks **Tests:** Two tests of 20 marks each should be conducted in a semester. The first test is to be conducted when approx. 40% syllabus is completed and second test when additional

	40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be 1 hour and addition of both tests will be considered as a head of passing.
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.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC402	Database Management System	03	0	0	03

Prerequisite:	1. Data Structures.
Course Objectives: (COBs):	1.Learn and practice data modelling using the entity-relationship and developing database designs. 2.Understand the use of Structured Query Language (SQL) and learn SQL syntax. 3.Apply normalization techniques to normalize the database. 4.Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.
Course Outcomes: (COs):	1. Explain the fundamentals of a database system 2. Design and draw ER and EER diagrams for the real life problem. 3. Formulate relational algebra queries. 4. Query a database using SQL. 5. Apply concepts of normalization to relational database design. 6. Explain the concept of transaction, concurrency and recovery.

Module No. & Name	Subtopics	COs Mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction Database Concepts	1.1 Introduction, Characteristics of databases, File system v/s Database system, Users of Database system.	CO1	02	03
	1.2 Data Independence, DBMS system architecture, Database Administrator.		01	
2.Entity–Relationship Data Model	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation.	CO2	06	06
3.Relational Model and relational Algebra	3.1 Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model.	CO3	03	06
	3.2 Relational Algebra – unary and set operations, Relational Algebra Queries.		03	
4.Structured Query Language (SQL)	4.1 Overview of SQL Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands.	CO4	03	10

	4.2 Set and string operations, aggregate function - group by, having. Views in SQL, joins, Nested and complex queries, Integrity constraint: key constraints, Domain Constraints, Referential integrity, check constraints.		05	
	4.3 Triggers.		02	
5.Relational–Database Design	Pitfalls in Relational-Database designs, Concept of Normalization, Function Dependencies, First Normal Form, 2nd ,3rd, BCNF, multi valued dependencies, 4NF.	CO5	04	05
6.Transactions Management and Concurrency	6.1 Transaction concept, Transaction states, ACID properties, Concurrent Executions, Serializability–Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols.	CO6	05	10
	6.2 Recovery System: Failure Classification, Log based recovery. Deadlock handling.		05	
II. Course Conclusion	**Recap of Modules, Outcomes, Applications and Summarization.**	**---**	**01**	**01**
			Total hours	**42**

Books:	
Text Books:	1. G. K. Gupta "Database Management Systems", McGraw – Hill. 2. Korth, Slberchatz,Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill . 3. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson education. 4. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
Reference Books:	1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press. 2. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley Publication. 3. Sharaman Shah, "Oracle for Professional", SPD. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc19_cs46/preview
	2. https://www.edx.org/course/modeling-and-theory
	3. https://www.edx.org/course/databases-5-sql
	4. https://www.coursera.org/lecture/sql-data-science/introduction-to-databases-XO9Ak
	1. https://onlinecourses.nptel.ac.in/noc19_cs46/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)(60 Marks):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Course Code	Lab course Name	Credits		
		P	TUT	Total
AIL402	Database Management System Lab	01	0	01

Lab Prerequisite:	1.Any programming language
Lab Objectives (LOBs):	1. To identify, define problem statements and construct conceptual data model for real life applications. 2. To build Relational Model from conceptual model (ER/EER). 3. To apply SQL to store and retrieve data efficiently. 4. To demonstrate notions of normalization for database design.
Lab Outcomes (LOs):	1. Identify the need of database and define the problem statement for real life applications. 2. Create relational model for real life applications 3. Formulate query using SQL for efficient retrieval of data. 4. Submit the documentation on time before deadline. 5. Write accurate documentation for experiments performed.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
I.	Lab Prerequisite	--	02
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER)/Extended Entity-Relationship (EER) Model & Mapping ER/EER to Relational schema.	LO1, LO4, LO5	02
2	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified case study.	LO2, LO4, LO5	02
3	Apply DML commands for the specified system & perform simple queries, string manipulation operations and aggregate functions.		02
4	Implement various join operations, nested and complex queries.	LO3, LO4, LO5	02
5	Implementation of views and triggers.		02
6	Implement procedure and functions		02
7	Use of database connectivity like JDBC.		02
8	Deploy the application.	LO2, LO3, LO4, LO5	02

Useful Lab Links:	http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/index.php

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 "Database Management System". 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
AIC403	Operating System	03	0	0	03

Prerequisite:	1. Data Structure. 2. Digital Logic & Computer Architecture.
Course Objectives: (COBs):	1. To introduce basic concepts and functions of operating systems. 2. To understand the concept of process, thread and resource management. 3. To understand the concepts of process synchronization and deadlock. 4. To understand various Memory, I/O and File management techniques.
Course Outcomes: (COs):	1. Describe the objectives, functions and structure of OS. 2. Analyse the concept of process management and evaluate performance of process scheduling algorithms. 3. Apply the concepts of synchronization and deadlocks. 4. Evaluate performance of Memory allocation and replacement policies. 5. Explain the concepts of file management. 6. Apply concepts of I/O management and analyse techniques of disk scheduling.

Module No. & Name	Subtopics	COs Mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course outline	**Prerequisite Concepts and Course Introduction**	**---**	**02**	**02**
1. Operating System Overview	1.1 Introduction, Objectives, Functions and Evolution of Operating System.	CO1	02	06
	1.2 Operating system structures: Layered, Monolithic and Microkernel, Types of Operating Systems: Batch, multiprogramming. Multitasking, time sharing, parallel, distributed & real-time O.S., Linux OS, Mobile OS, Shell and System Calls.		04	
2.Process and Process Scheduling	2.1 Concept of a Process, Process States, Process Description, Process Control Block.	CO2	02	08
	2.2 Types of Scheduling-: Preemptive and Non-preemptive Scheduling algorithms and their performance evaluation, Uniprocessor Scheduling: FCFS, SJF, SRTN, Priority, and Round Robin. Multiprocessor and Real time Scheduling.		04	
	2.3 Threads: Definition and Types, Concept of Multithreading, Types of Threads		02	
3. Process Synchronization and	3.1Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization.	CO3	03	07
	3.2Mutual Exclusion: Requirements, Hardware and Software Support, Semaphores and Mutex, Monitors, Classical synchronization problems: Producer and Consumer problem, Readers/Writers Problem.		04	

4. Deadlock	4.1 Principles of Deadlock: Conditions for Deadlock and Resource Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem	CO4	07	07
5. Memory Management	5.1 Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best- Fit, First Fit, Worst Fit, Paging and Segmentation, TLB	CO5	06	06
	5.2 Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU, Thrashing			
6. File Management and I/O management	6.1 Overview, File Organization and Access, File Directories, File Sharing, Secondary Storage Management	CO6	02	05
	6.2 I/O devices, Organization of the I/O Function, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK. RAID			
II. Course Conclusion	**Recap of Modules, Outcomes, Applications and Summarization.**	**---**	**01**	**01**
			Total hours	**42**

