SOMAIYA
VIDYAVIHAR

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

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

Autonomy Syllabus Scheme III (2023-24)

(As per NEP 2020 Guidelines)

for

Four Year Multidisciplinary

Bachelors of Technology (B.Tech.)

Artificial Intelligence and Data Science

with

Multiple Entry and Multiple Exit Options

Levels 4.5 - 6

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

From the Principal's Desk:

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

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

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

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

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

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

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

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

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

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

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

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

Dr. Vivek Sunnapwar
Principal and Chairman - Academic Council

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

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

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

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

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

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

Board of Studies in Artificial Intelligence and Data Science are,

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

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

Dr. Milind Nemade

HoD and Chairman, Board of Studies

Nomenclature and Alignment of Verticals and Components

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

Other Abbreviations:

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

Programs Offered with Multiple Entry Multiple Exit Options

Level 4.5: UG Certificate in Technology

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

Level 5: UG Diploma in Technology

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

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

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

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

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

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

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

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

Major Disciplines with Offered Honors and Multidisciplinary Minors:

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

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

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

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

Major Disciplines with Multidisciplinary Minors and Specialization Minors:

Multidisciplinary Minors:

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

Specialization Minors:

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

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

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

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

SEMESTER V

TEACHING SCHEME

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

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

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

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

EXAMINATION SCHEME

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

SEMESTER VI
TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
AIC601	Artificial Neural Network	3 – 0 – 1	04	3 – 0 – 1	04	BS
AIC602	Big Data Analytics	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC603	Cloud Computing	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIDLC60X	(Major / Professional Elective- Department Level Course-II)	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
MMC604	(Multidisciplinary Minor Course-III)	3 – 0 – 0	03	3 – 0 – 0	03	MM
AIL601	Artificial Neural Network Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL602	Big Data Analytics Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL603	Cloud Computing Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIDLL60X	(Major / Professional Elective- Department Level Course-II) Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
AIPR64	Project Based Learning-Minor Project-II	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
AIXS613	Skill Enhancement – SAT XIII: Skill Based Learning (Cloud/R Prog/Mobile App/WebTech/linux/Networking/Server Con)	0 – 2[*] – 0	02	0 – 1 – 0	01	SE-SAT
AIXT614	Value Education – SAT XIV: Technology-Based Learning (Digital Technology-NPTEL/Spoken/Coursera certification)	0 – 2[*] – 0	02	0 – 1 – 0	01	VE-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.

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

Group A:	Group B:	Group C:	Group D:
(AIDLC6031)	(AIDLC6032)	(AIDLC6033)	(AIDLC6034)
AI in E Commerse	AI in Agriculture	Artificial Intelligence of Things (AIOT)	AI for Bioinformatics Data Management
(AIDLL6031)	(AIDLL60312)	(AIDLL6033)	(AIDLL6034)
AI in E Commerse Lab	AI in Agriculture Lab	Artificial Intelligence of Things (AIOT) Lab	AI for Bioinformatics Data Management Lab

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P&O	
AIC601	Artificial Neural Network	20	20	40	60	2.5	-	-	-	-	100
AIC602	Big Data Analytics	20	20	40	60	2.5	-	-	-	-	100
AIC603	Cloud Computing	20	20	40	60	2.5	-	-	-	-	100
AIDLC60X	(Major / Professional Elective-Department Level Course-II)	20	20	40	60	2.5	-	-	-	-	100
MMC604	(Multidisciplinary Minor Course-III)	20	20	40	60	2.5	-	-	-	-	100
AIL601	Artificial Neural Network Lab	-	-	-	-	-	25	25	-	-	50
AIL602	Big Data Analytics Lab	-	-	-	-	-	25	25	-	-	50
AIL603	Cloud Computing Lab	-	-	-	-	-	25	-	-	25	50
AIDLL60X	(Major / Professional Elective-Department Level Course-II) Lab	-	-	-	-	-	25	-	-	-	25
PR604	Project Based Learning-Minor Project-II	-	-	-	-	-	25	-	-	25	50
AIXS613	Skill Enhancement – SAT XIII: Skill Based Learning (Cloud/R Prog/Mobile App/WebTech/linux/Networking/Server Con)	-	-	-	-	-	25	-	-	-	25
AIXT614	Value Education – SAT XIV: Technology-Based Learning (Digital Technology-NPTEL/Spoken/Coursera certification)	-	-	-	-	-	25	-	-	-	25
Total		**100**	**100**	**200**	**300**	-	**175**	**50**	-	**50**	**775**

Honors with Research

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

General Guidelines for Semester VII:

- Students should pursue an online course on Research Methodology offered through the SWAYAM or other platform.
- Students should select a research topic that aligns with their interests, academic goals, and the availability of resources. Students are required to define the objectives and goals of your research project.

- Students should conduct a comprehensive literature review to understand the existing knowledge and research related to their topic. Accordingly, gaps or areas that require further investigation should be identified.
- Students should create a detailed research plan outlining the methodologies, experiments, data collection methods, and analysis techniques that they shall employ with ethical considerations.
- It is expected that the students complete 40% implementation of research in this semester.
- Evaluation of research shall be done through 03 presentations (viva-voce) during the entire semester.

General Guidelines for Semester VIII:

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

Baskets for Verticals – All Programs

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

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

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

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

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

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

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

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

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

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

Baskets for Honors Courses

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

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

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

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

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

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

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

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SEMESTER VI
TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
AIC601	Artificial Neural Network	3 – 0 – 1	04	3 – 0 – 1	04	BS
AIC602	Big Data Analytics	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIC603	Cloud Computing	3 – 0 – 0	03	3 – 0 – 0	03	PC
AIDLC60X	(Major / Professional Elective- Department Level Course-II)	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
MMC603	(Multidisciplinary Minor Course-III)	3 – 0 – 0	03	3 – 0 – 0	03	MM
AIL601	Artificial Neural Network Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL602	Big Data Analytics Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIL603	Cloud Computing Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
AIDLL60X	(Major / Professional Elective- Department Level Course-II) Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
AIPR64	Project Based Learning-Minor Project-II	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
AIXS613	Skill Enhancement – SAT XIII: Skill Based Learning (Cloud/R Prog/Mobile App/WebTech/linux/Networking/Server Con)	0 – 2[*] – 0	02	0 – 1 – 0	01	SE-SAT
AIXT614	Value Education – SAT XIV: Technology-Based Learning (Digital Technology-NPTEL/Spoken/Coursera certification)	0 – 2[*] – 0	02	0 – 1 – 0	01	VE-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.

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

Group A:	Group B:	Group C:	Group D:
(AIDLC6031)	(AIDLC6032)	(AIDLC6033)	(AIDLC6034)
AI in E Commerse	AI in Agriculture	Artificial Intelligence of Things (AIOT)	AI for Bioinformatics Data Management
(AIDLL6031)	(AIDLL60312)	(AIDLL6033)	(AIDLL6034)
AI in E Commerse Lab	AI in Agriculture Lab	Artificial Intelligence of Things (AIOT) Lab	AI for Bioinformatics Data Management Lab

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P&O	
AIC601	Artificial Neural Network	20	20	40	60	2.5	-	-	-	-	100
AIC602	Big Data Analytics	20	20	40	60	2.5	-	-	-	-	100
AIC603	Cloud Computing in AI	20	20	40	60	2.5	-	-	-	-	100
AIDLC60X	(Major / Professional Elective-Department Level Course-II)	20	20	40	60	2.5	-	-	-	-	100
MMC603	(Multidisciplinary Minor Course-III)	20	20	40	60	2.5	-	-	-	-	100
AIL601	Artificial Neural Network Lab	-	-	-	-	-	25	25	-	-	50
AIL602	Big Data Analytics Lab	-	-	-	-	-	25	25	-	-	50
AIL603	Cloud Computing in AI Lab	-	-	-	-	-	25	-	-	25	50
AIDLL60X	(Major / Professional Elective-Department Level Course-II) Lab	-	-	-	-	-	25	-	-	-	25
PR604	Project Based Learning-Minor Project-II	-	-	-	-	-	25	-	-	25	50
AIXS613	Skill Enhancement – SAT XIII: Skill Based Learning (Cloud/R Prog/Mobile App/WebTech/linux/Networking/Server Con)	-	-	-	-	-	25	-	-	-	25
AIXT614	Value Education – SAT XIV: Technology-Based Learning (Digital Technology-NPTEL/Spoken/Coursera certification)	-	-	-	-	-	25	-	-	-	25
Total		**100**	**100**	**200**	**300**	**-**	**175**	**50**	**-**	**50**	**775**

