SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
An Autonomous Institute affiliated to University of Mumbai

Item No: 4.7
A.C. Date: 09/07/2022

Autonomy Syllabus Scheme-II (2022-23)

Bachelor of Technology
in
Artificial Intelligence and Data Science

(Third Year)
(Semester V and VI)

(With effect from AY 2022-23)

Somaiya Ayurvihar Complex, Eastern Express Highway, Sion (East), Mumbai. 400 022, India
Telephone: (91-22)24061404, 24061403 email: principal.tech@somaiya.edu, Web:www.somaiya.edu/kjsieit

From the Principal's Desk:

The challenges and demands of the dynamic industry increasingly require technocrats to be skilled, adaptive, and innovative. The National Educational Policy 2020 (NEP 2020) framed by the Government of India intends to induce a paradigm shift by re-conceptualising the higher education. Recent academic reforms recommended by the AICTE and UGC have also effectually upscaled the higher education system in India. It is further the role of HEIs to offer high-quality educational opportunities and enable the next generation to succeed globally. Hence, to adhere to the status quo, and enhance the academic standards and quality of engineering education further, it is essential to assimilate innovation and recurrent revision in curriculum, teaching-learning methodology, examination, and assessment system.

In congruence with it, the University of Mumbai has adapted Outcome-Based Education (OBE) system and has revised the engineering curriculum thrice in the last decade — as Rev 2012, Rev 2016, and the recent Rev 2019, 'C' scheme focusing on cutting-edge technology courses.

K. J. Somaiya Institute of Engineering and Information Technology (KJSIEIT), being an autonomous institute possesses more flexibility in adapting newer approaches to reach higher levels of excellence in engineering education. The Syllabus Scheme-I implemented under the academic autonomy conferred to KJSIEIT w.e.f. A.Y. 2021-22 already comprises of state-of-the-art courses and laboratory sessions on emerging areas of technology. With an ideology that the root of innovation is 'interest', the curriculum offered a wide range of elective courses grouped into core and inter-disciplinary domains. At par with international engineering education, it followed a learner-centric approach, where the students could choose to study courses concerning areas of their interests.

This curriculum introduces 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 were practiced across the first three years of engineering, focusing on graduate attributes like work responsibilities towards society, problem-solving ability, communication skills, motivation for life-long learning, leadership and teamwork, etc. that could not be copiously imbibed through regular engineering courses. The inclusion of induction program for the First Year students is deliberated as per the guidelines of AICTE and helps students belonging to diverse backgrounds to adjust in the new academic environment.

However, sustained initiatives are required to assure efficiency, academic excellence, and growth. Hence, KJSIEIT Syllabus Scheme –II introduces 03 newer dimensions to Scheme – I: Internship, SBL of Foreign and Indian Languages, and Honours Degree that shall be implemented w.e.f. from A.Y. 2022-23 across all the branches and all 04 years of engineering.

1. **Internship:** Firstly, the redesigned Scheme-II incorporates 14 Credits for Internship (cumulative 600-700 Hours), which shall be mandatory for all the students and is to be pursued during all 04 years of graduation. Based on the AICTE Internship Policy, this initiative shall enable graduates to respond to the current needs of the industry and equip them with skills required at national and global level. The students shall gain practical understanding and training on cutting-edge technologies and industry practices in a suitable industry or organization. While innovation and entrepreneurship are emerging as fulcrums of higher education, the internship will also provide an exposure to innovation, entrepreneurial, and incubation opportunities through various related activities, and instill a start-up spirit in the students.

   Further, the students of KJSIEIT already have an exposure to the work culture and trends in industries

through live / collaborative projects / product developments, etc. and they often contribute significantly to the society through various projects. Under autonomy too, through the component of Project-Based Learning included in the syllabus, the students develop Mini, Minor, and Major projects in Second, Third, and Last Year respectively concerning healthcare, agriculture, societal / industrial need-based problems, etc. Through duality of Major Project development and newly introduced activities / components as a part of Internship, the students shall learn about research methodology, IP and IPR — resulting into generation of quality research articles, copyrights, and patents.

2. **Honours Program**: Another major initiative through the Scheme–II is the introduction of B.Tech. with Honours program 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. This Honours program is of high-end industry standards and shall offer multi-fold opportunities for the learners such as additional credits, specialization in the chosen domain, job-ready skills, multidisciplinary knowledge, etc.
3. **Foreign and Indian Languages**: As another initiative, the Skill-Based Learning (SBL) in Scheme – II shall also comprise of developing verbal and written communication skills in Foreign and Indian Languages, which is a blooming trend and future necessity for various career prospects. The students shall acquire these skills through MOOC courses, giving them opportunities to learn the target language from beginners to advanced level. These SBL and the TBL courses shall acquaint students with skills of digital age learning from online platforms, along with time management ability, ethics, and professionalism.

Through joint efforts of all stakeholders, newer initiatives, strategic planning, and efficient execution of neoteric educational practices with hi-tech wizardry, KJSIEIT is endeavouring to become a role model for all autonomous institutes across the nation.

Dr. S. K. Ukarande
Principal and Chairman - Academic Council

Preamble by Member Secretary, Academic Council:

K J Somaiya Institute of Engineering and Information Technology (KJSIEIT) has been granted academic autonomy by University Grants Commission (UGC) from Academic Year 2021-22 for 10 years. UGC states the benefits of granting academic autonomy to higher education institutes as 'the freedom to modernize curricula, making it globally competent, locally relevant and skill oriented to promote employability'.

We, autonomous KJSIEITs Board of Studies in Computer Engineering (CE), Artificial Intelligence and Data Science (AI-DS), Electronics and Telecommunication (ET) and Information Technology (IT) had prepared Autonomy Scheme-I curricula from Academic Year 2021-22 for 4 years undergraduate (UG) and 2 years of post-graduation (PG) in Engineering and Technology disciplines, exercising academic freedom, meeting the needs of Industry 4.0, addressing the world wide challenges and providing globally required exposure to our UG and PG learners, focusing sound theoretical background supported by practical experiences in the relevant areas of engineering and technology.

Industry 4.0 demands modern and industry-oriented education, up-to-date knowledge of analysis, interpretation, designing, implementation, validation, and documentation of not only computer software and systems but also electronics and communication systems, hardware devices and tools, trained professionals, ability to work in teams on multidisciplinary projects, etc from engineering graduates. KJSIEITs autonomy Scheme-I syllabus was framed looking at the overall demands of Industry 4.0 and society to successfully acquaint learners with life-long experiential learning, professional ethics with universal human values, needed skill sets, in line with the objectives of higher and technical education, AICTE, UGC and various accreditation and ranking agencies, by keeping an eye on the technological developments and innovations.

It provides unique learning experiences to learners through extracurricular activities, innovations, and research with the introduction of Skill Based, Activity Based, Technology based and Project Based learning, showcasing learners' creativity, interest and talent by developing additional skill sets, social involvement and contributions through activities, case studies, field visits, internships, creative learning, innovative mini, minor and major project developments. This helped in strengthening learners' profile with increased chances of employability and avenues for start-ups. It is also provided with Value addition learning through MOOCs platforms such as IBM-ICE, Coursera, NPTEL, SWAYAM, Spoken Tutorial, Udemy etc.
We are happy to present the additional exposure to our learners under the Autonomy Academic Scheme-II, implemented w.e.f academic year 2022-23 for developing the intellectual climate of our country, bringing academic excellence in higher education system with the introduction of additional credit and audit courses for

1. Internships,
2. Skill Based Learning and
3. Honours Degree Programs in 6 emerging areas of technologies.

These additions are targeted for promoting academic, professional and personal development of learners through hands-on working experience under internships, exposure to foreign and Indian Regional Languages through MOOCs and award of specialisation through Honours Degree Program. Internships will channelize learners' working experience with Industries, Government Sectors, NGO, MSMEs, Long term Rural Developments, and Research, Innovation, IPRs and Entrepreneurial setup. Two innovative courses on skill based implementing NEP 2020 guidelines and Honours Degree Program along with Regular B.Tech degree will boost the knowledge of graduating engineers in emerging areas of technologies contributing largely for industrial and personal automation, cyber, digitization, digital currency, security and artificial intelligence sector.

We are sure that with Scheme-I in academic year 2021-22 and Scheme-II from Academic Year 2022-23, the blend of innovative learning components in the curriculum shall strengthen the research and entrepreneurial culture of the institute benefitting the graduating engineers immensely.
We would like to place on record our gratitude to the faculty, alumni, students, industry experts, academicians and stakeholders, helping continuously strengthen the academics, making KJSIEIT as one of best engineering colleges across nation and top most choice of engineering aspirants.

Dr. Sunita R Patil
Member Secretary, Academic Council and Vice Principal, KJSIEIT, Sion

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-II of Second Year and Third Year of B. Tech in Artificial Intelligence with effect from the Academic Year 2022-23. We are assured that you will discover this syllabus interesting and challenging.

AI-DS is one of the newest programme amongst engineering students. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas like human intelligence and its applications in industry, defence healthcare, agriculture and many other areas. It is envisioned to deliver a modern, industry-oriented education in AI-DS. It aims at creating skilled engineers who can successfully acquaint with the demands of the industry worldwide. We have included internships under Autonomy Syllabus Scheme-II from SEM-II to SEM-VIII of B.Tech AI-DS. Also honor degree courses introduced in this Syllabus Scheme-II of AI-DS. They obtain skills and experience in up-to-date knowledge to analysis, design, employ, technologies, software and systems.

In this course, the students may have career opportunities in healthcare, business, e-Commerce, social networking companies, biotechnology, genetics and other areas. For holistic development of students Foreign and Regional Indian language and other skill-based courses introduced first time in this new scheme. At the beginning of every course, we have added two theory lectures for prerequisites and course outline and at the end one theory lecture added for coverage of course conclusion which includes recap of modules, outcomes, applications, and summarization. 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)	11	Prof. Vrinda Ullas	Member
2	Dr. Michel Mistry	Experts from outside parent university nominated by Academic council	12	Prof. Vidya Sagvekar	Member
3	Dr. Sanjay Shitole		13	Prof. Sejal Shah	Member
4	Dr. Madhav Chandane	One expert to be nominated by the Vice-Chancellor	14	Prof. G. R. Phadke	Member
5	Mr. Akhil Hada	One Representative from Industry /Corporate Sector/ Allied area relating to Placement	15	Prof. Sarika Mane	Member
6	Dr. Vaishali Wadhe	Member	16	Prof. Sheetal Jagtap	Member
7	Prof. Pankaj Deshmukh	Member	17	Prof. Devanand Bathe	Member
8	Prof. Medha Asurlekar	Member	18	Prof. Ganesh Wadmare	Member
9	Dr. Sunita Patil	Other Member	19	Dr. Hariram Chavan	Other Member
10	Dr. Namrata Gharat	Other member	20	Dr. Radhika Kotecha	Other member

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Program Structure for Third Year UG Technology (AI-DS)

Semester-V- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC501	Artificial Intelligence	3–0–0	03	3–0–0	03	PC
AIC502	Data Warehousing and Mining	3–0–0	03	3–0–0	03	PC
AIC503	Software Engineering	3–0–0	03	3–0–0	03	PC
AIC504	Information Theory and Coding	3–0–0	03	3–0–0	03	PC
AIDLC505X	Department Level Elective-1	3–0–0	03	3–0–0	03	DLE
AIL501	Artificial Intelligence 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
AIL503	Software Engineering Lab	0–2–0	02	0–1–0	01	PC
AIDLL505X	Department Level Elective-1 Lab	0–2–0	02	0–1–0	01	DLE
AIL506	Business Communication and Ethics	0–4**–0	04	0–2–0	02	BS
AIPR53	Project Based Learning - Minor Project Lab-1	0–2–0	02	0–1–0	01	PBL
AIXS57	Skill Based Learning-VII	0–2*–0	02	0–1–0	01	SAT
AIXT58	Technology Based Learning-VIII	0–2*–0	02	0–1–0	01	SAT
INT 54	Internship-4	--	--	--	--	INT
Total		**15–18–0**	**33**	**15-9-0**	**24**	

*SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.
**2 hours class wise and 2 hours batch wise
PBL - Minor Project Lab 1 and 2:

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load: 1 hour per week per four groups

Semester-V- Examination Scheme

Course Code	Course Name	Examination Scheme Marks									
		CA				ESE	TW	O	P	P&O	Total
		T-1	T-2	Average (T-1 & T-2)	IA						
AIC501	Artificial Intelligence	30	30	30	10	60	--	--	--	--	100
AIC502	Data Warehousing and Mining	30	30	30	10	60	--	--	--	--	100
AIC503	Software Engineering	30	30	30	10	60	--	--	--	--	100
AIC504	Information Theory and	30	30	30	10	60	--	--	--	--	100
AIDLC505X	Department Level Elective-1	30	30	30	10	60	--	--	--	--	100
AIL501	Artificial Intelligence Lab	--	--	--	--	--	25	--	--	25	50
AIL502	Data Warehousing and Mining Lab	--	--	--	--	--	25	--	--	--	25
AIL503	Software Engineering Lab	--	--	--	--	--	25	--	--	25	50
AIDLL505X	Department Level Elective-1 Lab	--	--	--	--	--	25	--	--	--	25
AIL506	Business Communication and Ethics	--	--	--	--	--	25	25	--	--	50
AIPR53	Project Based Learning - Minor Project Lab-1	--	--	--	--	--	25	--	25	--	50
AIXS57	Skill Based Learning-VII	--	--	--	--	--	25	--	--	--	25
AIXT58	Technology Based Learning-VIII	--	--	--	--	--	25	--	--	--	25
INT 54	Internship-4	--	--	--	--	--	--	--	--	--	--
Total		**--**	**--**	**150**	**50**	**300**	**200**	**25**	**25**	**50**	**800**

Department Level Elective-1			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC5051	AIDLC5052	AIDLC5053	AIDLC5054
Computer Networks	Image and Video Processing	Embedded System and Design	Algorithms for Bioinformatics

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Program Structure Template for Third Year UG Technology (AI-DS)

Semester-VI- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC601	Artificial Neural Network	3–0–0	03	3–0–0	03	PC
AIC602	Machine Learning	3–0–0	03	3–0–0	03	PC
AIC603	Data Analytics and Visualization	3–0–0	03	3–0–0	03	PC
AIC604	Big Data Analytics	3–0–0	03	3–0–0	03	PC
AIDLC605X	Department Level Elective-2	3–0–0	03	3–0–0	03	DLE
AIL601	Artificial Neural Network Lab	0–2–0	02	0–1–0	01	PC
AIL602	Machine Learning Lab	0–2–0	02	0–1–0	01	PC
AIL603	Data Analytics and Visualization Lab	0–2–0	02	0–1–0	01	PC
AIDLL605X	Department Level Elective-2 Lab	0–2–0	02	0–1–0	01	DLE
AIPR64	Project Based Learning - Minor Project Lab-2	0–2–0	02	0–1–0	01	PBL
AIXS69	Skill Based Learning-IX (R Programming)	0–2*–0	02	0–1–0	01	SAT
AIXT610	Technology Based Learning-X	0–2*–0	02	0–1–0	01	SAT
INT 65	Internship-5	--	--	--	--	INT
Total		**15–14–0**	**29**	**15-7-0**	**22**	--

*SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.

PBL - Minor Project Lab 1 and 2:

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load: 1 hour per week per four groups.

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Semester-VI-Examination Scheme

Course Code	Course Name	Examination Scheme Marks									
		CA				ESE	TW	O	P	P & O	Total
		T-1	T-2	Average (T1 & T2)	IA						
AIC601	Artificial Neural Network	30	30	30	10	60	--	--	--	--	100
AIC602	Machine Learning	30	30	30	10	60	--	--	--	--	100
AIC603	Data Analytics and Visualization	30	30	30	10	60	--	--	--	--	100
AIC604	Big Data Analytics	30	30	30	10	60	--	--	--	--	100
AIDLC605X	Department Level Elective-2	30	30	30	10	60	--	--	--	--	100
AIL601	Artificial Neural Network Lab	--	--	--	--	--	25	--	--	25	50
AIL602	Machine Learning Lab	--	--	--	--	--	25	-	--	25	50
AIL603	Data Analytics and Visualization Lab	--	--	--	--	--	25	--	--	25	50
AIDLL605X	Department Level Elective-2 Lab	--	--	--	--	--	25	--	--	--	25
AIPR64	Project Based Learning - Minor Project Lab-2	--	--	--	--	--	25	--	25	--	50
AIXS69	Skill Based Learning-IX (R Programming)	--	--	--	--	--	25	--	--	--	25
AIXT610	Technology Based Learning-X	--	--	--	--	--	25	--	--	--	25
INT 65	Internship-5	--	--	--	--	--	--	--	--	--	25
Total		--	--	**150**	**50**	**300**	**175**	--	**25**	**75**	**775**

Department Level Elective-2			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC6051	AIDLC6052	AIDLC6053	AIDLC6054
AI in E-Commerce	AI in Agriculture	Internet of Things	Bioinformatics Data Management

Details of AI-DS Courses Common with Other Departments

Semester	Course Name	B.Tech Programs		
		COMP	IT	EXTC
III	Applications of Mathematics in Engineering-I	√	√	-
III	Discrete Structure and Graph Theory	√	-	-
III	Digital Logic and Computer Architecture	√	-	-
III	Computer Graphics	√	-	-
III	Skill Based Learning-IV	√	√	√
IV	Applications of Mathematics in Engineering-II	√	√	-
IV	Analysis of Algorithms	√	-	-
IV	Database Management Systems	√	-	-
IV	Operating Systems	√	-	-
IV	Skill Based Learning-V	√	-	-
IV	Skill Based Learning-VI	√	√	√
V	Artificial Intelligence	√	-	-
V	Business Communication and Ethics	√	√	√

Program Structure for Third Year UG Technology (AI-DS)

Semester-V- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC501	Artificial Intelligence	3–0–0	03	3–0–0	03	PC
AIC502	Data Warehousing and Mining	3–0–0	03	3–0–0	03	PC
AIC503	Software Engineering	3–0–0	03	3–0–0	03	PC
AIC504	Information Theory and Coding	3–0–0	03	3–0–0	03	PC
AIDLC505X	Department Level Elective-1	3–0–0	03	3–0–0	03	DLE
AIL501	Artificial Intelligence 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
AIL503	Software Engineering Lab	0–2–0	02	0–1–0	01	PC
AIDLL505X	Department Level Elective-1 Lab	0–2–0	02	0–1–0	01	DLE
AIL506	Business Communication and Ethics	0–4**–0	04	0–2–0	02	BS
AIPR53	Project Based Learning - Minor Project Lab-1	0–2–0	02	0–1–0	01	PBL
AIXS57	Skill Based Learning-VII	0–2*–0	02	0–1–0	01	SAT
AIXT58	Technology Based Learning-VIII	0–2*–0	02	0–1–0	01	SAT
INT 54	Internship-4	--	--	--	--	INT
Total		**15–18–0**	**33**	**15-9-0**	**24**	

*SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.
**2 hours class wise and 2 hours batch wise
PBL - Minor Project Lab 1 and 2:

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load: 1 hour per week per four groups

Semester-V- Examination Scheme

Course Code	Course Name	Examination Scheme Marks									
		CA				ESE	TW	O	P	P&O	Total
		T-1	T-2	Average (T-1 & T-2)	IA						
AIC501	Artificial Intelligence	30	30	30	10	60	--	--	--	--	100
AIC502	Data Warehousing and Mining	30	30	30	10	60	--	--	--	--	100
AIC503	Software Engineering	30	30	30	10	60	--	--	--	--	100
AIC504	Information Theory and Coding	30	30	30	10	60	--	--	--	--	100
AIDLC505X	Department Level Elective-1	30	30	30	10	60	--	--	--	--	100
AIL501	Artificial Intelligence Lab	--	--	--	--	--	25	--	--	25	50
AIL502	Data Warehousing and Mining Lab	--	--	--	--	--	25	--	--	--	25
AIL503	Software Engineering Lab	--	--	--	--	--	25	--	--	25	50
AIDLL505X	Department Level Elective-1 Lab	--	--	--	--	--	25	--	--	--	25
AIL506	Business Communication and Ethics	--	--	--	--	--	25	25	--	--	50
AIPR53	Project Based Learning - Minor Project Lab-1	--	--	--	--	--	25	--	25	--	50
AIXS57	Skill Based Learning-VII	--	--	--	--	--	25	--	--	--	25
AIXT58	Technology Based Learning-VIII	--	--	--	--	--	25	--	--	--	25
INT 54	Internship-4	--	--	--	--	--	--	--	--	--	--
Total		--	--	**150**	**50**	**300**	**200**	**25**	**25**	**50**	**800**

Department Level Elective-1			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC5051	AIDLC5052	AIDLC5053	AIDLC5054
Computer Networks	Image and Video Processing	Embedded System and Design	Algorithms for Bioinformatics

Course Code	Course Name	Credits (TH+P+TUT)
AIC501	Artificial Intelligence	(3+0+0)

Prerequisite:	1. Discrete Structures 2. Data Structure 3. Analysis of algorithm 4. Programming Language
Course Objectives:	1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems. 2. To make students understand and explore the mechanism of mind that enables intelligent thought and action. 3. To make students understand advanced representation formalism and search techniques. 4. To make students understand how to deal with uncertain and incomplete information
Course Outcomes:	At the end of the course, the students will be able to 1. Describe the basic concepts of AI. 2. Develop a basic understanding of AI building blocks presented in intelligent agents. 3. Choose an appropriate problem-solving method and knowledge representation technique. 4. Design models for reasoning with uncertainty as well as the use of unreliable information. 5. Analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving. 6. Design and develop AI applications in real world scenarios.

Module No & Name	Sub Topics	CO Mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1.Introduction to Artificial Intelligence	1.1.Introduction, Intelligent Systems: Categorization of Intelligent System	CO1	01	03
	1.2.Components of AI Program, Foundations of AI, Subareas of AI, Applications of AI, Current trends in AI.		02	
2.Intelligent Agents	2.1.Agents and Environments, the concept of rationality, the nature of environment, the structure of Agents, Types of Agents, Learning Agent	CO2	03	05
	2.2.Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems		02	
3.Problem Solving Using Artificial Intelligence	3.1.Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID)	CO3	02	10
	3.2.Informed Search Methods: Greedy best first			

	3.3.Search, A* Search, Memory bounded heuristic Search		03	
	3.4.Local Search Algorithms and Optimization Problems: Hill climbing search, Simulated Annealing, Genetic algorithms		03	
	3.5.Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning		02	
4.Knowledge and Reasoning	4.1.Knowledge based Agents, Brief overview of Propositional Logic	CO4	01	10
	4.2.First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, Backward chaining. Knowledge Engineering in First-Order Logic, Unification, Resolution		05	
	4.3.Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an Uncertain domain, The semantics of belief network, Simple Inference in belief network		04	
5.Planning and Learning	5.1.The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning	CO5	04	08
	5.2.Learning: Forms of Learning, Theory of Learning, Introduction to Statistical learning (Introduction only), Introduction to reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning		04	
6.AI Applications	AI applications in: • Healthcare • Retail • Banking • Machine Translation	CO6	04	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:

Text Books	1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition" Pearson Education, 2020. 2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011 3. George F Luger, "Artificial Intelligence" Low Price Edition, Fourth edition, Pearson Education.,2005
Reference Books	1. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication. 129 2. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication 3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education. 4. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, McGraw Hill Education,2017.