Books:	
Text Books:	1. 1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition, 2014. 2. Abraham Silber Schatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9th Edition, 2016.
Reference Books:	1. Achyut Godbole and Atul Kahate, "Operating Systems", McGraw Hill Education, 3rd Edition. 2. Andrew Tannenbaum, "Operating System Design and Implementation", Pearson, 3rd Edition. 3. Maurice J. Bach, "Design of UNIX Operating System", PHI. 4. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4th Edition.
Useful Links:	1. Introduction to Operating Systems - Course (nptel.ac.in)
	2. NPTEL : Electronics & Communication Engineering - Linux Programming & Scripting
	3. Free Online Course: Introduction to Operating Systems from Swayam | Class Central
Continuous Assessment (CA):	Test-1, Test-2 and Average (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 compulsory.
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 Course Name	Credits		
		P	TUT	Total
AIL403	Operating System Lab	01	00	01

Lab Prerequisite:	Knowledge on Operating system principles
Lab Objectives:	1. To gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment. 2. To familiarize students with the architecture of Linux OS. 3. To provide necessary skills for developing and debugging programs in Linux environment. 4. To learn programmatically to implement simple operation system mechanism.
Lab Outcomes (LOs):	1. Demonstrate basic Operating system Commands, Shell scripts, System Calls and API wrt Linux. 2. Implement various process scheduling algorithms and evaluate their performance. 3. Implement and analyze concepts of synchronization and deadlocks. 4. Implement various Memory Management techniques and evaluate their performance. 5. Implement and analyze concepts of virtual memory. 6. Demonstrate and analyze concepts of file management and I/O management techniques.

Lab. No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Explore Linux Commands Explore usage of basic Linux Commands and system calls for file, directory and process management. For eg: (mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. sort, grep, awk, etc.).	LO1	02
2.	Linux shell script Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. Display current shell, home directory, operating system type, current path setting, and current working directory.	LO2	02
3.	Linux- API Implement any one basic commands of Linux like ls, cp, mv and others using kernel APIs.	LO1	02
4.	Linux- Process a.Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system calls.	LO2	02

	b.Explore wait and waitpid before termination of process.		
5.	Process Management: Scheduling a. Write a program to demonstrate the concept of non-pre-emptive scheduling algorithms. b. Write a program to demonstrate the concept of pre-emptive scheduling algorithms	LO2	02
6.	Process Management: Synchronization a. Write a C program to implement solution of Producer consumer problem through Semaphore.	LO3	02
7.	Process Management: Deadlock a. Write a program to demonstrate the concept of deadlock avoidance through Banker's Algorithm. b. Write a program demonstrate the concept of Dining Philosopher's Problem.		02
8.	Memory Management a. Write a program to demonstrate the concept of MVT and MFT memory management techniques. b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e. Best Fit, First Fit, Worst-Fit etc.	LO4	02
9.	Memory Management: Virtual Memory a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation. b. Write a program in C demonstrate the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.	LO5	02
10.	File Management & I/O Management a. Write a C program to simulate File allocation strategies typically sequential, indexed and linked files. b. Write a C program to simulate file organization of multi-level directory structure. c. Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN.	LO6	02

Virtual Lab Links:	http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/CRUX/labs/exp1/procedure.html

Term work:	1.Term work should consist of a minimum of 10 experiments. 2.Journal must include at least 2 assignments on content of theory and practical of the course "Operating System 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).

P&O: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	PR	TUT	Total
AIC404	AI Algorithms & Ethics	03	0	0	03

Prerequisite:	1. Discrete Structures. 2. Data Structure. 3. Analysis of algorithm. 4. Programming Language.
Course Objectives:	1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems. 2. To make students understand and explore the mechanism of mind that enables intelligent thought and action. 3. To make students understand advanced representation formalism and search techniques. 4. To make students understand how to deal with uncertain and incomplete information and to follow AI ethics.
Course Outcomes:	At the end of the course, the students will be able to 1. Describe the basic concepts of AI. 2. Develop a basic understanding of AI building blocks presented in intelligent agents. 3. Choose an appropriate problem-solving method and knowledge representation technique. 4. Provide a foundational understanding of AI ethics, including key principles, historical context, and the identification and mitigation of bias and privacy concerns. 5. Examine the ethical challenges in AI development and deployment, focusing on ethical design, accountability, transparency, and regulatory frameworks. 6. Explore the societal and global impacts of AI, including workforce transformation, AI for social good, autonomous systems safety, global inequality, and future ethical challenges.

Module No. & Name	Sub Topics	CO Mapped	Hrs /Subtopic	Total Hrs/ Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	--	--	02
1. Introduction to Artificial Intelligence	Introduction, Intelligent Systems: Categorization of Intelligent System.	CO1	01	03
	Components of AI Program, Foundations of AI, Subareas of AI, Applications of AI, Current trends in AI.		02	
2. Intelligent Agents	Agents and Environments, the concept of rationality, the nature of environment, the structure of Agents, Types of Agents, Learning Agent.	CO2	03	05
	Solving problem by Searching: Problem Solving Agent, Formulating Problems, and Example Problems.		02	
3. Problem Solving using Artificial	Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID).	CO3	02	10

Intelligence	Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search		03	
	Local Search Algorithms and Optimization Problems: Hill climbing search, Simulated annealing, Genetic algorithms		03	
	Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning		02	
4. Introduction to AI Ethics	Overview of AI Ethics: Definition and scope of AI ethics, Importance of ethical considerations in AI, Historical context and evolution of AI ethics.	CO4	01	07
	Key Ethical Principles: Autonomy, justice, beneficence, non-maleficence, Privacy, fairness, transparency, accountability Ethical Theories and AI: Utilitarianism, deontology, virtue ethics, Application of ethical theories to AI.		02	
	Bias and Fairness in AI: Understanding bias in AI systems, Sources of bias: data, algorithms, human factors, Case studies: Bias in facial recognition, hiring algorithms.		02	
	Privacy and Surveillance: Data privacy issues in AI, Surveillance technologies and ethical implications, Balancing security and privacy.		02	
5. Ethical Issues in AI Development and Deployment	Ethical AI Design: Principles of ethical AI design, Inclusive design and participatory approaches. Accountability and Responsibility: Defining accountability in AI systems, Who is responsible: developers, users, companies?	CO5	03	08
	Transparency and Explainability: Importance of transparency in AI, Techniques for achieving explainability, Challenges and limitations.		01	
	AI in Decision-Making: AI in critical decision-making contexts: healthcare, criminal justice, finance, Ethical challenges and case studies, Human-in-the-loop and human oversight. Regulation and Governance: Current regulatory frameworks for AI, International perspectives and emerging guidelines, Future directions in AI governance.		04	
6.Societal and Global Impacts of AI	AI and the Workforce: Impact of AI on jobs and employment, Reskilling and upskilling the workforce, Ethical considerations in workforce transformation. AI and Social Good: AI applications for social good, Ethical frameworks for AI in social initiatives.	CO6	03	06
	Autonomous Systems and Safety: Ethical concerns with autonomous vehicles and drones, Safety protocols and risk management, Case studies on accidents and ethical dilemmas. AI and Global Inequality: AI's impact on global inequality, Digital divide and access to AI technologies.		02	
	Future of AI Ethics: Emerging trends and challenges in AI ethics, Ethical considerations in advanced AI (AGI, ASI), Preparing for an ethical AI future.		01	

II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total Hours	**42**
Books:				
Text Books	1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition" Pearson Education, 2020. 2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011 3. George F Luger, "Artificial Intelligence" Low Price Edition, Fourth edition, Pearson Education.,2005			
Reference Books	1. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication. 129 2. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication 3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education. 4. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, McGraw Hill Education, 2017. 5. Vincent C. Müller, "Ethics of Artificial Intelligence and Robotics", ISBN: 978-1138821233			
Useful Links:	1. https://www.coursera.org/learn/introduction-to-ai			
	2.Artificial intelligence and expert systems: a ... - IEEE Xplorehttps://ieeexplore.ieee.org › document			
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 "Artificial Intelligence" 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.			