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC601	Artificial Neural Network	03	0	0	03

Prerequisite:	1. Knowledge of linear algebra, multivariate calculus, and probability theory. 2. Knowledge of a programming language (PYTHON/C/C ++recommended).
Course Objectives:	1. To study basics of biological Neural Network. 2. To study the architecture, learning algorithm of ANN. 3. To know the issues of various feed forward and feedback ANN. 4. To know application of ANN.
Course Outcomes:	After successful completion of the course students will be able to: 1. Explain the biological Neural Network and its architecture. 2. Evaluate different neural networks of various architectures both feed forward and feed backward and perform the training of neural networks using various learning rules. 3. Analyze single layer perceptron and multilayer perceptron. 4. Perform the testing of neural networks and do the perform analysis of these networks for various pattern recognition applications. 5. Interpret the concepts of Associative memory networks 6. Apply the suitable neural network algorithms for real time application.

Module No. & Name	Sub Topics	CO Mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction	1.1 Human brain, Biological neurons, Neural network viewed as directed graphs, Types of activation function.	CO1	02	06
	1.2 Network architectures, Knowledge representation. Linear & non-linear separable classes & Pattern classes.	CO1	03	
	Applications and scope of Neural Networks	CO1	01	
2. Fundamental concepts of ANN	2.1 Models of ANN, Feed forward and feedback network.	CO2	03	08
	2.2 Learning Rules: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule,	CO2	03	
	2.3 Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner Take-All Learning Rule.	CO2	03	
3. Single layer perceptron and multilayer perceptron	3.1 Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters.	CO3	02	08
	3.2 Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques.	CO3	02	
	3.3 Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment.	CO3	02	
	3.4 Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection.	CO3	02	

4. Self-organizing Maps and Support Vector Machine	4.1 Self-Organizing Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map.	CO4	02	06
	4.2 SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification.	CO4	02	
	4.3 Support Vector Machines, SVM application to Image Classification.	CO4	02	
5. Associative memory network	5.1 Introduction, Training algorithms for Pattern Association.	CO5	03	07
	5.2 Auto-associative Memory Network, Hetero-associative Memory Network.	CO5	02	
	5.3 Bidirectional Associative Memory, Discrete nalyse network.	CO5	02	
6. Case study on ANN	6.1 Handwritten Digit Recognition, Process Identification, Expert Systems for Low Back Pain Diagnosis, (list is not limited to above mentioned topics, case study on any recent topics with due approval will be considered)	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. Jacek M. Zurada, "Introduction to Artificial Neural Systems," Jaico Publishing House. 2. Ivan N., Danilo H. , "Artificial Neural Networks- A practical course", 3rd ed. Springer International Publishing, Switzerland, 2017. 3. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing," 2nd ed. Wiley India.
Reference Books	1.Simon Haykin, "Neural Networks A Comprehensive Foundation", Pearson Education. 2.Hugh Cartwright, "Artificial Neural Networks", 2nd edition, Humana Press,2015. 3.B. Yegnanarayana, "Artificial Neural Networks", Prentice Hall of India Pvt. Ltd. 2005.
Useful Links:	
1. https://nptel.ac.in/courses/127/105/127105006/	
2. https://nptel.ac.in/courses/117/105/117105084/	
3. https://www.coursera.org/learn/neural-networks-deep-learning	
Continuous Assessment (CA):	**Test-1 and Test-2 (20 Marks)**: Test-1 and Test-2 consists of two class tests of 20 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIL601	Artificial Neural Network lab	01	0	01

Lab Prerequisite:	Knowledge of a programming language (PYTHON/C/C ++ recommended)
Lab Objectives:	1. To study different activation functions. 2. To implement a learning algorithm. 3. To implement different memory network algorithms.
Lab Outcomes (Los):	After successful completion of the course students will be able to: 1. Implement different activation functions used in ANN. 2. Implement different Neuron models. 3. Implement Single layer and multilayer perceptron network 4. Implement a self-organized feature map network. 5. Demonstrate use of Associative Memory Network to calculate weight for given pattern. 6. Case study on ANN.

Lab. No.	Experiment Title	LO mapped	Hrs/Lab
1	Implement different Activation functions.	LO1	02
2	Implement McCulloch Pitts Neuron Model.	LO2	02
3	Implement Hebbian learning.	LO2	02
4	Implement Single layer perceptron neural network.	LO3	02
5	Implement Multi-layer perceptron neural network.	LO3	02
6	Implement Error Back propagation neural network.	LO3	02
7	Implement Kohonen Self-organizing Feature Maps.	LO4	02
8	Implement Auto Associative memory network.	LO5	02
9	Implement Hetero Associative memory network.	LO5	02
10	Case Study on ANN	LO6	-

Virtual Lab Links:	1. http://vlabs.iitkgp.ernet.in/scte/index.html# 2. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/exp1/index.php

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 3. **"**Artificial Neural Network Lab". 4. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 5. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

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

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC602	Big Data Analytics	03	0	0	03

Prerequisite:	1. Database Management System. 2. Data warehousing and Mining. 3. Familiarity with Intermediate Python/R.
Course Objectives:	1. To provide an overview of an exciting growing field of Big Data analytics. 2. To discuss the challenges traditional data mining algorithms face when analyzing Big Data. 3. To introduce the tools required to manage and analyze Big Data like Hadoop, NoSql Map-Reduce. 4. To teach the fundamental techniques and principles in achieving Big Data analytics with scalability and streaming capability. 5. To introduce to the students several types of Big Data like social media, web graphs and data streams. 6. To enable students to have skills that will help them to solve complex real-world problems in decision support.
Course Outcomes:	1. The student will be able to explain the key issues in Big Data management and its associated applications. 2. Use Big Data frameworks and noSQL databases. 3. Apply Map-reduce algorithm in different scenarios. 4. Apply different algorithms to stream data model. 5. Apply classification algorithms and pattern mining for Big Data. 6. Use Big Data Systems for AI solutions.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	CO1	02 02 01	05
2.Frameworks: Spark	Overview of: Apache Spark, features, architecture, spark components, RDD. What is NoSQL? NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, MongoDB	CO2	02 02 02 02 02	10
3.MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix	CO3	02 02 02	08

	Multiplication, Matrix Multiplication with One MapReduce Step. Illustrating use of MapReduce with use of real life databases and applications.		02	
4.Mining Big Data Streams	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream: Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk- Motwani Algorithm, Query Answering in the DGIM Algorithm.	CO4	02 02 02	06
5.Big Data Mining Algorithms	Frequent Pattern Mining: Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with MapReduce Classification Algorithms: Parallel Decision trees, Overview SVM classifiers, Parallel SVM, K-Nearest Neighbor classifications for Big Data, One Nearest Neighbour.	CO5	02 02 01	05
6.Big Data Analytics Applications	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. Mining Social- Network Graphs: Social Networks as Graphs, Types, Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. Recommendation Engines: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	CO6	05	05
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**
Books:				
Text Books	1. Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications. 2. Anand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press. 3. Amirghodsi, Siamak, et al. Apache Spark 2. X machine learning			