Useful Links:
1. https://www.coursera.org/learn/introduction-to-ai
2. https://www.bing.com/ck/a?!&&p=9f8e8fd56979b2b3JmltdHM9MTY1NjY1MjY0MCZpZ3VpZD1iZThkNmVlMS1iMzU1LTRjZDctOTllMS1lODcyYmE5MDgyNzkmaW5zaWQ9NTE1NQ&ptn=3&hsh=3&fclid=14f28812-f8fd-11ec-94e5-8791cc1e3817&u=a1aHR0cHM6Ly9pZWVleHBsb3JlLmllZWUub3JnL2RvY3VtZW50LzM1MjEyMg&ntb=1
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)
AIL501	Artificial Intelligence Lab	(1+0)

Lab Prerequisite:	1. Discrete Structures 2. Data Structure 3. Analysis of Algorithm 4. Programming Language
Lab Objectives:	1. To realize the basic techniques to build intelligent systems. 2. To apply appropriate search techniques used in problem solving. 3. To create a knowledge base for uncertain data.
Lab Outcomes (LOs):	At the end of the course, the student will be able to: 1. Identify languages and technologies for Artificial Intelligence. 2. Apply uninformed and informed searching techniques for real world problems. 3. Create a knowledge base using any AI language. 4. Design and implement expert systems for real world problems. 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Suggested Practical List:

Lab No.	Experiment Title	LO Mapped	Hrs./Lab
1	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal	LO4, LO5	02
2	Design of Intelligent System Using PEAS: (Any Two) ● A Music Composer. ● An Aircraft Autolander. ● An Essay Evaluator. ● A Robotic Sentry Gun for the Keck Lab. ● Medical Diagnosis System	LO2, LO5	02
3	Implement the Informed Search Techniques for the following problem definition. (Any two) ● 8-Puzzle Problem using Hill Climbing. ● Tic-Tac-Toe using A* Algorithm. ● 8-Puzzle Problem using A* Algorithm. ● Travelling Salesman Problem (TSP) using A* Algorithm. ● 8-Queen Problem with Heuristic Function.	LO1, LO2, LO5	02
4	Implement the Uninformed Search Techniques using Depth-First Search (DFS) or Breadth-First Search (BFS). (Any one) ● Path Finding in Maze. ● Water Jug Problem.	LO1, LO2, LO5	02
5	To write a program on Game playing algorithms.	LO1, LO2, LO5	02
6	To write a program for first order logic.	LO1, LO3, LO5	02
7	To write a program on unification.	LO1, LO3, LO5	02
8	To write on implantation of any one type of Planning.	LO1, LO3, LO5	02

9	Implement Adversarial Search for the Min-Max algorithm.	LO1, LO3, LO5	02
10	Mini Project for creating a chat bot using IBM Watson's tool.	LO1, LO3, LO5	02
Text Books:	1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition 2. Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, 3rd Edition		

Useful Links:

1. https://www.tutorialspoint.com/artificial_intelligence_with_python/artificial_intelligence_with_python_tutorial.pdf
2. https://stacks.stanford.edu/file/druid:qn160ck3308/qn160ck3308.pdf

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 "Artificial Intelligence Lab".
- 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: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits (TH+P+TUT)
AIC502	Data Warehousing and Mining	(3 + 0 + 0)

Prerequisite:	Database Concepts
Course Objectives:	1.To identify the significance of Data Warehousing and Mining. 2.To analyze data, choose relevant models and algorithms for respective applications. 3.To develop research interest towards advances in data mining.
Course Outcomes:	After the successful completion of this course, learners will be able to: 1. Elaborate on the concepts of data warehouse 2. Analyse data using appropriate tools 3. Design data warehouse 4. Perform data pre-processing and visualization. 5. Identify appropriate data mining algorithms to solve real world problems. 6. Compare and evaluate different data mining techniques

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs /Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Data Warehousing Fundamentals	1.1.Introduction to unstructured data, No SQL, Document database features and queries	CO1	02	06
	1.2.Operational vs Decision support systems, why Data warehousing? Data warehouse concepts, defining features, data warehouse versus data marts, data warehouse architecture, Overview of the components, metadata in the data warehouse, E-R Modeling versus Dimensional Modeling		04	
2. Data Design and Data Preparation	2.1.Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Constellation Schema, Fact less Fact Table.		02	06
	2.2.Update to the dimension tables. Major steps in ETL overview, requirement, steps, summary OLTP versus OLAP, Data cube and OLAP, OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.		04	
3. Introduction to Data Mining, Data Exploration and Data Pre processing	3.1.Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining,	CO2	02	07
	3.2.Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization,		02	
	3.3.Data Preprocessing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.		03	

4. Classification	4.1.Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Accuracy and Error measures	CO3	03	07
	4.2.Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling,		02	
	4.3.Cross Validation, Bootstrap, Applications of classification, Introduction to Ensemble methods.		02	
5. Clustering	5.1.Types of data in Cluster analysis, Partitioning Methods (k-Means)	CO4	02	06
	5.2.Partitioning Methods (k-Medoids)		02	
	5.3.Hierarchical Methods (Agglomerative, Divisive), Applications of Clustering.		02	
6. Web Mining	6.1.Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining,	CO5, CO6	02	07
	6.2.Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate generation,		03	
	6.3.Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:

Text Books	1. Han, Jiawei, Jian Pei, and Micheline Kamber. Data mining: concepts and techniques. Elsevier, 2011. 2. Ponniah, Paulraj. Data warehousing fundamentals for IT professionals. John Wiley & Sons, 2011.
Reference Books	1. Dunham, Margaret H. Data mining: Introductory and advanced topics. Pearson Education India, 2006 2. Reema Thareja, "Data warehousing", Oxford University Press 2009. 3. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson Publisher 2nd Edition. 4. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining", Morgan Kaufmann 3rd edition. 5. Kimball, Ralph, and Margy Ross. The data warehouse toolkit: the complete guide to dimensional modeling. John Wiley & Sons, 2011.Inmon, William H. Building the data warehouse. John wiley & sons, 2005.

Useful Links:

https://onlinecourses.nptel.ac.in/noc20_cs12/preview

https://www.coursera.org/specializations/data-mining

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)
AIL502	Data Warehousing and Mining Lab	(1+0)
Lab Prerequisite:	Database Concepts	
Lab Objectives:	1. Learn how to create and query a data warehouse. 2. Gain an understanding of data sets and data preprocessing. 3. Demonstrate how data mining methods like classification, clustering, association rule mining, and web mining function. 4. Use data mining techniques with a wide range of input values for various parameters. 5. Use open-source software to do data mining tasks (such as WEKA).	
Lab Outcomes (Los):	After the completion of course , student will be able to 1. Design a data warehouse and conduct various OLAP operations. 2. Use classification techniques in data mining. 3. Look into open-source software that can be used to run data mining techniques. 4. Apply clustering methods to a given sample of data. 5. Use the web mining algorithm and the association rule mining method. 6. Follow laboratory guidelines and follow ethical norms such as punctuality.	

Suggested Practical List:

Lab No.	Experiment Title	LO Mapped	Hrs./Lab
1.	Write a detailed problem statement and design dimensional modeling for a data warehouse/data mart case study (creation of star and snowflake schema)	LO1, LO6	02
2.	Based on the experiment 1 case study, implement all dimension tables and fact tables	LO1, LO6	02
3.	Based on the experiment 1 case study, implementation of OLAP operations: Slice, Dice, Rollup, Drilldown, and Pivot	LO1, LO6	02
4.	Implementation of Bayesian algorithm	LO2, LO6	02
5.	Based on the experiment 1 case study, implementation of OLAP operations: Slice, Dice, Rollup, Drilldown, and Pivot.	LO3, LO6	02
6.	Using a data mining tool (WEKA/R tool), do data pre-processing and illustrate the Classification, Clustering, and Association algorithms on data sets.	LO3, LO6	02
7.	Implementation of Clustering algorithm (K-means/K-medoids)	LO4, LO6	02
8.	Implementation of any one Hierarchical Clustering method	LO4, LO6	02
9.	Implementation of Association Rule Mining algorithm (Apriori)	LO5, LO6	02
10.	Implementation of Page rank/HITS algorithm	LO5, LO6	02

Term work:

1. Term work should consist of minimum 8 experiments
2. Journal must include at least 2 assignments on content of theory and practical of the course “Data Warehousing and Mining”
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments:-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)
AIC503	Software Engineering	(3+0+0)

Prerequisite:	1. Object Oriented Programming with Java 2. Python Programming
Course Objectives:	1. To provide the knowledge of software engineering discipline. 2. To apply analysis, design and testing principles to software project Development. 3. To demonstrate and evaluate real world software projects.
Course Outcomes:	After the successful completion of this course, learner will be able to: 1. Identify requirements & assess the process models. 2. Plan, schedule, estimation and track the progress of the projects. 3. Design the software projects. 4. Perform testing of software project. 5. Identify risks, manage the change to assure quality in software projects. 6. Explain the concept of maintenance and its types

Module No. & Name	Sub Topics	CO Mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisites and Course outline	Class, Objects, Examples, Characteristics of OOPS	-	01	02
			01	
1. Introduction To Software Engineering and Process Models	1.1Software Engineering-process framework, the Capability Maturity Model (CMM), Advanced Trends in Software Engineering.	CO1	01	07
	1.2Prescriptive Process Models: The Waterfall, Incremental Process Models, Evolutionary Process Models: RAD & Spiral.		05	
	1.3Agile process model: Extreme Programming (XP), Scrum, Kanban		01	
2. Software Requirements Analysis and Modeling	2.1Software Requirements Analysis and Modeling	CO1	01	04
	2.2Requirement Engineering, Requirement Modeling, Data flow diagram (Eg)		02	
	2.3Software Requirement Specification document format (IEEE)		01	
3. Software Estimation Metrics	3.1Software Metrics.	CO2	01	07
	3.2Software Project Estimation (LOC, FP, COCOMO II)		05	
	3.3Project Scheduling & Tracking		01	
4. Software Design	4.1Design Principles & Concepts, Effective Modular Design	CO3	01	07
	4.2Cohesion and Coupling		01	
	4.3Architectural design		02	
	4.4UML Diagrams		03	
5. Software Testing	5.1Unit testing, Integration testing, validation testing, System testing, Testing Techniques	CO4	01	06

	5.2White-box testing: Basis path, Control structure testing		03	
	5.3Black-box testing: Graph based Static Testing, Equivalence, Boundary Value		02	
6. Software Configuration Management, Quality Assurance and Maintenance	6.1Risk Analysis & Management: Risk Mitigation, Monitoring and Management Plan (RMMM).	CO5, CO6	02	08
	6.2Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability, The Software Configuration Management (SCM)		02	
	6.3Version Control and Change Control		02	
	6.4Types of Software Maintenance, Re-Engineering, Reverse Engineering		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:

Text Books	1. Roger Pressman, "Software Engineering: A Practitioner's Approach", 9th edition ,McGraw-Hill Publications, 2019 2. Ian Sommerville, "Software Engineering", 9th edition, Pearson Education,201. 3. Ali Behfrooz and Fredeick J. Hudson, "Software Engineering Fundamentals", Oxford University Press, 1997 4. Grady Booch, James Rambaugh, Ivar Jacobson, "The unified modeling language user guide", 2nd edition, Pearson Education, 2005
Reference Books	1. Pankaj Jalote, "An integrated approach to Software Engineering", 3rd edition, Springer, 2005 2. Rajib Mall, "Fundamentals of Software Engineering", 5th edition, Prentice Hall India, 2014 3. Jibitesh Mishra and Ashok Mohanty, "Software Engineering", Pearson, 2011 4. Ugrasen Suman, "Software Engineering – Concepts and Practices", Cengage Learning,2013 5. Waman S Jawadekar, "Software Engineering principles and practice", McGraw Hill Education, 2004

Useful Links:

1. https://nptel.ac.in/courses/106/105/106105182/
2. https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3. https://www.mooc-list.com/course/software-engineering-introduction-edx

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)
AIL503	Software Engineering Lab	(1+0)