Project Based Learning Code	Project Based Learning	Credits		
		P	TUT	Total
AIPR42	Community Engagement PBL-Mini Project-II	01	0	01
PBL Prerequisites:	Mini Project Lab 1			
PBL 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 acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.			
PBL Outcomes:	Learner will be able to… 1. Identify problems based on societal /research needs. 2. Conduct comprehensive reviews of existing literature to understand the current state of knowledge on a specific topic 3. Apply Knowledge and skill to solve societal problems in a group. 4. Develop interpersonal skills to work as member of a group or leader. 5. Analyze the impact of solutions in societal and environmental context for sustainable development. 6. Excel in written and oral communication. 7. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 8. Demonstrate project management principles during project work.			
Guidelines for Mini Project:				
1.	Project based learning Mini Project Lab 2 should be implemented using Python programming (AIXS45)			
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 needs, which shall be converted into problem statement for mini 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 mini 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 mini 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.	Students shall convert the best solution into working model using Java programming.			
9.	The solution to be validated with proper justification and report to be compiled in standard format of the college.			
10.	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be			

	carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.
11	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini 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 Mini 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 mini 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**
1.	Marks awarded by guide/supervisor based on implementation (Minimum 2 modules implementation is expected) *Modules- Operations, Functions as per the requirement of project)	10
2.	Peer assessment by team members	05
3.	Marks awarded by review committee	05
4.	Quality of Project report and Review Paper	05

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 Mini Project.

Mini Project shall be assessed based on following criteria;

1.	Quality of survey and identification of problem statement
2.	Innovativeness in solutions
3.	Implementation
4.	Team work
5.	Project report

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1.	Report should be prepared as per the guidelines.
2.	Mini 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.

Mini 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
Practical & Oral (P&O):	P&O examination will be based on mini project implementation.
Term Work:	Term work shall be awarded based on 1. Logbook maintained by each project group and weekly meeting based on the same. 2. Students active participation in Technology learning. 3. Presenting/Showcasing Learned Technology uses in social /Outreach/ Extension activities / Events/ Competitions/ Trainings/ Internships/ Development programs etc. 4. Submission of participation/online course completion certificate with results of regular assignments / tests submission / performance and grades awarded, etc. 5. Term work of 25 marks.

Lab Code	Lab Course Name	Credits		
		P	TUT	Total
AIXS48	Python Programming(Basics to Advanced)Skill Enhancement-SAT VIII: Skill-Based Learning	01	0	01

Skill Prerequisite:	1. Knowledge of some programming language like C, Java
Skill Objectives:	1. Basics of Python programming. 2. Decision Making, Functions in Python. 3. Object Oriented Programming using Python. 4. Web framework for developing.
Skill Outcomes (SOs):	1. To understand basic concepts in python. 2. To explore contents of files, directories and text processing with python 3. To understand data structure in python. 4. To explore flask web framework for developing python-based web Application and Demonstrate CRUD operations 5. To understand the basics of NumPy and Pandas. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Module No. & Name	Sub Topics	SO mapped	Hrs/Sub topics
I. Prerequisites and Course Outline	Introduction to python, Features	--	01
1.Python basics	1.1Data types in python, Operators in python, Input and Output, Control Statement	SO1, SO6	01
	1.2String and Character in python, Functions		01
	1.3Introduction to OOP, Classes, Objects, Interfaces, Inheritance		02
2.File Handling	2.1 Files in Python, Directories	SO2 SO6	01
	2.2 Building Modules		01
	2.3 Packages, Text Processing		01
	2.4 Regular expression in python.		01
3.Data Structure in Python	3.1 List and Tuples	SO3, SO6	02
	3.2 Dictionaries, Set		02
4. Python Integration Primer	4.1 Graphical User interface, Networking in Python	SO4, SO6	02
	4.2 Python database connectivity		02
	4.3Introduction to flask		02
5. Numpy	5.1Creating NumPy arrays, Indexing and slicing in NumPy, creating multidimensional arrays, NumPy Data types	SO5, SO6	02
	5.2Array Attribute, Indexing and Slicing, Creating array views copies, Manipulating array shapes I/O		02
6. Pandas	6.1 Basics of Pandas, Using multilevel series, Series	SO5,	02

	and Data Frames, Grouping, aggregating, Merge Data Frames	SO6	
	6.2 Cleaning Data, Web Scraping		02
	6.3 Introduction to Hugging face, Gradio, Github		01

Textbooks:	1. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press.
	2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne,Wrox Publication.
	3. Anurag Gupta, G. P. Biswas, "Python Programming", McGraw-Hill
	4.E. Balagurusamy, "Introduction to computing and problem-solving using python",McGraw Hill Education.
References:	1.Learn Python the Hard Way, 3rd Edition, Zed Shaw's Hard Way Series
	2.Laura Cassell, Alan Gauld, "Python Projects", Wrox Publication
Digital material:	1."The Python Tutorial" ,,http://docs.python.org/release/3.0.1/tutorial
	2. Beginning Perl,https://www.perl.org/books/beginning-perl/
	3. http://spoken-tutorial.org/
	4. https://starcertification.org/Certifications/Certificate/python

Lab. No.	Suggested experiments using Python:
1	Exploring basics of python and control statements.
2	Creating functions, classes and objects using python.
3	Demonstrate exception handling and inheritance.
4	Exploring Files and directories a. Python program to append data to existing file and then display the entire file b. Python program to count number of lines, words and characters in a file. c.Python program to display file available in current directory.
5	Exploring Data structures like Dictionary, List, Tuple, Sets in Python
6	Creating GUI with python containing widgets such as labels, textbox, radio, checkboxes and custom dialog boxes.
7	Implement Menu driven program using match case.
8	Program to demonstrate CRUD (create, read, update and delete) operations on database (SQLite/ MySQL) using python.
9	Creation of simple socket for basic information exchange between server and client.
10	Creating web application using flask web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).
11	Exploring basics of NumPy Methods.
12	Program to demonstrate use of NumPy: Array objects.
13	Program to demonstrate Data Series Data Frames and Data Cleaning using Pandas.
14	Program to send email and read content of URL.