	4. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press. 5. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press 6. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O’Reilly Publications.
Reference Books	1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series. 2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited. 3. Hadoop: The Definitive Guide by Tom White, O’Reilly Publications.
Useful Links:	1.https://spark.apache.org/ 2.https:// nalys.apache.org/ 3. https://www.mongodb.com/atlas
Continuous Assessment:	**Test-1 and Test-2** (**20 Marks**): Test-1 and Test-2 consists of two class tests of 20 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIL602	Big Data Analytics Lab	01	0	01

Lab Prerequisite:	Python Programming/ Java Programming
Lab Objectives:	1. To interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
Lab Outcomes:	**After successful completion of the course students will be able to:** 1. Show proficiency in using Big Data frameworks like Hadoop. 2. Create scalable algorithms with MapReduce for large datasets. 3. Develop Big Data applications using tools like Pig, NoSQL, and MongoDB. 4. Design algorithms to analyze streams, web graphs, and social media data; build recommendation systems. 5. Apply clustering, classification, and association techniques to Big Data. 6. Use Big Data knowledge to develop real-world BDA applications.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
I.	Lab Prerequisite	-	02
1	Installation of Single Node Hadoop Cluster on Ubuntu.	LO1	02
2	Hadoop Programming: Word Count MapReduce Program.	LO2	02
3	Implementing Matrix Multiplication Using One Map-Reduce Step.	LO2	02
4	Implementing Relational Algorithm on Pig.	LO3	02
5	Implementing Bloom Filter using Map-Reduce.	LO4	02
6	Implementing Page Rank Algorithm using Map-Reduce.	LO4	02
7	Implementing Flajolet-Martin Algorithm.	LO4	02
8	Implementing Frequent Item Set Algorithm using Map-Reduce.	LO5	02
9	Implementing Clustering Algorithm using Map-Reduce.	LO5	02
10	Mini Project. One large data application to be implemented (Use standard Datasets available on the web) (mandatory)	LO6	-

Useful Links:	1. https://hadoop.apache.org 2. https://hadoop.apache.org/docs/r2.8.0/ nalys-project-dist/ nalys-common/core-default.xml
Term work:	• Term work should consist of a minimum of 8 experiments. • Mini Project based on the content of the syllabus (Group of 2-3 students) • The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. • Journal must include at least 2 assignments on content of theory and practical of the course "Big data Analytics Lab". • Total 25 Marks (Programming Exercises : 20-marks, Assignments : 5-marks)
Oral/Practical/P&O:	• P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC603	Cloud Computing with AI	03	0	0	03

Prerequisite:	1. Computer Networks 2. Artificial Intelligence.
Course Objectives:	1. Students will understand the concept of cloud services based on AWS (Amazon Web Services), compute services, storage service, database services and they also learn how to utilize the AI using cloud services. 2. Students will learn the concept of RDS as cloud services, automating AWS with lambda, AI Manage services.
Course Outcomes:	After the successful completion of this course, the learner will be able to: 1. Analyze the importance of cloud computing, explore cloud architecture and components, compare public and private clouds, and evaluate AWS, IAM groups, and IAM roles. 2. Explore compute and storage services, nalyse the EC2 lifecycle, examine EC2 storage and concepts, differentiate instance types and families, launch servers, and utilize SQL databases as cloud services. 3. Analyze AWS Lambda and develop skills in interacting with cloud services. 4. Evaluate Face-based user verification using Amazon Rekognition and nalyse techniques for automatic extraction of text, handwriting, and data from scanned documents.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs/Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	--	01	01
1. Introduction of cloud computing	1.1 What is cloud? Cloud Architecture, Cloud Components, Public and Private cloud	CO1	02	03
	1.2 Introduction of AWS, What is AI with cloud?		01	
2. AWS Identity and Access Management	2.1 IAM Group, IAM Role	CO2	02	04
	2.2 IAM Policies		02	
3. **Compute and Storage Services**	3.1. What is compute?, Introduction Elastic cloud computing(EC2): EC2 lifecycle, EC2 Storage,	CO3	01	07
	3.2. EC2 Concepts, Instance types and families, AMIs		02	
	3.3. Metadata and User data Launch the Server, What is Storage?		02	
	3.4. Introduction to Simple Storage Service (S3): Introduction of S3, Buckets, Objects. Introduction of EBS(Volumes, Snapshots)		02	
4. SQL Database as Cloud Services	4.1. Amazon Relational Database Service (Amazon RDS)	CO4	03	06
	4.2. Introduction to different DBs. Importance of cloud db migration tools.		03	

5. Automating AWS with Lambda, Python, and Boto3	Introduction to AWS Lambda and Server less Architecture (Part-1) 1.8 Introduction to Serverless Computing • What is serverless? • Advantages over traditional server-based computing. • Use cases for serverless architecture. 1.9 AWS Lambda Basics • What is AWS Lambda? • How it works: Trigger → Execute → Terminate. • Supported languages (focus on Python).	CO5	02	10
	1.10 Creating Your First Lambda Function • Step-by-step function creation via AWS Console. • Writing a simple Python function (e.g., return "Hello from Lambda"). • Configuring basic settings: memory, timeout, role. 1.11 Understanding Lambda Triggers • S3 Events • API Gateway • CloudWatch Events • DynamoDB Streams (briefly mention for context) 1.12 IAM Role for Lambda • Creating and assigning IAM roles to Lambda functions. • Permissions required to access S3, RDS, etc		02	
	Automating AWS Services Using Python and Boto3 (Part-2) 1.13 Introduction to Boto3 • What is Boto3? • Installation: pip install boto3 • Configuring credentials with AWS CLI. 1.14 AWS Automation Use Cases • Uploading/downloading files to/from S3 • Reading/writing to DynamoDB or RDS • Managing EC2 instances		02	
	1.15 Python Script to Interact with S3 • Create a new S3 bucket • Upload and download files • List all buckets and files		02	
	1.16 Trigger Lambda via Python using Boto3 • Invoke Lambda programmatically • Pass event payloads 1.17 Integrating Lambda + S3 + RDS (Example Flow) • File uploaded to S3 triggers Lambda • Lambda reads the file and inserts data into RDS		02	
6. AI manage Services with Amazon	6.1 Introduction to Amazon Rekognition How Rekognition works: Overview of deep learning and neural networks behind it, Rekognition vs other computer vision tools, Use cases in industry (security, retail, healthcare, law enforcement, etc.).		02	11

	1.2 Rekognition Image vs Rekognition Video, Face Detection and Analysis: Facial Recognition and Comparison, Object and Scene Detection, Celebrity 1.3 Recognition, Text in Image, PPE Detection, Unsafe Content Detection, Labels and Moderation		02	
	6.3 Facial Detection and Analysis: How facial detection works, Attributes extracted: age range, gender, emotions, facial features, Face bounding boxes and landmarks, Use cases in smart surveillance, retail analytics		02	
	6.4 Object and Scene Detection: What is Label Detection? Common detected categories (vehicles, animals, nature, tools, etc.), Confidence scores and bounding regions, Real-world applications: surveillance, e-commerce, agriculture 6.5 PPE Detection Using Rekognition: Introduction to PPE detection feature, Supported gear types: Face covers, Helmets, Vests, Application in industrial safety, factory compliance, Integration with surveillance systems	O6	02	
	6.6 Introduction to Amazon Textract and OCR: Traditional OCR vs Amazon Textract (machine learning-based), Use cases of Textract: Invoice processing, Identity verification, Healthcare and legal documents, Automated data entry, Supported document types: PDF, JPEG, PNG, TIFF 6.7 Extracting Data from Documents and Images: How to use Textract via Python + Boto3, Extracting: Plain text from images or scanned pages (DetectDocumentText), Structured data like key-value pairs and tables (AnalyzeDocument), Block structure explanation (KEY, VALUE, LINE, TABLE, CELL, WORD		03	
	6.8 Organizing Extracted Data into Structured Formats: Storing extracted data: As key-value pairs (JSON or dictionary), In tables (CSV, Excel, or Pandas DataFrame), In databases (e.g., DynamoDB, MySQL), Categorizing data: Personal details (name, address, email), Financial info (total amount, invoice ID), Dates and document metadata, Automating the process: Lambda + Textract + S3 pipeline, Event-driven workflows			
Total Hours				**42**
Useful Links:	**https://docs.aws.amazon.com/** https://www.geeksforgeeks.org/cloud-computing/ https://www.tutorialspoint.com/cloud_computing/cloud_computing_overview.html			