Lab Prerequisite:	1. Object Oriented Programming with Java 2. Python Programming
Lab Objectives:	1. To solve real life problems by applying software engineering principles 2. To impart state-of-the-art knowledge on Software Engineering
Lab Outcomes (LOs):	At the end of the course, the student will be able to 1. Identify requirements and apply software process model to selected case study. 2. Develop architectural models for the selected case study. 3. Use computer-aided software engineering (CASE) tools. 4. Create test cases for case study using testing approaches. 5. Design timeline chart and network diagram, risk plan. 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 of at least two traditional process models and Problem Definition of case study name. -	LO1, LO6	02
2.	Preparation of software requirement specification (SRS) Document in IEEE format.	LO1, LO6	02
3.	To study and create Gantt chart/Time line chart for selected case study	LO4, LO5, LO6	02
4.	To study and create structured data flow analysis. (DFD)	LO2, LO6	02
5.	Use of metrics to estimate the cost.	LO3, LO6	02
6.	To draw the class diagram for selected case study with any open source (Dia software).	LO4, LO6	02
7.	To study and design test cases of selected case study.	LO4, LO6	02
8.	To study and design test cases for white box testing. (Basic path testing)	LO4, LO6	02
9.	To prepare Risk Mitigation, Monitoring and Management Plan (RMMM).	LO5, LO6	02
10.	To study and design version controlling of the project.	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 "Software Engineering"
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)
AIC504	Information Theory and Coding	(3+0+0)

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

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

Text Compression	Static Dictionary, Digram coding, Adaptive Dictionary: LZ77 (Sliding Window), LZ78, LZW		03	
4. Image and Video Compression	4.1.Approaches to Image compression, Types of images, GIF, JPEG, Gray codes, Differential Lossless Compression, DPCM	CO4	04	07
	4.2.Video Compression principle, video compression techniques, types of frames, H.261standard, MPEG 4 Encoding and Decoding		03	
5. Audio Compression	The Human Auditory System, μLaw and A-Law Companding, Audio compression, MPEG Audio coding-Layer 1, 2 and 3 (MP3 Format)	CO5	03	03
6. Error Control Coding	6.1.Linear Block Codes: Hamming Code, Error Detection and Correction Capability of Hamming Code, Encoder of (7,4) Hamming Code, Syndrome Decoding	CO6	02	08
	6.2. Cyclic Codes: Cyclic property, Generator and Parity Check Matrices, Encoder and Decoder, Syndrome decoding		03	
	6.3.Convolutional Codes: Transform Domain Analysis of Convolutional Encoder, Code Tree, Trellis and State Diagram,		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:

Text Books	1. David Salomon, Data Compression: The Complete Reference, Springer, Third Edition, 2005. 2. Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann Publishers, Second Edition, 2006. 3. Ranjan Bose, Information Theory, Coding and Cryptography, Tata McGraw Hill, Second Edition. 4. R. Avudaiammal, Information Coding Techniques, Tata McGraw Hill, Second Edition. 5.Jorge Castineira Moreirra, Essentials of Error Control Coding, Wiley-India, First Edition. 6. K.S. Shivaprakasha, Murlidhar Kulkarni, Information Theory and Coding, Wiley, 2014.
Reference Books	1. Mark Nelson, Jean-Loup Gailly, The Data Compression Book, BPB Publications, Second Edition, 1995. 2. Drozdek, Elements of Data Compression, Cengage Learning, First Edition, 2001. 3. Thomas Cover wiley, Element of Information Theory, Second Edition.

Useful Links:

1. http://www.nptelvideos.com/video.php?id=989
2. https://www.coursera.org/lecture/algorithms-part2/introduction-to-data-compression-OtmHU
3. https://nptel.ac.in/courses/106102064/19

Continuous Assessment:

- 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.

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC5051	Computer Networks	(3+0+0)

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs./Module
I. Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Network Architectures, Protocol Layers, and Service models	1.1. Introduction to computer networks and it's uses. LAN, MAN, WAN, Network topologies Addressing: Physical / Logical /Port addressing, Protocols and Standards.	CO1	02	04
	1.2. Protocol Architecture: Need of layered protocol architecture, Layers details of OSI.		01	
	1.3.TCP/IP Model: Protocol suite, Comparison of OSI and TCP/IP		01	
2. Physical Layer	2.1. Transmission Media: Guided media like Coaxial, Optical Fiber, twisted pair, and Wireless media, Transmission Impairments, Multiplexing, Spread Spectrum, FTTX	CO2	03	05
	2.2 Interconnecting Devices: Hub, Bridges, Switches, Router, Gateway. 2.3 Switching: Introduction, circuit switched networks, packet switching, structure of a switch.		02	
3. Data Link Layer	3.1 Data Link Control: DLC services, data link layer protocols, HDLC	CO3	02	08
	3.2 Media Access Control: Random access, controlled access, channelization Wired LANs – Ethernet Protocol, standard ethernet, fast ethernet, gigabit ethernet, 10 gigabit ethernet, CSMA, CSMA/CA		04	
	3.3 Wireless LAN: IEEE 802.11: System architecture, protocol architecture, 802.11b, 802.11a, 802.11g, 802.11n, 802.11ac		02	

4. Network Layer	4.1 Network layer services, packet switching, network layer performance, forwarding of IP packets, Internet Protocol,IPv4 header format	CO4	02	11
	4.2 IPv4 Addressing (classful and classless), Subnetting, Supernetting design problems IPv4 Protocol, IP-v6 addressing, transition from IPv4 to IPv6		04	
	4.3 Routing algorithms: Shortest Path (Dijkastra's), Link state routing, Distance Vector Routing, Bellman Ford's Algorithm, OSPF and RIP.		03	
	4.4 Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms.		02	
5. Transport Layer	5.1. Transport layer services: Flow control and error control methods (Simple protocol, Stop-and-wait protocol, Go-Back-n protocol, Selective repeat protocol), Sliding Window protocol	CO5	04	08
	5.2 Connection oriented Transport Protocol Mechanisms: TCP Services, TCP Header format, TCP three way handshaking, Connectionless transport mechanisms: User Datagram Protocol (UDP) - header format		04	
6. Application layer	HTTP, DNS, SMTP, DHCP, SSH, Telnet, Introduction of Software Defined Networking	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:	
Text Books	1. S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition. 2. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition. 3. Alberto Leon Garcia, "Communication Networks", McGraw Hill Education, Second Edition.
Reference Books	1. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition. 2. Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition. 3. Bhushan Trivedi, "Data Communication and Network", Oxford Publication Press, 1st edition.
Useful Links:	
1: https://www.nptel.ac.in	
2: https://swayam.gov.in	
3: https://www.coursera.org/	
Continuous Assessment:	

- 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)
AIDLL5051	Computer Networks Lab	(1+0)

Lab Prerequisite:	Computer Network basics
Lab Objectives:	1. To practically explore OSI layers and understand the usage of simulation tools. 2. To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure. 3. To identify the various issues of a packet transfer from source to destination.
Lab Outcomes (LOs):	The student will be able to: 1. Explain different hardware components and commands of computer networking. 2. Execute different IP networking commands. 3. Implement different algorithms in the C language 4. Simulate different protocols in NS2 software and cisco packet tracer 5. Simulate different protocols in NS2 software.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
1	Lab Prerequisite	--	02
2	Study of hardware components of computer communication and networking	LO1, LO5	02
3	IP networking and network commands: ifconfig, ping, traceroute, netstat, arp, nslookup dig and route etc.	LO2, LO5	02
4	Implementation for cyclic redundancy code	LO3, LO5	02
5	Installation of ns2 and implementation for simple example of ns2	LO4, LO5	02
6	Implementation of star and mesh topology in ns2.	LO4, LO5	02
7	Simulation of connection of two LANs using Router on Cisco Packet Tracer	LO4,LO5	02
8	Simulation of distance vector routing (bellman-ford algorithm	LO3, LO5	02
9	Study of wireshark and analyzing packet using wireshark	LO3, LO5	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 "Computer Networks Lab".
- 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: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC5052	Image and Video Processing	(3+0+0)

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Sub topic	Total Hrs. /Module
I.Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	--	02	02
1. Digital Image Processing Fundamentals	Introduction: Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	CO1	01	04
	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Image File Formats: BMP, TIFF and JPEG. RGB Color model		03	
2. Enhancement in Spatial and Frequency Domain	Enhancement in the spatial domain: Negative Transformation, Power Law Transformation, Logarithmic Transformation, Gray Level Slicing (with and without background), Bit Plane Slicing, Histogram Processing, Arithmetic and logical operations on image (addition, subtraction, ANDing, ORing).	CO2	05	09
	Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter, 2D-DFT/FFT of an image, Frequency domain image enhancement techniques		04	
3. Image Segmentation and Morphological Operations	Relationship between pixels and connectivity, Detection of Discontinuities, Thresholding, Region based image segmentation, split and merge techniques. Image Representation and Description, Chain Code, Polygonal Representation.	CO3	07	10
	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Thinning and Thickening.		03	

4. Image Compression	Fundamentals: Coding Redundancy, Interpixel Redundancy, Psycho visual Redundancy Lossless Compression Techniques: Run Length Coding, Huffman Coding, Lossy Compression Techniques: Predictive Coding, Improved Gray Scale Quantization, Transform Coding, JPEG Standard.	CO4	06	06
5. Basic Steps of Video Processing:	Analog video, Digital Video, Time varying Image Formation models: 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations	CO5	04	04
6. Video Segmentation	Temporal segmentation–shot boundary detection, hard-cuts and soft-cuts; spatial segmentation – motion-based video object detection and tracking	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	**42**

Books:

Text Books	**1.** Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition. **2.** S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009
Reference Books	**1.** Jain A K, "Fundamentals of Digital Image Processing" **2.** William K Pratt, "Digital Image Processing"

Useful Links:

1. https://www.coursera.org/learn/digital
2. https://onlinecourses.nptel.ac.in/noc22_ee86/preview

Continuous Assessment:

- 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)
AIDLC5052	Image & Video Processing Lab	(1+0)

Lab Prerequisite:	1. Knowledge of a programming language (OpenCV/ Python/ MATLAB recommended)
Lab Objectives:	1. To learn basic programming skills like OpenCV, Python or Matlab 2. To enhance, segment or compress a gray level image. 3. To develop a small DIP application.
Lab Outcomes (LOs):	1. Enhance a given gray scale image 2. Apply different processing techniques on an image 3. Apply different techniques on a video 4. Neatly document and submit the practical on time.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
1.	Lab Prerequisite	--	02
2.	Image Enhancement	LO1, LO4	02
3.	Image Enhancement with Histogram Equalization	LO1, LO4	02
4.	Implementation of Averaging and Sharpening filters	LO2, LO4	02
5.	Edge detection using Prewitt / Sobel / Robert operator/ Laplacian of Gaussian	LO2, LO4	02
6.	Digital Image Watermarking	LO2, LO4	02
7.	Morphology Image Processing	LO2, LO4	02
8.	Image Segmentation	LO2, LO4	02
9.	Detection of an object in a video	LO3, LO4	02

Mini Project (if any)

Mini project on an application of Image/ Video Processing to be implemented.