Virtual Lab Links:	Welcome to Virtual Labs - A MHRD Govt of india Initiative (vlabs.ac.in)
Term work:	Term work shall be awarded based on 1. Students should perform a minimum of 10 experiments. The programs performed along with the screenshot of output have to be submitted within two days. A cover page will be attached stating the aims, objectives and post lab questions. This will be

	considered towards 15 marks. 2. Journal must include at least 2 assignments. This will carry 5 Marks3. A spoken tutorial test will be conducted at the end of the syllabus for 05 marks. 4. Term work total 25 marks. (Experiment :15 Marks, Assignments: 5 Marks, Spoken Tutorial Test:5 Marks).

Lab course Code	Lab Course Name	Credits			
		TH	P	TUT	Total
AIXS49	Indian/ Foreign Modern Language [Ability Enhancement-SAT-IX: Skill Based Learning]	0	01	0	01

Lab Prerequisite:	---
Skill Objectives (LOBs):	1.Acquire reading and writing proficiency in the target language. 2.Understand the common heritage of, and diversity among, countries that speak the target language. 3.Communicate and interact effectively with citizens of the target cultures.
Skill Outcomes (LOs):	1.Upon completion of the course, the learners will be able to: 2.Demonstrate of communicative proficiency in the target language. 3.Write the target language in formal expository prose that impede communication. 4.Learn through MOOC online courses to adopt hybrid mode of learning.

Guidelines:-

Each student has to complete any one MOOC course from NPTEL/Coursera/Udemi sites as given in the list.

Sr.No.	Courses offered	SO mapped	Hrs/Lab
I.	Lab Prerequisite.	--	02
1	Introduction to Japanese Language and Culture.	LO1, LO5	02
2	German.	LO1, LO5	02
	The Psychology Of Language.	LO1, LO5	02
3	Spanish Vocabulary: Meeting People , Cultural Experience, Sports, Travel, and the Home, Careers and Social Events, Spanish Vocabulary Project.	LO1, LO5	02
4	A Bridge to the World: Korean Language for Beginners, First Step Korean, Learn to Speak Korean 1, The Korean Alphabet: An Introduction to Hangeul.	LO1, LO5	02
5	Complete French Course: Learn French for Beginners.	LO1, LO5	02
6	Complete German Course: Learn German for Beginners.	LO3, LO5	02
7	Spanish 1-4: Beginner, Elementary, Intermediate and Advanced.	LO3, LO5	02
8	Complete Japanese Course: Learn Japanese for Beginners.	LO1, LO5	02
9	Complete Korean Course: Learn Korean for Beginners.	LO2, LO5	02
10	The Complete Russian Language Course.	LO2, LO5	02
11	Spoken Sanskrit: Basic and Intermediate Levels.	LO2, LO5	02
12	Applied Linguistics.	LO2, LO5	02
13	Fundamental Concepts in Sociolinguistics.	LO2, LO5	02
14	Introduction to Basic Spoken sanskrit and intermediate level to Basic Spoken Sanskrit.	LO1, LO5	02
15	Perform Animation (such as Rising Sun, Moving Vehicle, Smileys, Screen saver etc. using C/C++/Java/OpenGL/Blender/ any other tool).	LO1, LO2, LO3, LO4, LO5	02
16	Case Study: Virtual Reality and Sample program using VRML.	LO4, LO5	02

Useful Lab Links:	https://onlinecourses.nptel.ac.in/noc22_hs84/preview
	https://onlinecourses.nptel.ac.in/noc22_hs89/preview
	https://onlinecourses.nptel.ac.in/noc22_hs123/preview
	https://www.coursera.org/learn/spanish-vocabulary-cultural-experience
	https://www.coursera.org/learn/spanish-vocabulary-sports-travel-home

	https://www.coursera.org/learn/spanish-vocabulary-careers
	https://www.coursera.org/learn/spanish-vocabulary-project
	https://www.coursera.org/learn/korean-beginners
	https://www.coursera.org/learn/learn-korean
	https://www.coursera.org/learn/learn-speak-korean1
	https://www.coursera.org/learn/the-korean-alphabet-an-introduction-to-hangeul
	https://www.udemy.com/course/complete-french-course/
	https://www.udemy.com/course/complete-german-course-learn-german-for-beginners/
	https://www.udemy.com/course/spanish-101-beginning-spanish-spanish-for-beginners/
	https://www.coursera.org/learn/spanish-vocabulary-careers
	https://www.udemy.com/course/complete-korean-course-learn-korean-for-beginners-level-1/
	https://www.udemy.com/course/the-complete-russian-language-course/
	https://onlinecourses.nptel.ac.in/noc22_hs114/preview
	https://onlinecourses.nptel.ac.in/noc22_hs85/preview
	https://onlinecourses.nptel.ac.in/noc22_hs139/preview
Term work(TW):	Each student has to complete any one MOOC course from NPTEL/Coursera/ Udemi sites as given in the list.

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	PR	TUT	Total
MMVLSIC405	Digital System Design	03	0	0	03

Prerequisite:	1. Digital Electronics
Course Objectives:	1. To introduce the foundational concepts of digital design, including Boolean algebra, combinational and sequential logic, and IC technology. 2. To enable students to design, analyze, and optimize combinational and sequential circuits while addressing hazards and ensuring reliable performance. 3. To provide hands-on experience in using Verilog for modeling, simulating, and implementing digital systems. 4. To familiarize students with programmable logic devices like ROM, CPLD, and FPGA, and their applications in digital system design.
Course Outcomes:	1. Understand the fundamental concepts and methodologies of digital system design. 2. Apply techniques to design and optimize combinational circuits, addressing common issues like hazards. 3. Analyze the behavior and performance of sequential circuits and storage elements. 4. Create efficient state machine designs for real-world applications. 5. Develop and implement digital designs using Hardware Description Languages (HDL). 6. Evaluate programmable logic devices for their suitability in digital system applications.

Module No. & Name	Sub Topics	CO Mapped	Hrs /Subtopic	Total Hrs/ Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	--	--	02
1. Introduction to Design Methodology	1.1 Design Methodology	CO1	02	03
	1.2 IC Technology		01	
2. Review of Logic Design Fundamentals	2.1 Combinational Logic, Boolean Algebra and Algebraic Simplification, Boolean Algebra and Algebraic Simplification, Designing with NAND and NOR Gates	CO2	02	10
	2.2 Glitches and Hazards in Combinational Circuits : Static Hazards, Elimination of static hazards, static hazards in multi -level circuit, elimination of static hazards in multi -level circuits, dynamic hazards		03	
	2.3 Storage elements: SR Latch, D Latch, JK Latch		01	
	2.4 Analysis of clocked sequential circuits: Set up and hold time for D Flip Flop, JK Flip Flop		04	
3. Design of sequential machines	3.1 Types of state machines: Mealy machine, Moore machines	CO3	01	06
	3.2 State table and graphs		01	
	3.3 Sequence detector		01	
	3.4 State reduction and equivalent state		01	
	3.5Case study of Mealy and Moore machines: NRZ to Manchester code converter, sequential parity checker, comparator.		02	