Books:	
Recommended Books	1. Michael J. Kavis, "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)",Wiley. 2. Giuseppe Ciaburro, "Hands-On Machine Learning on Google Cloud Platform: Implementing Smart and Scalable Models Using the Google Cloud AI Platform", O'Reilly Media. 3. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", O'Reilly Media. 4. Himanshu Singh, "Practical Machine Learning with AWS: Process, Build, Deploy, and Productionize Your Models Using AWS", Apress.
Continuous Assessment:	• Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 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). • Average marks of T-1 and T-2 will be considered. • Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIL603	Cloud Computing with AI Lab	01	0	01

Lab Prerequisite:	1. Computer Networks. 2. Artificial Intelligence.
Lab Objectives:	1. To provide hands-on experience on AWS core services including IAM, EC2, S3, Lambda, and RDS, ensuring students understand how to create, configure, and manage these services. 2. To demonstrate automation techniques using Python and Boto3 for interacting with AWS services, focusing on cost-efficient and scalable server less architectures. 3. To explore AI-managed services of AWS such as Rekognition for face detection and text extraction, enabling students to integrate intelligent features into their applications.
Lab Outcomes (LOs):	After the successful completion of this course, learner will be able to: 1. Create and manage AWS accounts and navigate the AWS Management Console, including IAM roles, user creation, and access policies. 2. Launch and configure EC2 instances with specified memory, storage, and network settings for deploying virtual servers on the cloud. 3. Use S3 buckets for object storage, performing operations like uploading, retrieving, and managing data in the cloud. 4. Deploy cloud-based databases using RDS and connect them with remote systems to perform SQL operations through programming scripts. 5. Automate AWS services using Python and Boto3, including Lambda functions for S3 and RDS interactions without provisioning servers. 6. Implement AI-based solutions using Amazon Rekognition to perform face recognition, comparison, and text extraction from multimedia content using Python.

Lab No	Experiment Title	LO mapped	Hrs/Lab
1.	Introduction of cloud computing • Amazon account creation & AWS dashboard utilization understanding	LO1	02
2.	AWS Identity and Access Management • Attach the access of different AWS services from IAM service dashboard • Create the user • Role & Policy level access & restrictions to the created user	LO1	02
3.	Compute and Storage Services (Part-1) • EC2 virtual server (instance) creation & configuration of storage, memory, networking etc.	LO2	02
4.	Compute and Storage Services (Part-2) • Storage service utilization by creating & configuring the bucket to store data in cloud.	LO3	02
5.	SQL Database as cloud services • Cloud based remote database connectivity with different databases & perform database related operations via programming script.	LO4	02

6.	Automating AWS with Lambda, Python, and Boto3 (Part-1) • Configure server less architecture with python	LO5	02
7.	Automating AWS with Lambda, Python, and Boto3 (Part-2) • Python scripting with lambda to utilize & automate the different AWS services like S3, RDS, etc.	LO5	02
8.	AI manage services (Part-1) • Implementation the Face Recognition, Face Comparison, services using Amazon Rekognition with python.	LO5	02
9.	AI manage services (Part-2) • Implementation of python script to extract the texts from different sources like images, documents.	LO6	02
10.	Building a Chatbot with Google Cloud AI and Dialogflow.	LO6	02
Term work:	• Term work should consist of a minimum of 8 experiments. • Journal must include at least 2 assignments on content of theory and practical of the course "Cloud Computing with AI". • The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. • Total 25 Marks (Experiments: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
AIDLC601	AI in E-Commerce	03	0	0	03
Prerequisite:	1. Data Warehousing and Mining. 2.Knowledge of a programming language like Python/R.				
Course Objectives:	This course aims to introduce ecommerce environment to students along with the applications of various machine learning algorithms used to improve the performance of an e-business.				
Course Outcomes:	After the successful completion of this course, learners will be able to: 1. Explain e-commerce and its components, functions. 2. Understand diverse aspects of retailing in e-commerce, business models, security, payments and mobile commerce. 3. Implement AI-driven techniques for effective business insights. 4. Implement web mining techniques and learn security measures. 5. Implement e-commerce analytics, dashboards. 6. Explain strategies for global e-commerce success, regulations and ethics.				

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to E-Commerce and E-Market places	Overview of E-commerce, E- Marketplaces: E-commerce Mechanisms, Infrastructure and Tools, Impacts of E-commerce. Overview of technology stack for e-commerce	CO1	04	04
2. Electronic Commerce Applications	Retailing in E-commerce - Products and services, e-tailing business models, types B2B, B2C, C2C Ecommerce, E-supply chains -CRM, Collaborative commerce and Corporate portals, Mobile commerce and Ubiquitous computing, Ecommerce Support services- E Commerce Security and fraud protection, Electronic Commerce Payment systems Web2.0 and Social Networks	CO2	10	10
3. AI applications in E-commerce-Business cases-1	Propensity modelling Regression Decision tree algorithm Customer profiling using clustering Web clickstream analysis Introduction to recommendation systems	CO3	06	06
4. Web mining	Introduction, Web Mining Web Content Mining: Web Crawlers, Harvest System , Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining	CO4	05	05
5. E- Commerce Analytics	Creating Business Value using E-commerce Analytics, E-commerce Analytics Value Chain, Methods and Techniques for Ecommerce Analysis: Sentiment Analysis– Analyzing customer reviews and feedback	CO5	10	10

	Topic Modeling– Extracting insights from customer discussions Visual Search (CNN, ResNet) – Product recommendation using image recognition Visualization, Dash boarding and Reporting text matching: TF-IDF modeling, Image matching: PCA analysis			
6. Ecommerce Strategy and Implementation	Ecommerce Strategy and Global E-commerce, launching successful e business, Regulatory, ethical and Compliance issues in Ecommerce, Auctions and Application Development.	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. Ifrain Turban, Jae K. Lee, David King, "Electronic Commerce: A Managerial Perspective", United States Edition, 1999. 2. Judah Phillips, "Ecommerce Analytics: Analyze and Improve the Impact of Your Digital Strategy", Pearson FT Press, 2016. 3. Han, Jiawei, Jian Pei, and Micheline Kamber. *Data mining: concepts and techniques*. Elsevier, 2011. 4. Giudici, Paolo "Applied data mining: statistical methods for business and industry", John Wiley & Sons, 2005. 5. Chio, Clarence, and David Freeman "Machine learning and security: Protecting systems with data and algorithms", O'Reilly Media, Inc.", 2018. 6. E-Commerce, S.K.Mourya, Narosa Publishing House Pvt Ltd., New Delhi 2015.
Reference Books	1.Harvey M. Deitel, Paul J.Deitel, Kate Steinbuhler, e-business and e-commerce for managers, Pearson, 2011. 2.Kelly Rainer, Brad Prince,Management Information Systems, Wiley . 2.Gary P Schneider "Electronic commerce", Thomson learning & James T Peny Cambridge USA, 5th edition 2001. 3.Zhang, Z. (2019). Practical Data Processing for Social and Behavioral Research Using R. Retrievable from https://books.psychstat.org/rdata.
Useful Links:	1.http://infolab.stanford.edu/pub/papers/google.pdf
	2.https://blogs.cornell.edu/info2040/2016/10/22/pagerank-on-ecommerce-sites/
	3.https://lizrush.gitbooks.io/algorithms-for-webdevs-ebook/content/chapters/page-rank.html
Continuous Assessment (CA):	**Test-1 and Test-2** (**20 Marks**): Test-1 and Test-2 consists of two class tests of 20 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE)(60 Marks):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIDLL601	AI in E-Commerce Lab	01	0	01