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 "Digital Image & Video Processing Lab".
- 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: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC5053	Embedded Systems Design	(3+0+0)

Prerequisite:	1. Digital Electronics 2. Basics of Microcontrollers
Course Objectives:	1. To study concepts involved in Embedded Hardware and Software for System realisation. 2. To learn the concepts of modern microcontroller cores used in artificial Intelligence 3. To learn Real-time programming to design time-constrained embedded systems.
Couse Outcomes:	After successful completion of the course students will be able to: 1. Identify and describe various characteristic features and applications of Embedded Systems. 2. Select appropriate hardware and communication protocols for Embedded System implementation. 3. Compare GPOS and RTOS and investigate the concepts of RTOS. 4. Describe the features of FreeRTOS, TinyML 5. Explain various tools for testing and debugging embedded systems 6. Design a system for different requirements based on life-cycle for an embedded system.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Embedded Systems	**1.1** Definition, Characteristics, Classification, Applications	CO1	01	03
	1.2 Design metrics of Embedded system and Challenges in optimization of metrics		02	
2. Embedded Hardware Elements	**2.1** Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores Types of memories.	CO2	02	12
	2.2 Communication Interfaces: Interfaces -RS-232, RS-485, SPI, I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. (only comparative study of Serial communication)		03	
	2.3 Sensors and Actuators		02	
	2.4 Introduction to ARM processors, comparison arm processors A, R, M, Cortex M3, M4, M5		02	
	2.5 AI accelerators		03	
3. Embedded Software	3.1 Program Modelling concepts: DFG, CDFG, FSM.	CO3	02	10
	3.2 Real-time Operating system: Need of RTOS in Embedded system software		08	

	and comparison with GPOS. Task, Task states, Multi-tasking, Task scheduling, and algorithms- Preemptive SJF, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First Inter-process communication: Semaphore, Message queues, Mailbox, Event timers. Task synchronization: Need, Issues- Deadlock, Shared Data problem, Priority inversion.			
4. Testing and Debugging Methodology	4.1 Testing and Debugging: Hardware testing tools	CO4	01	02
	4.2 Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing.		01	
5. TinyML	5.1 FreeRTOS Basics, Introduction to TinyML,	CO5	02	06
	5.2 Hardware: Arduino Nano 33 BLE Sense		02	
	5.3 Applications of TinyML using Arduino TinyML Kit		03	
6. System Integration (Case Studies)	6.1 Embedded Product Design Life-Cycle (EDLC)	CO6	01	06
	6.2 Hardware-Software Co-design		01	
	6.3 Case studies: AI enabled Automatic Chocolate Vending Machine, ALEXa , Banking Robot, (Highlighting i) Specification requirements, ii) Hardware architecture iii) Software architecture		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books

1. Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014.
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3. SriramIyer, Pankaj Gupta," Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.
4. Joseph Yiu,"The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.

Reference Books

1. David Simon,"An Embedded Software Primer", Pearson, 2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
3. AndrewSloss, Domnic Symes, Chris Wright," ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004
4. FrankVahid, Tony Givargis,"Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
5. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009.

Useful Links:

1. https://www.tinyml.org/
2. https://www.tensorflow.org/lite/microcontrollers

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)
AIDLL5053	Embedded Systems Design Lab	(1+0)

Lab Prerequisite:	1. Basics of Microcontroller programming 2. C programming
Lab Objectives:	1. Understand the communication interfaces. 2. Implementation of Free RTOS concepts 3. Implementation of Arduino TinyML. 4. Demonstration of embedded system case study.
Lab Outcomes (LOs):	After successful completion of the course students will be able to: 1. Analyze the comparison between various serial communications interfaces used in Embedded Systems. 2. Execute Free RTOS concepts. 3. Implement Arduino TinyML tasks. 4. Demonstrate case study. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
1.	To study the I2C communication.	LO1, LO5, LO6	2
2.	To create multiple specific tasks within a specified deadline using FreeRTOS real-time operating system with Arduino.	LO2, LO5, LO6	2
3.	To study semaphore and implementation of semaphore in multitasking system.	LO2, LO5, LO6	2
4.	To study mutex and implementation of mutex in multitasking system.	LO2, LO5, LO6	2
5.	To study Arduino Nano 33 BLE Sense	LO3, LO5, LO6	2
6.	To study Magic wand, person detection and speech detection on the Nano 33 BLE	LO3, LO5, LO6	2
7.	To implement of Colour, gesture, proximity and temperature sensors on the Nano 33.	LO3, LO5, LO6	2
8.	To interface IMU sensors, Barometer and Microphone on the Nano 33 BLE.	LO3, LO5, LO6	2
9.	BLE Communication on the Nano 33 BLE	LO3, LO5, LO6	2
10.	Case Study- AI Accelerators, Cores used in AI-DS Applications	LO4, LO5, LO6	2
11.	Case Study- Presentation	LO4, LO5, LO6	2

Useful Links:

1. https://www.tinyml.org/
2. https://www.tensorflow.org/lite/microcontrollers

Term work: (25 Marks)

- 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 "Embedded Systems Design Lab".
- 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: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC5054	Design Algorithms for Bioinformatics	(3+0+0)

Prerequisite:	1. Basics of data structures 2. Algorithms 3. Basic methods in computational biology
Course Objectives:	1. To develop an understanding of algorithms implementation for solving problems in biology.
Course Outcomes:	1. Explain algorithmic principles to address problems in biology 2. Analyze the biological data base. 3. Analyze problems in biology and able to design new protocols and algorithms for biological data analysis 4. Analyze the algorithms in computational biology and identify their limiting factors to propose new design principles 5. Analyse Brute force branch and bound algorithms 6. Assessment of biological complexity through algorithmic principles.

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	1.1The biological sequence structure deficit- Genome Projects-pattern recognition and prediction	CO1	02	05
	1.2An overview of Algorithms, Sequence and String search algorithms with mathematical formulations for similarity and distance scoring systems with their algorithmic implementations	CO1	03	
2. Information Network:	2.1Review of computer communication networks-the European molecular biology network- EMBnet National Centre for Biotechnology Information-NCBI-virtual tourism	CO2	03	06
	2.2Protein Information resources: Biological DataBases-Primary sequence Databases-Composite Protein sequence databases Secondary databases-Composite Protein pattern databases-structure classification databases-web addresses	CO2	03	
3. Dynamic Programming Algorithms	3.1The Power of DNA Sequence Comparison, Dynamic Programming, The Manhattan Tourist Problem, Edit Distance and Alignments	CO3	02	10
	3.2LCS, PAM and BLOSUM Scoring Matrices, Longest Common Subsequence, Global Sequence Alignment	CO3	02	
	3.3Needleman Wunsch Algorithm, Scoring Alignments, Local Sequence Alignment: Smith Waterman Algorithm , Alignment with Gap Penalties , Multiple Alignment, Progressives and iterative refinements of MSA algorithms	CO3	02	

	3.4Barton-Sternberg Iterative Refinement Algorithm, STAR and TREE alignment approaches, Greedy and Entropy approach for MSA.	CO3	02	
	3.5	CO3	02	
4. Graph Algorithms	4.1Graph Algorithms, Algorithms for Sequencing by hybridization (SBH), use of spectrum approach to solve SBH problem. Eulerian Paths	CO4, CO5	02	07
	4.2De-novo Peptide Sequencing: Longest Paths and Space Efficient Alignment Algorithms. Fast LCS using Table Lookup		02	
	4.3Graph algorithms in bioinformatics and their applications to fragment assembly, Eulerian and Hamiltonian Cycle Problem Interval graph algorithm, shortest superstring problem and its mapping with traveling salesman problem.		03	
5. Brute Force and branch and bound algorithms	Brute Force and branch and bound algorithms for Partial Digest Problem, restriction mapping, partial digest and double digest problems and their solutions through multiset and homometric sets.	CO4, CO5	03	03
6. Evolutionary Tress and Phylogeny	6.1Evolutionary Trees and Ultra metrics, Additive distance trees, Perfect Phylogeny Problem, Small Parsimony Problem, Nearest Neighbour Interchange	CO4, CO5	04	08
	6.2Hidden Markov Models, Basics, Forward and Backward (Viterbi) Algorithms, Randomized algorithms and their applications		04	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. Computational Molecular Biology: An algorithmic approach (2004), P.A. Pevzner, PHI. 2. An Introduction to Bioinformatics Algorithms (2004) N.C. Jones and P.A. Pevzner Ane Books. 3. Algorithms in Bioinformatics (2004), G. Benson and R. Page (Eds): Springer Verlag.
Reference Books	1. Bioinformatics Algorithms: Techniques and Applications, I.I. Mandoiu and A Zelikovsky, Wiley Interscience Press. 2. Biological Sequence Analysis: Probabistic models of proteins and nucleic acids (1998) Durbin R., et al, Cambridge University press.
Useful Links:	
1.https://nptel.ac.in/courses/102106065	
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)
AIDLL5054	Design Algorithms for Bioinformatics Lab	(2+0)

Lab Prerequisite:	1. Basics of algorithms and programming 2. Data structures 3. Object oriented technology
Lab Objectives:	1. Develop the ability to design, implement and manipulate algorithms. 2. Develop computer programs for Bioinformatics solutions to life and health science problems. 3. Apply programming concepts to various biological examples and real life applications.
Lab Outcomes (LOs):	1. Able to understand algorithmic principles 2. To write programs for specific computational biology problems 3. Analyse problems in biology and able to design new protocols and algorithms for biological data analysis 4. Able to analyse biological data through programs 5. Implement algorithms for bioinformatics problems and their assessments

Lab No.	Experiment Title	LO mapped	Hrs./Lab
1.	Program to solve the US change problem.	LO1	2
2.	Program to deal with Tower of Hanoi problem.	LO1	2
3.	Program to generate Fibonacci series using recursive algorithm and few other programs.	LO1	2
4.	Program to generate distinct sub-strings in a given DNA sequence using combinatorial and other methods.	LO2	2
5.	Program to generate palindrome of a string and for a nucleotide sequence, translation and reverse translation, find out the GC content in a sequence.	LO2	2
6.	Program to implement dynamic programming to solve local, semi-global, and global alignment of biological sequences.	LO2	2
7.	Program to generate redundant nucleotide sequences from given amino acid sequence using standard genetic code system and ambiguous character codes.	LO3	2
8.	Implementation of fragment assembly algorithms to make contigs.	LO3	2
9.	Program to predict genes using statistical approaches.	LO4	2
10.	Program to predict genes using similarity based approaches.	LO4	2
11.	Program to generate restriction map of DNA sequence using Brute force algorithm.	LO4	2
12.	Program to generate restriction map of DNA sequence using PDP (Partial Digest Problem) algorithm.	LO4	2
13.	Motif finding algorithms implementations in DNA and Protein sequences.	LO5	2
14.	RNA structure algorithms and their implementations.	LO5	2

Virtual Lab Links:

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

2. Bioinformatics Virtual Lab II : Biotechnology and Biomedical Engineering : Amrita Vishwa Vidyapeetham Virtual Lab
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 "Design Algorithms for Bioinformatics lab". • 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: P&O examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
AIL506	Business Communication & Ethics	(2+0)

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

Module No. & Name	Sub Topics	LO Mapped	Hrs/ Sub topic
I. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02

1.Advanced Technical Writing: Project/ Problem Based Learning	1.1 Classification of Reports, Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.) Physical Factors (Memorandum, Letter, Short & Long)	LO1, LO6	01
	1.2 Parts of a Long Formal Report, Prefatory Parts (Front Matter), Report Proper (Main Body) Appended Parts (Back Matter)		01
	1.3 Language and Style of Reports, Tense, Person & Voice of Reports Numbering Style of Chapters, Sections, Figures, Tables and Equations. Proofreading through Plagiarism Checkers.		01
	1.4 Definition, Purpose & Types of Proposals Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)		01
	1.5 Parts of a Proposal Elements, Scope and Limitations, Conclusion		01
	1.6 Technical Paper Writing: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting Referencing in IEEE Format		01
2. Employment Skills	2.1 Cover Letter & Resume: Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	LO2, LO4	01
	2.2 Verbal Aptitude Test, Modelled on CAT, GRE, GMAT exams		01
	2.3 Group Discussions, Purpose of a GD, Parameters of Evaluating a GD		01
	Types of GDs (Normal, Case-based & Role Plays)		01
	GD Etiquettes		01
	2.4Personal Interviews, Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual		01
3. Business Meetings	3.1Conducting Business Meetings, Types of Meetings, meeting etiquettes	LO3, LO6	01
	3.2 Documentation, Notice, Agenda, Minutes		01
4. Technical/ Business Presentations	4.1 Effective Presentation Strategies, Defining Purpose, Analyzing Audience, Location and Event Gathering, Selecting & Arranging Material	LO2, LO4	01

	4.2 Structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation		01
5.Interpersonal Skills	5.1 Emotional Intelligence, Motivation, Assertiveness,	LO5, LO6	07
	5.2 Start-up Skills, Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	LO2, LO5	01
6.Corporate Ethics	6.1 Intellectual Property Rights, Copyrights, Trademarks, Patents	LO6	01
	6.2 Case Studies Cases related to Business/ Corporate Ethics		01
II.Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01

Books

Text Books:

1. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.
2. Bovée, C. L., & Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.