4. Introduction to logic design using Verilog	4.1 HDL fundamentals : Design Methodology	CO4	01	08
	4.2 Verilog primitives and encapsulation		02	
	4.3 Models with example : Structural, Dataflow and Behavioral		01	
	4.4 Lexical convention		02	
	4.5 Data Type		01	
5. Advanced Verilog	5.1 Timing and Delays	CO5	02	08
	5.2 Switch Level Modelling		02	
	5.3 User Defined Primitives		02	
	5.4 Test bench		01	
	5.5 State machine case study: Traffic Signal controller		01	
6. Programma ble Logic Devices	6.1 ROM, Programmable Array Logic , Programmable Logic Array	CO5	02	04
	6.2 CPLD		02	
	6.3 FPGA			
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total Hours	**42**

Books:	
Text Books	1. Digital Design: with an introduction to Verilog HDL, VHDL and System Verilog by M. Morris Mano and Michael D. Ciletti, 5th Edition, Pearson Education, 2018. 2. Fundamentals of Logic Design by Roth and Kinney. 7th edition, Cengage learning, 2014. 3. Advanced Digital Design with the Verilog HDL by Michael D Ciletti, 2nd edition, Pearson education, 2017. 4. Digital system design using Verilog by Roth, John and Lee, 1st edition, Cengage learning, 2016.
Reference Books	Verilog HDL - A Guide to Digital Design and Synthesis, Second Edition Samir Palnitkar.
Useful Links:	NPTEL: 1. https://onlinecourses.nptel.ac.in/noc22_ee55/preview 2. https://onlinecourses.nptel.ac.in/noc22_ee55/preview
Term work:	• 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.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
MMVLSIL405	Digital System Design Lab	0	01	0	01

Hardware Requirements:	1. FPGAs
Software Requirements:	1. LogiSim. 2. Xilinx Vivado.
Prerequisites:	Digital Logic Design Lab.
Lab Objectives (LOBs):	1. Design and simulate combinational and sequential circuits using Verilog. 2. Demonstrate static hazards and setup/hold time violations in circuits. 3. Synthesize and implement a design on FPGA, optimizing for performance.
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Explain static hazards and timing constraints in digital circuits 2. Design and simulate combinational and sequential circuits in Verilog, and verify functionality with test benches. 3. Design and simulate state machines. 4. Synthesize and evaluate digital circuits for FPGA implementation, optimizing for performance. 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	LOs Mapped	Hours
I.	Lab Prerequisites	-	02
1	Detection and Mitigation of Static Hazards in Combinational Circuits	LO1	02
2	Demonstration of Setup and Hold Time in Sequential Circuits	LO1	04
3	Design and Simulation of a Mealy Machine for Sequence Detection	LO3	02
4	Design and Simulation of a Moore Machine for Sequence Detection	LO3	02
5	Design and simulation of combinational circuits using Verilog	LO2	02
6	Design and simulation of sequential circuits using Verilog	LO2	02
7	Develop and simulate test benches to verify the functionality of Verilog modules.	LO2	02
8	Design a state machine-based traffic signal controller using Verilog	LO2, LO3	02
9	Simulate and synthesize a circuit for FPGA implementation.	LO4	02
		Total Hours	**24**

Term Work (TW):	• Term work should consist of a minimum of 08 Experiments / Activities / Case Studies, or equivalent Mini-Project. • Term work evaluation shall be for Total 25 Marks based on performance.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMBTC405	Introduction to Biotechnology & Bioinformatics	03	0	0	03

Prerequisites:	Biology till 10th standard.
Course Objectives (COBs):	1. Become aware of the concept of Microbes and their potentials. 2. To familiarize with the fundamental make up of cells and the central dogma of life. 3. To make learners aware of the structure and properties of nucleic acids. 4. Understand Core Concepts: Grasp the fundamental principles of bioinformatics, including its history, scope, and essential data formats. 5. Explore Biological Databases: Learn to navigate and utilize various primary, secondary, and specialized biological databases effectively.
Course Outcomes (COs):	**After the successful completion of this course, learner will be able to:** 1. Identify and differentiate between major groups of microorganisms including bacteria, fungi, protists, and viruses and explain the concept of sterilization and disinfection 2. Examine the applications of microorganisms in different sectors of biotechnology. 3. Explain the structure and function of the cellular components in prokaryotic cell. 4. Illustrate structure and properties of DNA & RNA 5. Describe the fundamental principles of bioinformatics, including its history, scope, and essential data formats. 6. Explore Biological Databases to navigate and utilize various primary, secondary, and specialized biological databases effectively.

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	**Prerequisite Concepts and Course Introduction.**	--	01	01
1. Microbiology	Introduction to the concept of Biotechnology- Colors of Biotechnology.	CO1	01	06
	Introduction to the microbial world- Bacteria, Fungi, Protists, and Viruses.		02	
	Microbial growth and control- cultivation of microorganisms, Sterilization, and disinfection.		02	
	Effect of microbes on human health.		01	
2.Microbiology	Applications of Microbes in commercial sectors – Food, Dairy, Beverages, and pharmaceuticals(Two examples each	CO2	02	06
	Diagnostic Microbiology		01	
	Role of microorganisms in remediation of solid and liquid wastes-Bioremediation, Bioaugmentation,Phytoremediation		02	
	Wastewater treatment (Industrial wastewater and sewage treatment.)2L		01	

3. Cell Biology	**Prokaryotic Cell Biology** Cell Membrane: Structure and function of the prokaryotic cell membrane.	CO3	01	08
	Cell Wall: Composition and differences between Gram-positive and Gram-negative bacteria.		01	
	Capsule and Slime Layer: Structure and roles in protection and pathogenicity.		01	
	Cytoplasm: Components and functions within the prokaryotic cytoplasm. Nucleoid: Organization and function of the prokaryotic chromosome.		02	
	Ribosomes: Structure and role in protein synthesis. Inclusion Bodies: Types and functions of storage granules and gas vesicles.		01	
	Flagella and Pili: Structure, function, and role in motility and conjugation.		01	
	Cell Membrane: Structure and function of the prokaryotic cell membrane.		01	
4. Basic concepts of DNA & RNA	Introduction to central dogma of Molecular Biology, Features of genetic material,	CO4	01	07
	Structure of DNA, properties of DNA, Types of DNA.		01	
	Plasmids- introduction, features, and functions. Structure of RNA, Properties of RNA		02	
	Types of RNA, Differences between DNA and RNA Functions of RNA.		02	
	Electrophoretic separation of nucleic acids.		01	
5.Fundamentals of Bioinformatics - I	Introduction to Bioinformatics Overview of Bioinformatics: Definition, history, and scope. Human genome project and Biological data.	CO5	02	07
	Data Formats: FASTA, GenBank, and other common formats.		01	
	Database file structures and Database Management Systems: Flat file, Relational, Object oriented.		01	
	Biological Databases: Primary Databases: NCBI, EMBL, DDBJ Secondary Databases: UniProt, InterPro Specialized Databases: PDB, OMIM Database Examples and Usage: Practical examples and navigating biological databases. Introduction to Bioconductor package in R Biopython modules.		03	
6.Fundamentals of Bioinformatics - II	Sequence Analysis in bioinformatics: Understanding variation in biological organisms: Sources of variation: mutation/recombination. Concept of microevolution, synonymous and nonsynonymous mutations.	CO6	02	07