Lab Prerequisite:	1. Data Warehousing and Mining. 2. Knowledge of a programming language like Python/R.
Lab Objectives:	1.This course aims to introduce an e-commerce environment to students along with the applications of various machine learning algorithms used to improve the performance of an e-business.
Lab Outcomes (LOs):	After the successful completion of this course, learners will be able to: 1. Explain about the different technologies in e-Commerce. 2. Implement e-commerce case studies. 3. Implement AI/ML/DL analysis for ecommerce. 4. Design a dashboard for an ecommerce web site. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
1	To study different technologies in e-Commerce	LO1, LO5, LO6	02
2	To implement inventory analysis case study in E-commerce.	LO2, LO5, LO6	02
3	To perform On-line Retail to explore customer segmentation.	LO2, LO5, LO6	02
4	To perform E-Commerce Customer Churn End To End ML Project.	LO3, LO5, LO6	02
5	Sentiment Analysis for customer reviews and feedback	LO3, LO5, LO6	02
6	Topic Modeling for extracting insights from customer discussions	LO3, LO5, LO6	02
7	Visual Search (CNN, ResNet) for product recommendation using image recognition	LO3, LO5, LO6	02
8	Design a dashboard for an ecommerce web site	LO4, LO5, LO6	02

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

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC602	AI in Agriculture	03	0	0	03

Prerequisite:	1. Artificial Intelligence. 2. Internet of Things
Course Objectives:	1. To provide the knowledge of Soil Engineering. 2. To apply analysis, testing principles to Crop Production and fertility 3. To demonstrate and evaluate real world management and tool in agriculture
Course Outcomes:	**After the successful completion of this course, learner will be able to:** 1. Identify requirements & assess the soil. 2. Identity Quality or irrigation water; essential plants nutrients. 3. Explain the Agronomy of Crops and it Production. 4. Explain the concept of utilization of Fertilizer and its application equipment. 5. Identify of Harvesting equipment and tool of crops. 6. Design development system architecture of agricultural IoT.

Module No & Name	Sub Topics	CO Mapped	Hrs/Subtopic	Total Hrs /Module
I. Prerequisites and Course outline	Soil Engineering		**02**	**02**
1. Nature and origin of soil	Definition of soil classification of rock with suitable example. Composition of rock and minerals. Soil genesis, soil taxonomy, soil orders, great group, sub group series and family. Soil physical properties; and their importance soil textural class(particle distribution)	CO1	03	07
	Soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability.		02	
	Soil organic matter(SOM) SOM composition their importance on soil properties, Physical ,Chemical and Biological. Characteristics of saline, saline-sodic and sodic soil and their reclamation techniques.		02	
2. Quality or irrigation water and essential plants nutrients	Irrigation Quality Parameter. Suitability of irrigation water as their quality parameters. Criterion of Essential Plant nutrients. Physiology role of Essential Plant nutrients.	CO2	03	06
	Identification of deficiency symptoms of external plants nutrients and measure to overcome deficiency.		03	
3. Agronomy	Definition of agronomy scope and important of Agronomy. Classification of agronomical crops viz, cereals, pulses oil seeds forage crop, cash crops etc.	CO3	02	05
	Effect of different weather parameters on growth and development of agronomical crops. Define of tillage, its importance.		03	
4.Fertilizer application	Types of fertilizer: - Inorganic fertilizer, Organic fertilizers and its forms. liquid, powder, and granule	CO4	04	07

equipment	Define fertilizers with suitable example, Fate of major Micro nutrients and trace beneficial nutrients in Soil. Organic Manures-Define, classification with example and sources. Importance of organics manures.			
	Equipment:-Trolley Pump, Trailer sprayer. Combine Harvester, Cultivator, Roto Seed Drill, Manure Spreader, Rotary Tiller. sprayers ,Drone Mini sprayer, and dusters, their calibration, selection, constructional features of different components and adjustments,	CO4	03	
5. Equipment/Tool/ Mulching.	Types of equipment, tools, machinery for land preparation, sowing.	CO5	03	06
	Harvesting threshing ,Plant Protectors, seed treatments, weeding, interculturing etc.		03	
6. Development and system architecture of agricultural IoT	Development and system architecture of agricultural IoT, Development of agricultural IoT sensors, Application of agricultural IoT , System architecture of agricultural IoT.	CO6	02	08
	Key technologies of agricultural IoT:- Sensor perception technology, Information transmission technology, Node location technology, Wireless communication technology, Information processing technology, Radio-frequency identification, 3S technology, RS technology, GNSS technology, GIS technology-Image capturing		02	
	Typical applications of agricultural IoT:- Water-saving irrigation. Crop growth environment monitoring. Animal and plant life information monitoring. Animal life information monitoring. Plant life information .Intelligent agricultural machinery .Agricultural product quality safety and traceability.		02	
	Problems , system architecture design monitoring and feedback to end use based on Production depend on soil nutrient availability, yield function with optimal condition and its parameter		02	
II.Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total Hours	**42**
Books:				
Text Books	1. Bose, T.K and S.K. Mitra. (1990). Fruits, Tropical and Subtropical. Naya Prakash, 206 Bidthan saran, Calcutta. 2. Nature and Properties of Soils, The Hardcover – Import, 1 March 2016 Publishing House Pvt Ltd, New Delhi. 3. Das, P.C. (2012). Vegetable Crops of India. Kalayani Publishers, New Delhi. 4.Bosoi, E.S. (2018). Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2). Oxonion Press Pvt. Ltd., New Delhi. 5. Donnel Hunt. Farm Machinery and management. Iowa State University Press,			

	Ames, USA.
Reference Books	1. De, G.C. (1989). Fundamentals of Agronomy. Oxford & IBH Publishing Co Pvt Ltd, New Delhi. 2. Russel. Soil Condition and Plant Growth. ELBS, Longmans, U.K. 3.Review of agricultural IoT technology Jinyuan Xu a , Baoxing Gu a , Guangzhao Tian a,b**,**
Useful Links:	
1. https://www.sciencedirect.com/journal/artificial-intelligence-in-agriculture	
2. https://onlinecourses.nptel.ac.in/noc22_bt57/preview:-Biotechnology	
Continuous Assessment(CA):	• **Test-1 and Test-2** (**20 Marks**): • Test-1 and Test-2 consists of two class tests of 20 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).both tests are compulsorily.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Lab Code	Lab Name	Credits		
		P	TUT	Total
AIDLL602	AI in Agriculture Lab	01	0	01

Lab Prerequisite:	1. Artificial Intelligence 2. Internet of Things
Lab Objectives:	1. To provide the knowledge of Soil Engineering. 2. To apply analysis, testing principles to Crop Production and fertility 3. To demonstrate and evaluate real world management and tool in agriculture
Lab Outcomes (LOs):	**After the successful completion of this course, learner will be able to:** 1. Identify requirements & assess the soil . 2. Identity Quality or irrigation water; essential plants nutrients 3. understand the Agronomy of Crops and it Production 4. understand concept of utilization of Fertilizer and its application equipment 5. understand the Harvesting mechanisms of crops 6. Design development system architecture of agricultural IoT

Lab No	Experiment Title	LO mapped	Hrs/Lab
1.	Identification of Rock and minerals.	LO1	02
2.	Types of soil in Maharashtra and India.	LO1	02
3.	Identification of organic manures and chemical fertilizers.	LO1	02
4.	Aquitance with Agronomical field crops and their Morphological Characteristics	LO2,	02
5.	Criteria for irrigation water requirement and Measurement.	LO2	02
6.	Studies on irrigation water Measuring and soil moisture measuring devices.	LO2	02
7.	Yield contributing characters and yield Prediction.	LO3	02
8.	Type of tillage Equipment and their significance.	LO4	02
9.	Computation of fertilizer dose to field crops viz General recommended dose of fertilizers, soil test based Yield target based.	LO5	02
10.	Implement of Prototype field operation harvesting, threshing and Processing machinery	LO5	02
11.	Implement Prototypes of system for fertilizing using IOT	LO3,LO6	02