Reference Books:

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw- Hill.
2. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
3. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.
4. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.
5. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press.
6. Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press.

Useful video Links:

Sr. No	Topic	Links
1	TOEFL listening Skill	https://www.youtube.com/watch?v=jSUh0Civuv4
2	MBA Interview	https://www.youtube.com/watch?v=cwW9QBNuwC w
3	How to write a successful CV	https://www.youtube.com/watch?v=U0JAfqEak2c
4	Interview techniques (How to answer tell me about yourself)	https://www.youtube.com/watch?v=m5kR7TPAkSw
5	The 4 types of team members you can hire	https://www.youtube.com/watch?v=5bYYFfpbSqc
6	Every Meeting Ever	https://www.youtube.com/watch?v=K7agjXFFQJU

Assessment:

Term Work (25 marks):

Term work of 25 Marks shall consist of a minimum 8 Assignments. The distribution of marks for term work shall be as follows: Assignment : 10 Marks
Book Report (hard copy) : 10 Marks
Attendance : 05 Marks

Note: The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and Minimum passing in the term work.

Oral (25 Marks):

Oral Examination will be based on a GD & the Project/Book Report presentation

1.	Group Discussion	:10 marks
2.	Project Presentation	:15 Marks

Note:

1.The Main Body of the project/book report should contain a minimum ***25 pages*** (excluding Front and Back matter).

2.The group size for the final report presentation should not be less than 5 students or exceed 7 students.

There will be an end–semester presentation based on the book report.

Activity. No.	Activity/ Assignment Title (In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)	Hrs/Lab
1	Test of English as Foreign Language (TOEFL)	02
2	Group discussion (Practice session)-I	02
3	Group discussion (Practice session)-II	02
4	Final Group discussion-I	02
5	Final Group discussion-II	02
6	English Aptitude Test	02
7	Resume Writing	02
8	Mock interview	02
9	Role play techniques for interpersonal skills	02
10	Project Report Presentation-I	02
11	Project Report Presentation -II	02
12	Technical proposal	02
13	Corporate Ethics/role play/case studies	02
14	Business Meetings: case studies/role play	02

Project Based Learning Code	Project Based Learning Name	Credits (P+TUT)
AIPR53	Minor Project Lab-1	(1+0)

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 Contents	PRO Mapped	Hrs./Module
1	Problem Definition and Project Planning: 1.1 Literature Survey, Problem Definition, Objectives of the project	PRO1	02
	1.2 List of Input and Output (sensors, Actuators), list of components, Selection of Microprocessor/Microcontroller/Selection of Boards (Arduino/ ESP8266, etc.)		02
	1.3 Preparation of Gantt/PERT/CPM chart-weekly activity of mini project		02
2	Flow Chart/Algorithms: List the steps required to solve a problem, Preparation of Flow Chart/Algorithm	PRO2	02
3	Programming: 3.1 Study of programming languages C, Embedded C, Java, Python etc.	PRO3	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	PRO4	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	Report writing and presentation preparation: Documentation of the work done in a streamlined manner, Preparation and organisation of a report according to a standard format, Use of IEEE format of bibliography	PRO5	04
6	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
3. Project Report, Performance:10

Exposure Course Code	Exposure Course Name	Credits (P+TUT)
AIXS57	Skill-Based Learning Aptitude/Logic Building and Competitive Programming skills	(1+0)

SBL Prerequisite:	1.Knowledge of elementary mathematics (HSC level) . 2 Knowledge of basic English grammar. 3. Knowledge of Basic programming languages.
SBL Objectives (SOBs):	1.To have the basic awareness about how to prepare for recruitment process 2.To introduce the students to computational skills required to appear for recruitment tests. 3.To introduce the students to coding skills required to appear for recruitment tests.
SBL Outcomes (SOs):	1. Discuss the basic concepts of QUANTITATIVE ABILITY 2. Discuss the basic concepts of LOGICAL REASONING Skills 3. Acquire satisfactory competency in use of VERBAL REASONING 4. Solve campus placements aptitude papers covering Quantitative Ability, Logical Reasoning and Verbal Ability 5. Use most common algorithms for competitive programming. 6. Analyse data structures for competitive up solving.

Module No.	Module Title	SO mapped	Hrs./Module
1.	Basics of Quantitative Abilities 1.1 Problems on Number System, Problems on HCF and LCM, Problems on Average.	SO1, SO4	04
	1.2 Problems on Ratio and Proportion, Problems on Percentage.		
2.	Arithmetic Quantitative Abilities 2.1 Problems on Ages, Problems on Profit and Loss		04
	2.2 Problems on Simple and Compound Interest, Problems on Time and Distance.		
3.	Logical Reasoning 3.1 Number Series, Alpha Numerical, Letter & Symbol Series	SO2, SO4	02
	3.2 Numerical and Alphabet Puzzles, Seating Arrangement		
4.	Programming Techniques 4.1 What is Competitive Programming? Programming Contests, Language Features	SO5	05
	4.2 Recursive Algorithms, Bit Manipulation		
5.	Sorting Algorithms, Solving Problems by sorting, Binary Search	SO6	05
		Total hours	20

Books:

Text Books:	1.Quantitative abilities by Arun Sharma 2. Quantitative Aptitude for Competitive Examinations by R S Agrawal 3. Verbal and Non-Verbal reasoning by R S Agrawal

	4. Guide to Competitive Programming Learning and Improving Algorithms Through Contests Antti Laaksonen, Department of Computer Science, University of Helsinki, Finland
Reference Books:	1. Algorithms Illuminated by Tim Roughgarden 2. Algorithm Design, Jon Kleinberg and Éva Tardos 3. Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein 4. Competitive Programming 4: The Lower Bound of Programming Contests in the 2020s by Steven Halim and Felix Halim 5.Guide to Competitive Programming: Learning and Improving Algorithms Through Contests Antti Laaksonen.
Useful Links:	
https://doi.org/10.1007/978-3-319-72547-5	
Algorithms by Jeff Erickson (freely available online)	
https://onlinecourses.nptel.ac.in/noc21_cs99/preview	
https://unacademy.com/a/i-p-c-beginner-track	
Term Work:	

Term work shall be awarded based on

1. Student active participation in skill-based learning.
2. Presenting/showcasing learned skills through social /outreach/ extension activities/Events/ Competitions/Trainings/Internships etc;
3. Submission of Report/act/demonstrations/ specific participation/Idea creation/scope/creativity/Case study etc.

Term works of 25 marks.

Exposure (Technology Based Learning-VIII) Code	Exposure (Technology Based Learning-VIII) Name	Credits (P+TUT)
AIXT58	1.Online Certification Courses	(1+0)
	2.NPTEL certification	
	3.IITBs Spoken Tutorial	
	4.Swayam MOOCs	
	5.Coursera certification	
	6.Internshala Trainings	

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
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 solutions to real-world problems or other projects at hand.

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.

Course Code	Course Name	Hours/Duration
INT54	Internship-IV	2 - 4 Weeks

Prerequisite:	List of probable industries and organizations offering internships in Engineering and Technology. Awareness about problem areas in rural India
Course Objectives:	1.To get the awareness about engineer's responsibilities and ethics. 2.Opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
Couse Outcomes:	Upon completion of the course, students will be able to: 1.Get an opportunity to practice communication and teamwork skills. 2.Get an opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
Activity- Rural Internships &/ Internships	Supporting Activities to be completed under Internship 1. Long Term Goal under Rural Development Internships or 2. Mandatory internship for developing project with: ● Industries ● Government Sector ● Non-governmental Organization (NGO) ● MSMEs

Term Work Assessment:
Duration to be considered for assessment:
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)

Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HOD will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data 6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.

Item No: 4.7
A.C. Date: 09/07/2022

Program Structure Template for Third Year UG Technology (AI-DS)

Semester-VI- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC601	Artificial Neural Network	3–0–0	03	3–0–0	03	PC
AIC602	Machine Learning	3–0–0	03	3–0–0	03	PC
AIC603	Data Analytics and Visualization	3–0–0	03	3–0–0	03	PC
AIC604	AI in E-Commerce	3–0–0	03	3–0–0	03	PC
AIDLC605X	Department Level Elective-2	3–0–0	03	3–0–0	03	DLE
AIL601	Artificial Neural Network Lab	0–2–0	02	0–1–0	01	PC
AIL602	Machine Learning Lab	0–2–0	02	0–1–0	01	PC
AIL603	Data Analytics and Visualization Lab	0–2–0	02	0–1–0	01	PC
AIDLL605X	Department Level Elective-2 Lab	0–2–0	02	0–1–0	01	DLE
AIPR64	Project Based Learning - Minor Project Lab-2	0–2–0	02	0–1–0	01	PBL
AIX(S)69	Skill Based Learning-IX (R Programming)	0–2*–0	02	0–1–0	01	SAT
AIX(T)610	Technology Based Learning-X	0–2*–0	02	0–1–0	01	SAT
INT 65	Internship-5	--	--	--	--	INT
Total		**15–14–0**	**29**	**15-7-0**	**22**	--

*SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.

PBL - Minor Project Lab 1 and 2:

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load: 1 hour per week per four groups.

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Semester-VI-Examination Scheme

Course Code	Course Name	Examination Scheme Marks									
		CA				ESE	TW	O	P	P & O	Total
		T-1	T-2	Average (T1 & T2)	IA						
AIC601	Artificial Neural Network	30	30	30	10	60	--	--	--	--	100
AIC602	Machine Learning	30	30	30	10	60	--	--	--	--	100
AIC603	Data Analytics and Visualization	30	30	30	10	60	--	--	--	--	100
AIC604	Big Data Analytics	30	30	30	10	60	--	--	--	--	100
AIDLC605X	Department Level Elective-2	30	30	30	10	60	--	--	--	--	100
AIL601	Artificial Neural Network Lab	--	--	--	--	--	25	--	--	25	50
AIL602	Machine Learning Lab	--	--	--	--	--	25	-	--	25	50
AIL603	Data Analytics and Visualization Lab	--	--	--	--	--	25	--	--	25	50
AIDLL605X	Department Level Elective-2 Lab	--	--	--	--	--	25	--	--	--	25
AIPR64	Project Based Learning - Minor Project Lab-2	--	--	--	--	--	25	--	25	--	50
AIX(S)69	Skill Based Learning-IX (R Programming)	--	--	--	--	--	25	--	--	--	25
AIX(T)610	Technology Based Learning-X	--	--	--	--	--	25	--	--	--	25
INT 65	Internship-5	--	--	--	--	--	--	--	--	--	25
Total		--	--	**150**	**50**	**300**	**175**	--	**25**	**75**	**775**

Department Level Elective-2			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC6051	AIDLC6052	AIDLC6053	AIDLC6054
AI in E-Commerce	AI in Agriculture	Internet of Things	Bioinformatics Data Management

Course Code	Course Name	Credits (TH+P+TUT)
AIC601	Artificial Neural Network	(3 + 0 + 0)

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./ Subtopi	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction	Human brain, Biological neurons, Neural network viewed as directed graphs, Types of activation function	CO1	02	06
	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	Models of ANN, Feed forward and feedback network,	CO2	03	08
	Learning Rules: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule,	CO2	03	
	Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner Take-All Learning Rule	CO2	03	
3. Single layer perceptron and multilayer perceptron	Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters,	CO3	02	08
	Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques,	CO3	02	
	Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment	CO3	02	
	Multilayer Perceptron: Back Propagation	CO3	02	

	Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection			
4.Self organizing Maps and Support Vector Machine	Self-Organizing Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map,	CO4	02	06
	SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification	CO4	02	
	Support Vector Machines, SVM application to Image Classification,	CO4	02	
5.Associative memory network	Introduction, Training algorithms for Pattern Association	CO5	03	07
	Auto-associative Memory Network, Hetero-associative Memory Network,	CO5	02	
	Bidirectional Associative Memory, Discrete hopfield network	CO5	02	
6. Case study on ANN	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:

- 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)
AIL601	Artificial Neural Network lab	(1+0)

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:

- 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 **"**Artificial Neural Network Lab".
- 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: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits (TH+P+TUT)
AIC602	Machine Learning	(3+0+0)

Prerequisite:	1. Linear algebra, multivariate calculus and probability theory 2. Knowledge of a Python programming language 3. Information Theory and Coding
Course Objectives:	1. Learn Machine Learning concept. 2. Understand mathematical concepts required for Machine learning algorithms 3. Understand various Regression techniques. 4. Understand various Classification and Clustering techniques 5. Introduce Optimization techniques. 6. Learn dimensionality reduction techniques.
Course Outcomes:	After successful completion of the course students will be able to: 1. Explain Machine Learning concept used in real world scenarios. 2. Apply mathematical foundation of machine learning for solving problems. 3. Apply regression techniques for solving machine learning problems. 4. Apply different classification and clustering techniques for solving machine learning problems. 5. Apply different optimization techniques in machine learning applications 6. Analyse dimensionality reduction techniques.