	Sequence Alignment: Concepts of pairwise and multiple sequence alignment.		01	
	Dynamic Programming Algorithms: Needleman-Wunsch and Smith-Waterman algorithms.		01	
	Heuristic Methods: Introduction to BLAST and FASTA.BLAST and FASTA: Detailed usage and applications.		01	
	Multiple sequence alignment; algorithms, Progressive (CLUSTAL W) and Iterative algorithm.		01	
	Phylogenetics: Basics of phylogenetic tree construction. UPGMA, Neighbour Joining, Maximum parsimony.		01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	--	01	01
			Total Hours	**42**

Books:	
Text Books:	1. Text Book of Microbiology-Pawar and Daginwala Vol-I and II 2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (Library Editions) [Paperback] Dr. P S Verma & Dr. V K Augural Paperback · **ISBN**-13. 978-8121924429 3. Xiong, J. (2006). Essential bioinformatics. https://doi.org/10.1017/cbo9780511806087 4. Strachan and Read (2011). Human molecular genetics, 4th edition, Garland Science
Reference Books:	1. Molecular Biology Of The Cell, 7th Edition Paperback – 1 July 2022 by Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff , Keith Roberts, Peter Walter. ISBN-13 978-0393884852. 2. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill. 3. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. 4. Bioinformatics: Sequence and Genome Analysis, Second Edition ISBN-13 978-0879697129. 5. Machine Learning in Bioinformatics. (2009). Germany: Wiley. ISBN: 9780470397411, 047039741.
Useful Online Resource Links:	1. https://biotech01.vlabs.ac.in/List%20of%20experiments.html
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.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
MMBTL405	Bio-Informatics Lab	0	01	0	01

Lab Prerequisite:	Basic computer skills
Lab Objectives (LOBs):	To develop basic bioinformatics skills
Lab Outcomes (LOs):	**At the end of the course, the student will be able to** 1.Exhibit basic bioinformatics skills 2.Explore the structure of biological databases, retrieving and interpreting relevant biological data. 3.Apply machine learning and data mining algorithms to solve bioinformatics problems such as gene prediction and protein structure analysis, classification etc. 4.Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LOs Mapped	Hours
1	Practical examples and navigating biological databases.	1,4	02
2	BLAST/FASTA tool	1,4	02
3	CLUSTAL W for MSA	1,4	02
4	PSI BLAST	1,4	02
5	PROSITE	1,4	02
6	GeneMark	1,4	02
7	Protein Structural Classification tools and databases (CATHSCOP)	2,4	02
8	Apply Machine learning algorithm for gene prediction	3,4	02
9	Apply clustering algorithms (K-means,Hierarchial clustering) for gene expression data analysis.	3,4	02
10	Perform cancer classification with suitable machine learning	3,4	02
11	Identify suitable biological databseses and analyse it with different data analysis tools.	2,4	02
12	Develop an end to end application for solving bioinformatics problems	2,4	02
		Total Hours	**24**

Useful Links:	1. https://doi.org/10.1021/acs.jchemed.1c00289
Term work:	1. Term work should consist of 10 experiments. 2. Journal must include at least 2 assignments 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)

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMGISC405	Spatial Computing Technologies	03	0	0	03

Prerequisites:	No Pre-requisites needed
Course Objectives (COBs):	1. To learn the basics and concepts of GIS. 2. To understand the components and importance of GIS. 3. To study GIS capabilities in input, verification, analysis, modeling, and output generation. 4. To understand the importance of manipulation and applications. 5. To learn methods of spatial data analyses, simulation, and modeling aspects.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Understand basic concepts and benefits of GIS for handling geospatial data. 2. Gain skills to generate, group, and store geospatial data in effective data structures. 3. Working with external files and formats on mapping. 4. Apply GIS to solve geological problems geospatially. 5. Analysis for specific problems and decision making. 6. Develop abilities in manipulation, 3D visualization, spatial analysis, and spatial modeling.

Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module
I. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	01	01
1. Basics of GIS	1.1 Definition, Usefulness of GIS, Components of GIS	CO1	02	06
	1.2 Computer Hardware, Software Modules		02	
	1.3 Organizational Context of GIS		02	
2. Data Structure	2.1 Data Structure in GIS	CO2	01	06
	2.2 Types of Data (Points, Lines, Polygons)		02	
	2.3 Database Structures (Raster, Vector)		01	
	2.4 Data Conversion (Vector to Raster, Raster to Vector)		02	
3. Data Input, Verification, Storage, Output	3.1 Spatial Data Input Processes	CO3	02	09
	3.2 Devices		01	
	3.3 Non-spatial Data Entry		02	
	3.4 Data Verification and Correction		02	
	3.5 Data Output Methods		02	
4. Working with external data	4.1 Working with KML file	CO4	01	08
	4.2 CSV, Tables, Graphs and Report to Map		02	
	4.3 Plot the X and Y		01	
	4.4 Join and Relate		02	
	4.5 Properties and Data visualisation with its riles		02	
5. Spatial Modelling	5.1 Interpolation, Hotspot analysis and Overlay	CO6	02	02
6. Spatial	6.1 Basic Principles and Methods of Interpolation, Volume Estimation	CO5	02	09

Interpolation and DEM	6.1 Basic Principles and Methods of Interpolation, Volume Estimation		02	
	6.2 Digital Elevation Model (DEM) Methods and Applications		02	
	6.3 Slope Analysis		02	
	6.4 Contour Maps		02	
	6.5 Profile Mapping			
II. Course Conclusion	Recap of Mo dul e s, Outcomes, Applications, a n d Summarization.	**---**	01	01
			Total Hours	**42**

BOOKS:

Text Books:	1.Burrough, P.A., Principles of Geographical Information Systems for Land 2 . Resources Assessment, Clarendon Press, Oxford, 1986.Kang-Tsung Chang, Introduction to Geographic Information System, McGraw Hill, Boston, 2002.
Reference Books:	1. Campbell, J., Introductory Cartography, Prentice Hall, Englewood Cliffs, NJ, 1984. 2. Dent, B.D., Principles of Thematic Map Design, Addison-Wesley, Reading, MA, 1985. 3. Freeman, H., Pieroni, G.G., Map Data Processing, Academic Press, New York, 1980. 4. Monmonier, M.A., Computer Assisted Cartography - Principles and Prospects, Prentice Hall, Englewood Cliffs, NJ, 1982.
Term Work (TW):	• Presentations, Assignments, Class Participation, 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.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
MMGISL405	Geographical Information System (GIS)	0	01	0	01

Hardware Requirements:	**Operating System:** • Windows 10, 11 (64-bit) or Windows Server 2016, 2019, 2022 **Processor:** • Dual-core processor, 2 GHz minimum (Quad-core recommended) **Memory (RAM):** • 8 GB minimum (16 GB or more recommended) **Graphics Card:** • DirectX 11 or OpenGL 4.3 capable graphics card with at least 4 GB dedicated video memory (8 GB recommended for 4K displays and complex datasets) • NVIDIA, AMD, or Intel HD Graphics with the latest drivers installed **Storage:** • 32 GB minimum free space • Solid-state drive (SSD) recommended for better performance **Display:** • 1024x768 minimum resolution (1920x1080 or higher recommended) **Internet Connection:** • Required for software activation, updates, and access to online features **.NET Framework:** • Version 4.8 or later
Software Requirements:	ArcGIS / QGIS
Prerequisites:	No requirement
Lab Objectives (LOBs):	1. To study the principles and concepts of GIS 2. To learn the data input, editing in GIS 3. To develop the spatial database on GIS 4. To perform spatial analysis on GIS 5. To learn the Map projection and area calculation
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Digital map with geodatabase 2. Spatial database with real world coordinate 3. Geospatial models 4. Working with Dataset 5. Spatial Analysis and Decision making