Term work:	1. Term work should consist of minimum 10 experiments 2. Journal must include at least 2 assignments on content of theory and practical of the course "AI in Agriculture 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: 15-marks, Attendance (Theory & Practical): 05-marks, Assignments: 05-marks).
Oral/Practical/P &O :	**Oral/Practical /P&O examination** will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC603	Artificial Internet of Things	03	0	0	03

Prerequisite:	1. Artificial Intelligence. 2. Embedded System Design. 3. Computer Networks.
Course Objectives:	The objectives of this course are to: 1. Understand the role of AI and Internet of Things (IoT) 2. Introduce multiple ways of data communication and networking. 3. Understand importance of data handling in AIoT. 4. Apply AI based IoT Case studies
Couse Outcomes:	On successful completion of the course the students will be able to: 1.Explain the concepts of AI and Internet of Things. 2. Analyze basic multiple way of data communication and networking in IoT. 3. Apply design methodology for solving IoT case studies. 4. Analyze data handling in IoT. 5. Implementation of IoT Devices. 6. Illustrate various AI based IoT case studies.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to AI and IoT	1.1 Overview of Artificial Intelligence (AI) and its applications across various industries. 1.2 Introduction to the Internet of Things (IoT) and its significance in the modern interconnected world. 1.3 Understanding the concept of Artificial Intelligence of Things (AIoT) and its potential to revolutionize technology integration.	CO1	03	04
2. Basics of IoT	2.1 Define IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT	CO2	04	10
	2.2 IoT and M2M:- IoT/M2M System layers and Design Standardization, M2M, Difference between IoT and M2M.		03	
	2.3 IoT Levels: IoT Levels and Deployment Templates.		03	
3. Network & Communication aspects	3.1 Web Communication Protocols for connected devices, Web connectivity using Gateway, HTTP, WebSockets, (Publish–Subscribe), MQTT, Link Layer: 802.3 – Ethernet, 802.11 – WiFi, Network/Internet Layer- IPv4,IPv6,6LoWPAN Transport Layer-TCP,UDP.	CO3	03	05
	3.2 Internet Connectivity: IP addressing in IoT, LPWAN Fundamentals : LORA, NBIoT, SIGFOX.		02	

4. IoT Design Methodology	Introduction, Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration	CO4	03	05
5.IoT Components and Data	5.1 Components of IoT: Exemplary Devices: ESP32/ 8266, LED, DHT Sensor, Ultrasonic, Sensor, IR Sensor	CO5	04	10
	5.2 Data Acquiring, Organizing, Processing: - Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.		03	
	5.3 AWS, ThingSpeak, Blynk App		03	
6. AI Based IoT Case Study	AI Powered Smart Cities AI based Transportation AI in Inventory Management	CO6	05	05

Course Code	Course Name	Credits		
		P	TUT	Total
AIDLL603	Artificial Intelligence of Things Lab	01	0	01

Lab Prerequisite:	1. Artificial Intelligence 2.Embedded System Design 3.Computer Networks
Lab Objectives:	1. Understand ESP32/ 8266 for IoT practical. 2. Implementation of ESP32/ 8266 interfacing with LED, IR, Ultrasonic, DHT sensors. 3. Implementation of AI techniques on IoT Data. 4. Demonstration of IoT based case study. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.
Lab Outcomes (LOs):	After completing practical student will be able to: 1. Implement interfacing of nodemcu with LED, IR, Ultrasonic, DHT sensors. 2. Apply AI techniques to analyze IoT data. 3. Implement storing of data to AWS. 4. Demonstrate AI-IoT based case study. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1	Study of different communication protocols for IoT.	LO1, LO5, LO6	02
2	LED and IR sensor interfacing with Nodemcu.		02
3	Ultrasonic sensor interfacing with Nodemcu for distance Measurement.		02
4	Temperature/Humidity monitoring using Blynk App.		02
5	To study the MQTT and ThingSpeak and upload the DHT sensor data on ThingSpeak		02
6	Apply AI techniques to analyze IoT data	LO2, LO5, LO6	02
7	Apply AI techniques to analyze IoT data		02
8	Apply AI techniques to analyze IoT data		02
9	To study Amazon Web Service Platform.	LO3,LO5, LO6	02
10	AI-IoT Based Case Study	LO4,LO5, LO6	02

Virtual Lab Links:	1. https://aws.amazon.com/ 2. https://thingspeak.com/ 3. https://blynk.io/
Term work: (25 Marks)	1. Term work should consist of a minimum of 8 experiments 2. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. 3. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. 4. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. 5. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Note: Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC604	Bioinformatics Data Management	03	0	0	03

Prerequisite:	Database Management System
Course Objectives:	1. To store, analyze and disseminate the biological data via bioinformatics 2. To manage the next generation sequencing data to develop bioinformatic tools. 3. To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
Couse Outcomes:	After completion of this course , student will be able to 1. Explain different Omics and its applications. 2. Explain different methods for Biological Data Searching and databases. 3. Explain Biological Data Mining. 4. Explain general data cleaning method. 5. Compare three areas in biological data integration. 6. Explain Biological Data Processing In The Cloud.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Bioinformatics Data and Databases	Overview of bioinformatics data types (genomic, proteomic, transcriptomic, etc.).	CO1	02	08
	Biological data formats (FASTA, GenBank, XML, JSON, etc.).		02	
	Introduction to database management systems (DBMS).		02	
	Relational database concepts (tables, keys, SQL).			
	Non-relational database concepts (NoSQL databases).		02	
	Introduction to data lifecycle management.			
2. Biological Data Searching and Databases	DNA and Protein Databases (GenBank, UniProt).	CO2	02	8
	Metabolic Databases (KEGG).		02	
	BLAST: Basic Local Alignment Search Tool (Theory and Practical Applications).		02	
	Case Study: Phylogenetic Tree Database Search.		02	
	Case Study: RNA Pseudoknot Database Search.			
3.Biological Data Mining	Introduction to General Data Mining Concepts.	CO3	02	8
	Biological Data Mining: Techniques and Applications.		02	
	Case Study: Biological Pattern Discovery.		02	
	Case study: Biological Data Mining.		02	
4. Biological Data Cleaning	Introduction to General Data Cleaning Principles.	CO4	02	06
	Data Cleaning Techniques for Biological Data.		02	
	Case Study: Biological Data Cleaning.		02	
5.Biological Data Integration	Introduction to General Data Integration Concepts.	CO5	02	06
	Three Key Areas of Biological Data Integration.		02	
	Integrating different Omics datasets.		02	

6. Cloud based Biological Data Processing	Introduction to Cloud Computing Concepts. Data Processing in the Cloud. Biological Data Processing in the Cloud. Cloud based bioinformatics tools and resources.	CO6	02 02 02	06
II.Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
Books:				
Reference book	1. Attwood T. K., Parry-Smith D. J and Phukan S. (2009). Introduction to Bioinformatics. Pearson Education. 2. Harisha S. (2019). Fundamentals of Bioinformatics. Dreamtech Press			
Reference Books	1. Bioinformatics Database Systems, by Kevin Byron & Katherine G. Herbert & Jason T. L. Wang, CRC Press Taylor & Francis Group. 2. Basics of Bioinformatics, Rui Jiang Xuegong Zhang Michael Q. Zhang , Springer			
Continuous Assessment :	1. Test 1 – 20 marks 2. Test 2 – 20 marks **Test 1 and Test 2- 40 Marks**			
End Semester Exam	• End Semester Theory Examination will be of 60-Marks for 02:30 hrs duration.			