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 Machine Learning	1.1 What is Machine Learning? Why Machine Learning? Motivations for Machine Learning, Signal Processing Vs. Machine Learning, How to choose right algorithm? Steps involved in developing a Machine Learning application, Applications of Machine Learning, Issues of Machine Learning,	CO1	03	08
	1.2. Types of Machine Learning, Examples of Supervised, Unsupervised, Reinforcement Learning, Types of Supervised Learning- Regression and Classification, Applications of Supervised Learning, Clustering and Prediction, Testing and Validation dataset, cross validation, overfitting and underfitting of model, Hypothesis in Machine Learning		03	
	1.3 Performance Measures: Measuring Quality of Model-Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE		02	

2.Mathematics for Machine Learning	Linear Algebra: Systems of Linear Equations, Analytic Geometry: Norms, Inner Products, Lengths and distances between vectors, Orthogonal Vectors, Orthogonal projections Matrix-Decomposition: Determinant and Trace, Eigenvalues and Eigenvectors, Diagonalization	CO2	05	05
3.Learning with Regression	3.1The Least Square Method, Multiple Linear Regression, validation of regression methods Logistic Regression: Logit function	CO3	06	06
	3.2Constructing Decision Tree: Using Gini Index and ID3, Classification and Regression Trees (CART),			
4.Learning with Classification and Clustering	4.1Rule based classification, Binary Classification, Performance parameters, Naïve Bay's Classifier, Classification by Bayesian Belief Networks and Hidden Markov Models, Support Vector Machine	CO4	06	10
	4.2Clustering: K means Clustering, Hierarchical Clustering: Agglomerative clustering, Radial Basis Functions, Case Studies: Credit card fraud Detection and Healthcare		04	
5.Introduction to Optimization Techniques	Derivative based optimization- Steepest Descent, Newton method. Derivative free optimization- Random Search, Down Hill Simplex	CO5	06	06
6.Dimensionality Reduction:	Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis, Singular Value Decomposition, Image Processing applications of SVD	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. S. Sridhar and M. Vijayalakshmi, "Machine Learning", Oxford University Press 2021 2. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press 2020. 3. Peter Harrington "Machine Learning in Action", DreamTech Press.
Reference Books	1. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition-2013 2. C. M. Bishop: Pattern Recognition and Machine Learning, Springer 1st Edition-2013. 3. Tom M. Mitchell, "Machine Learning", McGraw Hill. 4. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", Cambridge University Press.
Useful Links:	
1.NPTEL	
2. https://www.learndatasci.com/out/coursera-machine-learning/	

3. https://www.learndatasci.com/out/google-machine-learning-crash-course/
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)
AIL602	Machine Learning Lab	(1+0)

Lab Prerequisite:	1. Python and C programming Language
Lab Objectives:	1. To introduce different machine learning tools 2. To Acquire advanced Data Analysis skill. 3. To develop ML solutions for various real life problems. 4.Understanding the nature of problems solved with Machine Learning
Lab Outcomes (LOs):	At end of successful completion of this course, student will be able to, 1. Explain different machine learning tools. 2. Apply Regression Methods. 3. Implement Classification and clustering methods. 4. Apply Optimization techniques 5. Apply the Dimensionality Reduction Techniques

Lab No.	Experiment Title	LO mapped	Hrs/Lab
I.	Lab prerequisite	---	02
1.	Study of Various ML tools Implementation of following algorithms for a given example data set-	LO1	02
2.	Data file manipulation, plotting and exploratory data analysis in Python	LO1	02
3.	Linear regression.	LO2	02
4.	Logistic regression.	LO2	02
5.	Decision tree.	LO2	02
6.	The Naïve Bayesian Classifier	LO3	02
7	Clustering using K means	LO3	02
8	Linear Discriminant Analysis	LO3	02
9.	Support Vector Machine	LO4	02
10.	Principal Component Analysis	LO5	02
11.	Optimization Technique	LO4	02
12.	Independent Component Analysis	LO5	02

Useful Lab Links:

1. https://www.learndatasci.com/out/edx-columbia-machine-learning/
2. https://www.learndatasci.com/out/oreilly-hands-machine-learning-scikit-learn-keras-and-ten sorflow-2nd-edition/
3. https://www.learndatasci.com/out/google-machine-learning-crash-course/

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 "Machine Learning Lab".
- 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)
AIC603	Data Analytics & Visualization	(3+0+0)

Prerequisite:	1. Data Structure 2. Programming Language in Python and Java
Course Objectives:	1. To understand the techniques of Data analysis 2. To understand technological advancements of data visualization 3. To understand various data visualization techniques 4. To understand basics of D3.js
Course Outcomes:	At the end of the course, the students will be able to: 1. Understand the statistical learning with R Programming. 2. Analyse data with various data analysis techniques. 3. Design visualization of data with various techniques. 4. Implement data visualization with various programming techniques. 5. Implement data visualization using D3.js 6. Implement animation ad wrapping in data visualization

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.Data Wrangling	1.1Elements, Variables, and Data categorization Levels of Measurement, Data management and indexing	CO1	01	04
	1.2Introduction to sources of data, Data collection and APIs, Exploring & fixing data, Homogenization Heterogenization, Missing data, Data transformation, Data Segmentation, Data clustering		03	
2.Exploratory Data Analysis	2.1Introduction to Exploratory data analysis (EDA), Typical data formats, Population and samples, Types of EDA, Graphical/Non graphical methods	CO2	03	08
	2.2Statistical hypothesis generation and testing Chi-Square test, t-Test, Analysis of variance		02	
	2.3Introduction to statistical learning and R-Programming, Correlation analysis with R		03	
3.Data Visualization	3.1Introduction to Data Visualization Acquiring and Visualizing Data, Simultaneous acquisition and visualization, Applications of Data Visualization	CO3	02	14
	3.2Exploring the Visual Data Spectrum: Charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Exploring advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts, Infographics)		06	

	3.3Reading Data from Standard text files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data(Building a table, Using Semantic Table, 3.4Configuring the columns), Assuring Maximum readability (Styling your table, Increasing readability, Adding dynamic Highlighting), Including computations, Using data tables library, relating data table to a chart		06	
4.Visualizing Data Programmatically	4.1Creating HTML5 CANVAS Charts (HTML5 Canvas basics, Linear interpolations, A simple column Chart, Adding animations), Starting with Google charts (Google Charts API Basics, A Basic bar chart, A basic Pie chart, Working with Chart Animations)	CO4	04	07
	4.2Getting setup with D3, Making selections, changing selection's attribute (attr()), D3 strives to be declarative, Changing methods, appending new elements, Putting all together, Selecting multiple elements with d3.selectall(), Building Bar charts with selections	CO5	03	
5.Advanced Data Visualization-I	5.1Making charts interactive and Animated: Data joins, updates and exits, interactive buttons, Updating charts, Adding transactions, using keys	CO6	03	03
6.Advanced Data Visualization-II	5.2Adding a Play Button: wrapping the update phase in a function, Adding a Play button to the page, Making the Play button go, Allow the user to interrupt the play, sequence	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery, "JavaScript and Query for Data Analysis and Visualization", WROX. 2. Ritchie S. King, "Visual storytelling with D3", Pearson 3. Dr. Ossama Embarak, "Data Analysis and Visualization Using Python", APress
Reference Books	1. A. Julie Steele and Noah Iliinsky, Designing Data Visualizations: Representing Informational Relationships, O'Relly. 2. Andy Kirk, Data Visualization: A Successful Design Process, PAKT. 3. Scott Murray, Interactive Data Visualization for Web, O'Relly

Useful Links:

1. Web Resources a. https://D3js.org
2. Artificial intelligence and expert systems: a ... - IEEE Xplorehttps://ieeexplore.ieee.org › document

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)
AIL603	**Data Analytics and Visualization Lab**	**(1+0)**
Lab Prerequisite:	1. Discrete Structures 2. Programming Language in Python or Java and R	
Lab Objectives:	1. To implement visual perception. 2. Apply core skills for visual analysis. 3. Apply visualization techniques for various data analysis tasks. 4. Design information dashboard.	
Lab Outcomes (LOs):	At the end of the course, the student will be able to: 1. Implement R programming for Data Analysis. 2. Apply techniques for data manipulation. 3. Implement data visualization with various techniques. 4. Perform visualization using D3.js 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Suggested Practical List:

Lab. No.	Experiment Title	LO Mapped	Hrs/Lab
1	To perform the basic mathematical operations in R programming	LO, LO2, LO5	02
2	Implementation of vector and list data objects operations in R	LO1, LO2, LO5	02
3	Implementation and perform the various operations on data frames in R	LO1, LO2, LO5	02
4	To Create Sample (Dummy) Data in R and perform data manipulation with R	LO1, LO2, LO3, LO5	02
5	Study and implementation of Data Visualization with ggplot2 in R	LO1, LO2, LO3, LO5	02
6	To perform visualization using D3.js	LO1, LO2, LO3, LO4 , LO5	02
7	To perform data exploration using Pandas	LO1, LO3, LO5	02
8	To perform scatter plots in matplotlib and seaborn with Python	LO1, LO2, LO3, LO5	02
9	Case Study on Data Visualization using Tableau	LO1, LO3, LO5	02
10	Case Study-2	LO1, LO3, LO5	02

Text Books:	1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition 2. Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, 3rd Edition

Useful Links:

1. https://www.tutorialspoint.com/artificial_intelligence_with_python/artificial_intelligence_with_python_tutorial.pdf
2. https://stacks.stanford.edu/file/druid:qn160ck3308/qn160ck3308.pdf

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 "Data Analytics and Visualization Lab".
- 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:

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

Course Code	Course Name	Credits (TH+P+TUT)
AIC604	Big Data Analytics	(3+0+0)

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	CO3	02 02	08

	Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step. Illustrating use of MapReduce with use of real life databases and applications.		02 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 cookbook. Packt Publishing Ltd, 2017. 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://hadoop.apache.org/

3.https://www.mongodb.com/atlas

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)
AIL604	Big Data Analytics Lab	(1+0)

Lab Prerequisite:	Java, Python
Lab Objectives:	1.To introduce the tools required to manage and analyze big data like Hadoop, NoSql 2. To impart knowledge of Map reduce paradigm to solve complex problems Map-Reduce. 3. To introduce several new algorithms for big data mining like classification, clustering and finding frequent patterns. 4. To introduce to the students several types of big data like social media, web graphs and data streams. 5. To identify various sources of Big data 6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.
Lab Outcomes (LOs):	1. Demonstrate capability to use Big Data Frameworks like Hadoop 2. Program applications using tools like Hive, pig, , NO SQL and MongoDB for Big data Applications 3. Construct scalable algorithms for large Datasets using Map Reduce techniques 4. Implement algorithms for Clustering, Classifying and finding associations in Big Data 5. Design and implement algorithms to analyze Big data like streams, Web Graphs and Social Media data and construct recommendation systems. 6. Apply the knowledge of Big Data gained to fully develop a BDA applications for real life Applications.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
1	Assignment on Study of Hadoop ecosystem	LO1	02
2	Programming exercises on Hadoop Using Hive, Pig, Hbase Sqoop, NOSQL, MongoDB	LO2	04
3	Implementing simple algorithms in Map-Reduce Matrix multiplication, Aggregates, joins, sorting, searching etc.	LO3	04
4	Implementing Algorithms using MapReduce(Any 2) Implementing Frequent Item set Mining Implementing Clustering algorithms Implementing Classification Algorithms	LO4	05
5	Big Data Applications (Any 2) Implementing Analytics on data streams Implementing Social Network Analysis Algorithms Implementing Web Graph Algorithms Implementing recommendation Engines	LO5	06
6	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining d) Recommendation Engines	LO5, LO6	06