Lab No.	Experiment Title	LOs Mapped	Hours
I.	Lab Prerequisites	-	02
1	Unit 1: Scanning/Data input and Geo referencing of map	1	02
2	Unit:2. Digitization, Data Editing, Labelling and geo database creation	1	04
3	Unit:3. Projection and Transformation of map & area calculation	2	02
4	Unit:4. Creation of non-spatial/attribute data base	2	02
5	Unit:5. Linking of Spatial and Non-Spatial data, Query based Retrieval and Spatial display of non- spatial data 2 hrs	3	02

6	Unit:6. Data editing/ error removal for GIS analysis – Regrouping, Dissolving / Merging 2 hrs	3	02
7	Unit:7. GIS spatial analyses (Overlay) & Preparation of criteria table	4	04
8	Unit:8. GIS spatial analyses (Buffering)	4	02
9	Unit:9. Map design and Map Layout creation	5	02
		Total Hours	**24**

Online Resource Links:	1. http://downloads.esri.com/support/documentation/ao_/1003Getting_Started_with _Ar cGIS.pdf 2. https://desktop.arcgis.com/en/arcmap/latest/get-started/introduction/arcgis- tutorials.htm 3. https://desktop.arcgis.com/en/documentation/
Term Work (TW):	• Term work should consist of a minimum of 08 Experiments / Activities / Case Studies, or equivalent Mini-Project. • Term work evaluation shall be for Total 25 Marks based on performance.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
MMIEC405	Design Thinking and Ideation	03	0	0	03

Prerequisites:	Communication and Collaboration Skills, Curiosity, Problem-Solving Fundamentals
Course Objectives (COBs):	1. To familiarize learners with the fundamentals of entrepreneurship and the start-up ecosystem. 2. To introduce the design thinking process and its importance in innovation. 3. To equip learners with methods for generating and evaluating innovative ideas. 4. To teach learners the basics of market research and its role in identifying opportunities. 5. To introduce learners to low-fidelity prototyping as part of the ideation process. 6. To provide practical insights through real-world start-up examples.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Define entrepreneurial traits and identify resources within the Indian start-up ecosystem 2. Demonstrate the use of the five phases of design thinking in addressing real-world problems. 3. Generate and present innovative and viable business ideas. 4. Conduct basic market research and recognize emerging trends. 5. Create simple, low-fidelity prototypes to test initial ideas. 6. Analyse the reasons for start-up successes and failures, evaluating them using learned concepts

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 Entrepreneurship and Start-up Ecosystem	Overview of Entrepreneurship and Start-up Ecosystems	CO1	01	05
	Traits and Mindset of Successful Entrepreneurs, The Role of Innovation in Entrepreneurship, Management of Micro, Small and Medium Enterprises		02	
	Sources of Innovation, Government Initiatives: Start-up India, Stand-up India, Make in India, Digital India		01	
	Sustainable Development Goals (SDGs) in Entrepreneurship: Aligning entrepreneurial ventures with SDGs		01	
2. Design Thinking Framework	Five Phases of Design Thinking: Empathize, Define, Ideate, Prototype, Test	CO2	02	08
	Empathy in Design Thinking: Tools and Methods		02	
	Problem Definition Techniques		03	
	Principles of Effectuation		01	

3.Ideation Techniques	Techniques for Generating Ideas: Brainstorming, SCAMPER, Mind Mapping.	CO3	02	07
	Evaluating and Selecting Ideas.		02	
	Tools for Creative Thinking, Ideation, Idea Pitching . and Feedback, Ideation for SDGs		03	
4. Market Research and Opportunity Analysis	Importance and Process of Market Research.	CO4	02	06
	Types of Market Research, Tools for Analyzing Market Data.		02	
	Opportunity Identification and Gap Analysis.		01	
	Case Studies on Market-Driven Start-ups.		01	
5. Prototyping Basics	Introduction to Prototyping	CO5	03	08
	Tools and Techniques for Simple Prototypes		03	
	Low Fidelity Prototyping		01	
	Introduction to High Fidelity Prototyping		01	
6. Case Studies of Start-ups	Case Studies of Start-ups in India / Abroad, Start- ups contributing to SDGs	CO6	02	05
	Case Studies of Start-ups using Design Thinking		02	
	Analysis of Failures and Lessons Learned		01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	---	01	01
			Total Hours	**42**

Text Books:	1. R. Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Review Press, 2009. 2. R. Ireland and B. Barringer, "Entrepreneurship: Successfully Launching New Ventures", Pearson, 2020.
Reference Books:	1. J. Knapp, "Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days", Simon & Schuster, 2016. 2. R. Bansal, "Stay Hungry, Stay Foolish', Westland Ltd., 2011. 3. N. Radjou, J. Prabhu, and S. Ahuja, "Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth", Jossey-Bass Inc Pub, 2012.
Useful Online Resource Links:	1. https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview 2. https://onlinecourses.swayam2.ac.in/cec24_cm13/preview 3. https://www.coursera.org/learn/entrepreneurialmindset 4. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship
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.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
MMIEL405	Design Thinking and Ideation Lab	0	01	0	01

Software Requirements:	Figma, Tinkercad, Thunkable
Prerequisites:	Problem-Solving Fundamentals
Lab Objectives (LOBs):	1. To foster an entrepreneurial mindset by understanding traits, mindsets, and practices of successful entrepreneurs. 2. To develop empathy and user-centric thinking by applying tools like empathy mapping. 3. To learn effective problem identification and definition techniques. 4. To explore creative ideation techniques for generating and evaluating innovative solutions. 5. To conduct market research and analyze opportunities for user-focused solutions. 6. To build and test low-fidelity prototypes and refine them based on user feedback.
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Demonstrate an understanding of entrepreneurial traits and the ability to explore entrepreneurial mindsets. 2. Apply empathy mapping to identify user needs, pain points, and goals effectively. 3. Use structured methods to define actionable problem statements. 4. Generate innovative ideas using creative thinking tools and evaluate their feasibility. 5. Conduct basic market research and identify customers, opportunities, and gaps in the target market. 6. Create and test prototypes of solutions to address user problems.