Course Code	Course Name	Credits		
		P	TUT	Total
AIDLL604	AI for Bioinformatics Data Management Lab	01	0	01

Lab Prerequisite:	Database Management System
Lab Objectives:	1.To store, analyze and disseminate the biological data via bioinformatics 2. To manage the next generation sequencing data to develop bioinformatic tools. 3.To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
Lab Outcomes (LOs):	After the completion of course 1. Understand and manipulate different bioinformatics data types and formats. 2. Develop proficiency in biological database management and SQL queries. 3. Retrieve, analyze, and compare biological sequences using BLAST and public databases. 4. Apply machine learning techniques to recognize patterns in biological data. 5. Perform multi-omics data integration and analysis using cloud-based bioinformatics tools

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Database Management System	--	02
1	1. **Overview of Bioinformatics Data Types** ○ Hands-on exploration of genomic, proteomic, transcriptomic, and metabolomics datasets. 2. **Biological Data Formats** ○ Parsing and manipulating FASTA, GenBank, XML, and JSON files using Python/Biopython.	LO1	02
2	Setting up and using MySQL for biological data storage and Creating tables, defining keys, and running SQL queries for biological datasets.	LO2	02
3	Retrieve data from GenBank and UniProt using APIs and Perform BLAST sequence similarity searches and analyze results.	LO3	02
4	Learn supervised and unsupervised learning for biological data and Recognize patterns in gene sequences using motif-finding tools.	LO4	02
5	Conduct multi-omics analysis using bioinformatics tools.	LO4	02
6	Explore pathways and metabolic interactions using KEGG database tools.	LO5	02
7	Construct and interpret phylogenetic trees using analysis tools	LO5	02
8	Run bioinformatics workflows on cloud services (AWS/GCP/Azure).	LO5	02

Term work: (25 Marks)	1. Term work should consist of minimum 10 experiments 2. Journal must include at least 2 assignments on content of theory and practical of the course "AI for Bioinformatics Data Management" 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: 15-marks, Attendance (Theory & Practical): 05-marks, Assignments: 05-marks)

Project Based Learning Code	Project Based Learning Name	Credits		
		P	TUT	Total
AIPR64	Minor Project Lab-2	01	0	01

PBL Prerequisite:	1. Project Based Learning- Mini Project Lab-I. 2. Project Based Learning- Mini Project Lab-II. 3. Microprocessors.
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 (PROs):	Learner will be able to: 1. Identify the problem statement based on societal /research needs. 2. Design algorithms/flow chart for the system. 3. Develop solution using suitable programming language. 4. Apply hardware/software knowledge to develop solution. 5. Excel in written and oral communication. 6. Demonstrate project management principles during project work.

Module No.	Module Title	PRO Mapped	Hrs./Module
1	Problem Definition and Project Planning:1.1 Literature Survey, Problem Definition, Objectives of the project.	PRO 1	02
	1.2 List of Input and Output (sensors, Actuators), list of components, Selection of icroprocessor/Microcontroller/Selection of Boards (Arduino/ ESP8266, etc.).		02
	1.3 Preparation of Gantt/PERT/CPM chart- weekly activity of mini project.		02
2	2.1 Flow Chart/Algorithms: List the steps required to solve a problem, Preparation of Flow Chart/Algorthm.	PRO 2	02
3	Programming: 3.1 Study of programming languages C, Embedded C, Java, Python.	PRO 3	02
	3.2 Simulation using Tinkercad / Proteus/ Suitable simulator as per application.		02
4	Implementation: 4.1 Design of Board- Identify, list and purchase elements of a development board, Design the board	PRO 4	02
	4.2 Solder and Interface devices like sensors, keyboards and displays to the board		02
	4.3 Integration of Hardware and Software components, Testing, Debugging using Keil/Ardiuno/python etc.		02
5	5.1 Report writing and presentation preparation: Documentation of the work done in a streamlined manner, Preparation and organization of a report	PRO 5	04

	according to a standard format, Use of IEEE format of bibliography.		
6	6.1 Project presentation & Demonstration: Project Presentation using PPT and Demonstration of working model of the system.	PRO 6	04
		Total hours	**26**

Books:

Reference Books	1. Rajkamal, "Embedded Systems: Architecture, Programming and Design",McGraw Hill Education (India) Private Limited, New Delhi, 2015,Edition 3rd. 2.Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009 3.Dr. Krishna Kumar Mohbey, Dr. Brijesh Bakariya "An Introduction to Python Programming: A Practical Approach", bpb publications.

Useful Links:

1. https://ieeexplore.ieee.org/
2. https://www.electronicsforu.com/
3. https://www.keil.com/
4. https://www.tinkercad.com/
5. https://www.arduino.cc/
6. https://www.tutorialspoint.com/python/index.htm

Guidelines for Minor Project:

1. Project is a group activity and students shall form a group of 2 to 3 students. A group shall not be more than three students.
2. Project Based Learning - Minor Project Lab-1 should be implemented with hardware and/or software.
3. Students will be assigned an open-ended problem which they will finalize according to their preferences and in consultation with the faculty supervisor.
4. Project should be implementation of Applied Artificial Intelligence/ Data Science/Embedded Systems/ Societal need based / Innovative idea implementation etc.
5. Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
6. A collaborative logbook will be prepared by each group, which will be verified regularly by; guide/supervisor can verify and record notes/comments.
7. The solution to be validated with proper justification and report to be compiled in standard format of the college.
8. The focus of project will be on self-learning, innovation, addressing societal problems and based solutions.

Guidelines for Assessment of Minor Project:

1. The review/ progress monitoring committee shall be constituted by faculty members in-charge and/or senior faculty members.
2. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews per semester. Assessment also considers peer review by students and observation of ethics.
3. Report should be prepared as per the guidelines issued by the college.
4. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of examiners.
5. In the case of a major project, the evaluation will be based on fulfillment of goals by the end of semester. Students shall be motivated to participate in poster & project competition.

Term work (25 Marks):

Distribution of term work marks are,

1. Marks awarded by guide/supervisor based on logbook: 10
2. Marks awarded by review committee (Internal Presentation and TPP/Poster/ Idea Competition/etc. Participation): 10
3. Quality of Project report: 05

Practical (25 Marks):

1. Minor Projects shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
2. Students shall be motivated to publish a paper based on the work in Conferences/students competitions

Distribution of practical marks are,

1. Presentation:5
2. Project Implementation:10
   Project Report, Performance:10

Exposure (Skill Based Learning-IX) Code	Exposure (Skill Based Learning-IX)	Credits		
		P	TUT	Total
AIXS69	R Programming	01	0	01

Prerequisite:	Engineering Mathematics
Skill Objectives:	1.Identify and use available R packages and associated Open Source software 2.Write efficient programs using R to perform routine tasks 3.Document and collaborate on code development 4.Work with datasets for analysis and presentation
Skill Outcomes (SOs):	1.Write simple structured programs in R. 2.Import different data formats into R using RStudio. 3.Wrangle data for analysis. 4.Query data using SQL and R. 5.Analyze a data set in R and present findings using the appropriate R packages. 6.Visualize data attributes using ggplot2 and other R packages.