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 "Big Data Analytics Lab".
- 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: P&O examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC6051	AI in E-Commerce	(3+0+0)

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 about the different technologies in e-Commerce 2.Build machine learning models using different algorithms. 3.Analyse customer behavior. 4.Create a dashboard for an ecommerce web site. 5.Discuss various E-business Strategies. 6.Discuss the ethical issues in e-Commerce

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	03	03
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	CO1	10	10
3. AI applications in E-commerce-Business cases-1	Market Basket Analysis: objectives, description, exploratory analysis and model building Propensity modelling: Regression Decision tree algorithm Customer profiling using clustering Web clickstream analysis Introduction to recommendation systems	CO3	10	10
4. Web mining and security	Introduction, Web Content Mining: Crawlers, Harvest System Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining Types of Abuse and the data that can stop them, Supervised Learning for Abuse	CO4	06	06

	Problems, Clustering Abuse Ethics and values			
5. E- Commerce Analytics/ customer review analysis	Creating Business Value using E-commerce Analytics, E-commerce Analytics Value Chain, Methods and Techniques for Ecommerce Analysis, Visualization, Dash boarding and Reporting text matching: TF-IDF modeling, Image matching: PCA analysis	CO3, CO4	06	06
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.	CO5, 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:

- 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.

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC6052	AI in Agriculture	(3+0+0)

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	Prerequisite Concepts and Course Introduction	--	02	02
1. Nature and origin of soil	1.1Definition 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
	1.2Soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability.		02	
	1.3Soil 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	2.1Irrigation Quality Parameter. Suitability of irrigation water as their quality parameters. Criterion of Essential Plant nutrients. Physiology role of Essential Plant nutrients.	CO2	03	06
	2.2Identification of deficiency symptoms of external plants nutrients and measure to overcome deficiency.		03	
3. Agronomy	3.1Definition of agronomy scope and important of Agronomy. Classification of agronomical crops viz, cereals, pulses oil seeds forage crop, cash crops etc.	CO3	02	05
	3.2Effect of different weather parameters on growth and development of agronomical crops. Define of tillage, its importance.		03	

4.Fertilizer application equipment	4.1Types of fertilizer: - Inorganic fertilizer, Organic fertilizers and its forms. liquid, powder, and granule Define fertilizers with suitable example, Fate of major Micronutrients and trace beneficial nutrients in Soil. Organic Manures- Define, classification with example and sources. Importance of organics manures.	CO4	04	07
	4.2Equipment:-Trolley Pump, Trailer sprayer. Combine Harvester, Cultivator, Roto Seed Drill, Manure Spreader, Rotary Tiller. sprayers, Drone Mini sprayer, and dusters, their calbration, selection, constructional features of different components and adjustments,	CO4	03	
5. Equipment/Tool/ Mulching.	5.1Types of equipment, tools, machinery for land preparation, sowing.	CO5	03	06
	5.2Harvesting threshing,Plant Protectors, seed treatments, weeding, interculturing etc.		03	
6. Development and system architecture of agricultural IoT	6.1Development and system architecture of agricultural IoT, Development of agricultural IoT sensors, Application of agricultural IoT, System architecture of agricultural Io T.	CO6	02	08
	6.2Key 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		02	
	6.3Typical 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	
	6.4Problems, 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:

- 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)
AIDLL6052	AI in Agriculture Lab	(1+0)

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. Explain the Agronomy of Crops and its Production 4. Explain concept of utilization of Fertilizer and its application equipment 5. Explain 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:

- 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 “AI in Agriculture Lab”.
- 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)
AIDLC6053	Internet of Things	(3+0+0)

Prerequisite:	1.Micro-controllers 2.Embedded System Design 3.Computer Networks
Course Objectives:	The objectives of this course are to: 1.Understand the design features of Internet of Things (IoT) 2.Understand importance of data handling in IoT Way. 3.Introduce multiple ways of data communication and networking. 4.Understand design issue in IoT
Couse Outcomes:	On successful completion of the course the students will be able to: 1.Explain the concepts of 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 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 IoT	1.1 Introduction: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT	CO1	04	08
	1.2 IoT and M2M:- IoT/M2M System layers and Design Standardization, M2M, Difference between IoT and M2M		01	
	1.3 IoT Levels: IoT Levels and Deployment Template		03	
2. Network & Communication aspects	2.1 Design Principles & Web Connectivity: Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets, (Publish–Subscribe), MQTT, AMQP, CoAP Protocols, Rabbit-MQ,	CO2	04	08
	2.2 Internet Connectivity: Internet based communication, IPaddressing in IoT, Media Access Control, and Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE M1, SIGFOX		04	
3. IoT Design Methodology	Introduction, Purpose & requirements, process, domain model, information model, service, IoT	CO3	03	05

	level, Functional view, Operational view, Device and Component Integration			
4.Data Handling in IoT	4.1 Data Acquiring, Organizing, Processing: - Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	CO4	03	06
	4.2 Data Collection and Storage:- Cloud Computing Paradigm for Data Collection, storage and computing,		03	
5. Components of IoT	Exemplary Devices: Arduino Boards, Arduino Interfacing, ESP32/ 8266, DHT Sensor, Ultrasonic Sensor, IR Sensor, NVDIA JETSON Nano	CO5	08	08
6.IoT Case Study	Home Automation, Energy Monitoring Case Study, Face Recognition, Object Detection (ANPR),	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press. 2. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, First edition 3. David Hanes, Gonzalo salgueiro "IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition. Andrew Minteer , "Analytics for the Internet of Things(IoT)", Kindle Edition
Reference Books	1. Adrian McEwen, Hakim Cassimally: Designing the Internet of Things", Paperback, First Edition 2. Yashavant Kanetkar , Shrirang Korde :Paperback "21 Internet of Things (IOT) Experiments" BPB Publications

Useful Links:

https://onlinecourses.nptel.ac.in/noc21_cs17/preview

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.

Course Code	Course Name	Credits (P+TU)
AIDLL6053	Internet of Things Lab	(1+0)

Lab Prerequisite:	1.Micro-controllers 2.Embedded System Design 3.Computer Networks
Lab Objectives:	1. Understand Arduino IDE for IoT practical. 2. Implementation of Arduino board and Nodemcu interfacing with LED, IR, Ultrasonic, DHT sensors. 3. Demonstration of IoT based case study. 4. Implementation of data storage. 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. Use Arduino IDE for IoT based practical. 2. Implement interfacing of Arduino board and nodemcu with LED, IR, Ultrasonic, DHT sensors. 3. Demonstrate IoT based case study. 4. Implement storing of data to AWS. 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	---	2
1.	LED and IR sensor interfacing with Nodemcu.	LO1, LO5, LO6	2
2.	Ultrasonic sensor interfacing with Nodemcu for distance measurement.		2
3.	Temperature/Humidity monitoring using Blynk App.		2
4.	DHT sensor interfacing with Nodemcu and communication of data using MQTT protocol/ Rabbit MQ.		2
5.	To study the MQTT and ThingSpeak and upload the DHT sensor data on ThingSpeak		2
6.	To study Amazon Web Service Platform.	LO4, LO5, LO6	2
7.	Study of IoT based industrial process monitoring and control system	LO3, LO5, LO6	2
8.	Case Study -I		2
9.	Case Study -II		4

Virtual Lab Links:
1. https://aws.amazon.com/
2. https://thingspeak.com/
3. https://blynk.io/
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 "Internet of Things Lab".
- 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)
AIDLC6054	**Bioinformatics Data Management**	**(3 + 0 + 0)**

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 bioinformatics tools. 3. To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
Course 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	Introduction to Bioinformatics: Definition and History of Bioinformatics, Different Omics and its application and Current status, Internet sources for Bioinformatics, Flat file, NCBI	CO1	02 02 02	06
2. Biological Data Searching and Databases	Introduction. Biological Data Searching Using Blast DNA and Protein Databases, Metabolism Database (KEGG), MSA, A Case Study In Phylogenetic Tree Database Search, A Case Study In Rna Pseudoknot Database Search.	CO2	02 02 02 02	08
3.Biological Data Mining	Introduction, General Data Mining, Biological Data Mining, A Case Study In Biological Pattern Discovery. A Case Study In Biological Data Mining General Regulatory Network Inference.	CO3	02 02 02 02	08
4. Biological Data Cleaning	Introduction. General Data Cleaning. A Case Study In Biological Data Cleaning	CO4	02 02 02	06
5.Biological Data Integration	Introduction. General Data Integration. Three Areas In Biological Data Integration	CO5	03 03	06
6. Cloud based Biological Data	Introduction. Data Processing In The Cloud.	CO6	05	05

Processing	Biological Data. Processing In The Cloud			
I. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	**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 (CA):

- 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.

Course Code	Course Name	Credits (P+TU)
AIDLL6052	Bioinformatics Data Management Lab	(1+0)

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. Explain how to construct phylogenetic trees 2. To use BLAST and its variants for the identification of very similar and divergent sequences. 3. To use database resource for understanding high-level functions and utilities of the biological system(KEGG) 4. To do the sequence analysis problems under the application layer. 5. To provide functional analysis of proteins by classifying them into families. 6. To do classification of protein domains. 7. To do visualization of proteins, nucleic acids. 8. To generate reliable three-dimensional protein structure models.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1	Multiple sequence alignment and Phylogenetic tree analysis	LO1	02
2	BLAST- BLASTn, BLASTp, primer BLAST.	LO2	02
3	Motif Finding- MEME and myhits	LO4	02
4	Secondary Structure Prediction: Interproscan	LO5	02
5	CATH and SCOP	LO6	02
6	KEGG	LO3	02
7	Tertiary Structure: PDB, Rasmol	LO7	02
8	Homology Modeling – SWISS-MODEL	LO8	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 "Bioinformatics Data Management Lab".
- 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.

Project Based Learning Code	Project Based Learning Name	Credits (P+TUT)
AIPR64	Minor Project Lab-2	(1+0)

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	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	Report writing and presentation preparation: Documentation of the work done in a streamlined manner, Preparation and organization of a report according to a standard format, Use of IEEE format of bibliography	PRO 5	04
6	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
3. Project Report, Performance:10

Exposure (Skill Based Learning-IX) Code	Exposure (Skill Based Learning-IX)	Credits (P+TUT)
AIXS69	R Programming	(1+0)

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 solutions to real-world problems or other projects at hand.

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

Course Code	Course Name	Hours/Duration
INT65	Internship-V	2-4 Weeks

Prerequisite:	List of probable industries and organizations offering internships on live projects. Awareness about probable solutions for identified problem areas in rural India
Course Objectives:	1. To understand the social, economic and administrative considerations of working environment in industries, government, NGOs and private organizations. 2. Learn to apply the Technical knowledge for solving real life problems.
Couse Outcomes:	Upon completion of the course, students will be able to: 1. Get an opportunity to get hired by the Industry/ organization. 2. Decide if working in the industry or set up a start-up would be best career option to pursue.

Activity- Rural Internships & Internships	Supporting Activities to be completed under Internship
	1. Long Term Goal under Rural Development Internships or
	2. Mandatory internship for developing project with:
	• Industries
	• Government Sector
	• Non-governmental Organization (NGO)
	• MSMEs

Term Work Assessment:

Duration to be considered for assessment:
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)

Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data 6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.