Lab No.	Experiment Title	LOs Mapped	Hours
I.	Lab Prerequisites	-	02
1	Entrepreneurial mindset exploration activity.	LO1	02
2	Analyzing case studies of successful entrepreneurs.	LO1	02
3	Empathy mapping exercise.	LO2	02
4	Problem definition workshop (using tools like the “5 whys” and “how might we” questions, group brainstorming, etc.)	LO3	02
5	Creative brainstorming for problem solving (using group ideation, scamper and mind mapping exercises, etc.)	LO4	02
6	Market research and customer discovery exercise.	LO5	04
7	Creating simple, low-fidelity prototypes of their solutions.	LO6	04
8	Testing on prototypes.	LO6	02
9	Group presentation on start-up case studies.	LO1,5,6	02
	Total Hours		**24**

Online Resource Links:	1. https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview 2. https://www.coursera.org/learn/entrepreneurialmindset
Term Work (TW):	• Term work will consist of a minimum of 08 Experiments / Activities / Case Studies, or equivalent Mini-Project. • Term work evaluation shall be for Total 25 Marks based on performance.

Course Code	Course	Credits			
		TH	P	TUT	Total
MMICCC405	Foundations of IoT	03	0	0	03

Prerequisite:	C Programming
Course Objectives:	1. IoT architecture and ecosystem. 2. Role of sensors, actuators, and microcontrollers (Arduino, ESP8266, ESP32). 3. Data acquisition and basic embedded interfacing (GPIO, ADC, PWM, Serial). 4. Communication protocols (HTTP, MQTT, CoAP, Zigbee, BLE). 5. Designing and prototyping basic IoT systems. 6. Introduction to IoT applications in domains such as smart home, healthcare, agriculture, and industry.
Course Outcomes:	By the end of this course, students will be able to: 1. Understand the basic concepts, architecture, and applications of the Internet of Things (IoT). 2. Identify and explain the role of various sensors, actuators, and microcontrollers used in IoT systems. 3. Demonstrate the use of GPIO, ADC, PWM, and Serial communication in microcontrollers like Arduino and ESP32 for basic IoT tasks. 4. Compare and select suitable communication protocols (HTTP, MQTT, CoAP, Zigbee, BLE) based on IoT application requirements. 5. Develop simple IoT-based applications integrating sensors, microcontrollers, and cloud/network communication. 6. Evaluate the challenges related to power, scalability, and security in IoT environments and propose basic solutions.

Module No. & Name	Sub Topics	CO mapped	Hrs / Sub topics	Total Hrs / Module
I. Prerequisites and Course Outline	Basic Programming knowledge (C, Java)	-	02	02
1. Introduction to Internet of Things	1.1 Definition	CO1	01	05
	1.2 Features, Ecosystem		02	
	1.3 Applications		02	
2. IoT Architecture	2.1 Perception Layers; Definition, Key Functions, Technologies Used, Interaction with Other Layers, Examples in Real Life	CO2	02	07
	2.2 Network Layers; Definition, Key Functions, Technologies Used, Interaction with Other Layers, Examples in Real Life		02	
	2.3 Application Layers: Definition, Key Functions, Technologies Used, Interaction with Other Layers, Examples in Real Life		02	

3 .Sensors and Actuators	3.1 Sensor Summary ● Overview of different types of sensors ● Explore the role of sensors in IoT applications and their significance in real- world use cases.	CO3	03	09
	3.2 Working Principles of Sensors		02	
	3.3 Transducers Introduction to devices that convert one form of energy into another (e.g., mechanical to electrical). 3.4 Sensor Calibration Explore methods to calibrate sensors and the impact of environmental factors.		04	
4. Microcontrollers (Arduino, ESP8266, ESP32):	4.1 GPIO: Concept of GPIO pins (input vs output),Digital Read and Digital Write (Arduino syntax),Controlling LEDs, reading button inputs, Internal pull-up/pull-down resistors, GPIO pin mapping and differences (Arduino vs ESP8266/ESP32), Debouncing techniques for inputs	CO4	03	09
	4.2 ADC: What is ADC and why it's needed in IoT PWM: Basics of PWM: digital signal simulation of analog output		03	
	4.3 Serial: Basics of UART: TX, RX lines		03	
5. IoT Communication Protocols	5.1. Overview of IoT Communication Protocols HTTP: Basics of HTTP (GET, POST, PUT, DELETE)	CO5	01	06
	5.2 MQTT : Role of MQTT Broker		01	
	5.3 CoAP: Designed for resource-constrained devices, UDP-based lightweight REST protocol, Comparison with HTTP and MQTT		02	
	5.4 ZigBee: Based on IEEE 802.15.4 standard, Mesh networking and device roles (Coordinator, Router, End Device), ZigBee vs Wi-Fi/Bluetooth in IoT BLE: Differences between Bluetooth Classic and BLE,BLE architecture: Central and Peripheral roles, GATT and GAP profiles, Services and characteristics		03	
6. Hands-on and Mini Projects	LED control, DHT11 data logging, IoT switch.	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total Hours	**42**
BOOKS:				

Text Books:	1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things 2. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York. 3. Dr.Raj Kamal,Internet of Things(IoT) , Architecture and Design Principles.McGraw Hill Education
Reference Books:	1. Sinlen Monk," Raspberry Pi Cookbook", Publisher(s). O'Reilly Media, Inc. ISBN.' 9781098130923 2. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020.
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			
		TH	P	TUT	Total
MMICCL405	Internet of Things Lab	0	01	0	01
Hardware Requirements:	IoT Gateway Arduino and Sensors ,				
Software Requirements:	Skilling & Innovation platform (www.grovator.com)				
Prerequisite:	C Programming				
Lab Objectives:	1. To introduce students to the fundamental concepts of IoT and its applications. 2. To learn how to interface different IoT sensors 3. To Equip students with the skills to design, develop, and deploy IoT systems. 4. To foster problem-solving and critical thinking skills in the context of IoT. 5. To provide hands-on experience with IoT devices, sensors, and communication protocols.				
Lab Outcomes:	On successful completion, of lab, learner/student will be able to: 1. Study various types of IoT sensors (temperature, motion, gas, moisture, etc.) 2. Learn to interface microcontrollers with sensors and actuators. 3. Develop IoT applications using programming languages like Python or C++. 4. Implement wireless communication between IoT devices. 5. Utilize cloud platforms for IoT data storage, processing, and visualization. 6. Analyze and visualize IoT data using data analytics tools.				
	Suggested List of Experiments				
Sr. No.	**Experiment Name**	**Hours**			
1.	Introduction to Arduino/NodeMCU – IDE setup & GPIO control	2			
2.	Implement LED Blinking and Switch-Based Toggling using GPIO pins	2			
3.	Read and Display Temperature & Humidity Using DHT11 Sensor	2			
4.	Measure Distance Using an Ultrasonic Sensor and Interpret Sensor Data	2			
5.	Study Controlling a servo motor with PWM	2			
6.	Study Sending data to ThingSpeak cloud using Wi-Fi (ESP8266)	2			
7.	Develop a Blynk-Based IoT Application for Home Automation	2			
8.	Study Establishing Basic MQTT Communication Between Two IoT Devices	2			
9.	Study IoT data visualization on mobile/PC	2			
10.	Design and Demonstrate a Mini Project Based on IoT Concepts	2			
	Total Hours	**20**			
Online Resource Links:	www.grovator.com				
Term Work (TW):	● Term work should consist of a minimum of 08 Experiments / Activities / Case Studies, or equivalent Mini-Project. ● Term work evaluation shall be for Total 25 Marks based on performance.				