Module No. & Name	Sub Topics	SO Mapped	Hrs/ Subtopic
1.Getting Started with R	What is R? • Installing R and RStudio • RStudio Overview • Working in the Console • Arithmetic Operators • Logical Operations • Using Functions Getting Help in R and Quitting RStudio	SO1	02
2.Basics of R	Atomic classes, Creating Variables • Numeric, Character and Logical Data, vectors, lists, factors, missing values, data frames and matrices, Special Values		02
3.Reading and storing data	Use read.table() for small and large data, calculating memory requirements, Using the readr Package, using file() connections, using textual and binary formats to store data	SO2	02
4.Data structures	Subsetting vector, matrix, lists, nested elements, multiple elements, removing NA values, Managing data frames with the dplyr package		02
5.Control structures	Control structures like if, while, and for, repeat	SO3	02
6.Functions	Functions, argument matching, evaluation, Looping the command line		02
7.Regular expressions	grep(), grepl(), regexpr(), sub(), gsub(),regexec(), the stringer package	SO4	02
8.Data exploration and visualization	Using the ggplot2 package to visualize data • Applying themes from ggthemes to refine and customize charts and graphs • Building data graphics for dynamic reporting	SO5	02
9.Debugging and profiling	Debugging tools, R profiler	SO6	02
10.Simulation	Simulating random and linear models		02
11. Data analysis case study	Data analysis and case study		02

Books:	
Text Books	1.Wickham, Hadley, and Garrett Grolemund. R for data science: import, tidy, transform, visualize, and model data. "O'Reilly Media, Inc.", 2016. Available for free at http://r4ds.had.co.nz 2.Peng, Roger D. R programming for data science. Victoria, BC, Canada: Leanpub, 2016. Available for free at R Programming for Data Science (bookdown.org).
Reference Books	1. Gardener, Mark. Beginning R: the statistical programming language. John Wiley & Sons, 2012. 2. Jones, Owen, Robert Maillardet, and Andrew Robinson. Introduction to scientific programming and simulation using R. Chapman and Hall/CRC, 2009.
Important links:	1. http://www.r-project.org/ 2. http://www.rstudio.com/ 3. http://www.statmethods.net/ 4. Google's R Style Guide: http://google-styleguide.googlecode.com/svn/trunk/ Rguide.xml
Term Work:	Programming labs to be conducted as 2hrs continuous theory + hands-on session. Discussion on the topics and Programs Involving the concepts mentioned will be performed during the assigned lab hours. Term work of 25 marks.

Exposure (Technology Based Learning-X) Code	Exposure (Technology Based Learning-X) Name	Credits	
		P	TUT
AIXT610	**1.Online Certification Courses** **2.NPTEL certification** **3.IITBs Spoken Tutorial** **4.Swayam MOOCs** **5.Coursera certification** **6.Internshala Trainings**	**1**	0

Technology Prerequisite:	Basic Engineering and Technology courses
Technology Objectives:	1. To acquire competency in emerging areas of technology. 2. To create a mindset for life-long learning required to persist technological shifts and be abreast with the market trends. 3. To facilitate learning at self-paced schedules. 4. To boost time management ability and self-discipline. 5. To provide opportunities of strengthening digital footprints by showcasing the additional proficiency acquired as well as improve connectivity and networking. 6. To enhance employment and entrepreneurial opportunities requiring specialization.
Technology Outcomes (TOs):	1. Explain concepts of the emerging technology learned through the pursued course. 2. Describe social, ethical, and legal issues surrounding the learned technology. 3. Demonstrate professionalism and skills of digital age learning and working. 4. Demonstrate knowledge in entrance exams for higher technical education, placement interviews, and other avenues. 5. Analyze real-world case studies in society/industry for applicability of sustainable technological solutions. 6. Apply the acquired knowledge in developing technology-based

Guidelines:

1. Learners should enroll for an online course based on their area of interest concerning emerging areas of technology in consultation with Faculty Supervisor nominated by the Head of Department.
2. The course duration should be of minimum 04 weeks.
3. Students should watch all the videos of the course to learn the course in-depth and entirety.
4. Students should solve weekly assignments that are to be submitted online within the prescribed deadline.
5. Students should register and appear for the course certification exam on scheduled date and time.
6. Students should submit the certificate of course completion to the Faculty Supervisor.
7. Faculty Supervisor shall monitor students' participation and progress at every stage — from course enrolment to certification.

Useful Links:

https://swayam.gov.in

https://www.nptel.ac.in

https://www.coursera.org

Term Work:	Term work shall be conducted for total 25 marks

SOMAIYA
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Autonomy Syllabus Scheme III (2023-24)

(As per NEP 2020 Guidelines) for

Four Year Multidisciplinary Bachelors of Technology

(B.Tech.) Program

Minors in

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

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

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

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

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

Analog circuit design	6.2 Stable voltage references across temperature variations		**03**	
	6.3 high-precision applications in integrated circuits.		**02**	

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

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

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

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

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

Books:

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

Useful Links:

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

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

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

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

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

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

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

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

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

	Case Studies of Financial Successes and Challenges		01	
5. Pre-incubation and Incubation	Stages of Pre-incubation and Incubation	**CO5**	**01**	**06**
	Resources and Support Mechanisms		**01**	
	Case Studies of Start-ups in Incubation		**02**	
	Group Activities: Pitching for Incubation		**02**	
6. Case Studies of Start-ups	Case Studies of Start-ups in India / abroad	**CO6**	**02**	**07**
	Case Studies of Start-ups using BMC and MVPs		**02**	
	Lessons from Real-World Start-up Failures		**01**	
	Group Presentations and Feedback Sessions		**02**	
II. Course Conclusio	Recap of Modules, Outcomes, Applications, and Summarization	**-**	**01**	**01**
			Total Hours	**42**
BOOKS:				
Text Books:	1. A. Osterwalder and Y. Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers", Wiley, 2010. 2. E. Ries. "The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*."* Crown Business, 2011.			
Reference Books:	1. K. Berman and J**.** Knight, "Financial Intelligence for Entrepreneurs: What You Really Need to Know About the Numbers", Harvard Business Review Press, 2008. 2. S. Daniel, "How to Start a Business in India", Clever Fox Publishing, 2020.			
Useful Online Resource Links:	1. https://onlinecourses.nptel.ac.in/noc25_ge11/preview 2. https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview 3. https://onlinecourses.swayam2.ac.in/ntr24_ed51 4. https://www.udemy.com/topic/minimum-viable product			
Term Work (TW):	• Term work will consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.			
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.			

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Books	

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

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

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

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

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

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

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

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

3. User Experience Design for the Internet of Things?	How Is UX for IoT Different? A Design Model for IoT Things: The Technology of Connected Devices-Types of Connected Device, Multipurpose Computers, Bridging Physical and Digital: Sensors and Actuators, The Challenge of Powering Devices, Conserving Battery Life Networks: The Technology of Connectivity-Why Is Networking Relevant to IoT UX?,Networking Issues That Cause UX Challenges for IoT, The Architecture of the Internet of Things, Types of Network , Network Communication Patterns, Internet Service.	CO3	07	07
4. Product/Service Definition and Strategy	Making Good Products, From Innovation to Mass Market, Tools Versus Products, What Makes a Good Product?, Services in IoT,Business Models, The Role of Research in Connected Product Design, Initial Questions and Concepts, Techniques: from Asking to Watching to Making.	CO4	07	07
5. Embedded Device Design	An Introduction to Thinking About Physical Objects in IoT,Making Stuff: Differences to UX,Essentials of the Design Process, Three Faces of a Physical Product, Design of a 3D printer.	CO5	05	05
6.Responsible IoT Design	Security,Privacy,Environment,Social Engineering.	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	--	01	01
			Total Hours	**42**
Books				
Text Books:	1. Jake VanderPlas,“ Python Data Science Handbook”, O’Reilly publication,2016.			
Reference Books:	1.Internet of Things, Principles and Paradigms by Rajkumar Buyya Designing Connected Products-UX for the Consumer Internet of Things by Claire Rowland, Elizabeth Goodman, Martin Charlier,Ann Light, and Alfred Lui.			
Useful Online Resource Links:	1.https://spoken-tutorial.org/watch/Arduino/Introduction+to+Arduino/English/ 2.https://mqtt.org/ 3.https://github.com/microsoft/IoT-For-Beginners			
Term Work (TW):	• Term work should consist of Presentations / Assignments / Class Participation and Performance / Group Activities / etc. • Term work evaluation shall be for Total 50 Marks based on performance.			
End Semester Examination (ESE):	• End Semester evaluation shall be of Total 50 Marks in the form of Oral Examination.			