SOMAIYA
VIDYAVIHAR

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

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

Autonomy Syllabus Scheme-II

for

Bachelor of Technology

in

Artificial Intelligence and Data Science (AI & DS)

(SY-Semester-III)

With effect from A.Y. 2022-23

Four Year Undergraduate Programmes leading to Bachelor of Technology (B.Tech.) Degree in Artificial Intelligence and Data Science Engineering implemented from in Academic Year 2021-22 for SY, TY.

Somaiya Ayurvihar Complex, Eastern Express Highway, Sion (East), Mumbai. 400 022, India
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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, Mumbai.

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

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

Semester-III- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC301	Applications of Mathematics in Engineering-I	3–0–1	04	3–0–1	04	**BS**
AIC302	Discrete Structures and Graph Theory	2–0–0	02	2–0–0	02	PC
AIC303	Data Structure	3–0–0	03	3–0–0	03	PC
AIC304	Digital Logic & Computer Architecture	3–0–0	03	3–0–0	03	PC
AIC305	Computer Graphics	3–0–0	03	3–0–0	03	PC
AIL303	Data Structure Lab	0–2–0	02	0–1–0	01	PC
AIL304	Digital Logic & Computer Architecture Lab	0–2–0	02	0–1–0	01	PC
AIL305	Computer Graphics Lab	0–2–0	02	0–1–0	01	PC
AIPR31	Project Based Learning- Mini Project Lab-I	0–2–0	02	0–1–0	01	PBL
AIXS33	Skill Based Learning-III	0-2*-0	02	0-1-0	01	SAT
AIXS34	Skill Based Learning-IV	0-2*-0	02	0-1-0	01	SAT
INT 32	Internship-2	--	--	--	--	INT
Total		**14–12–1**	**27**	**14-6-1**	**21**	

*SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.
PBL - Mini 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-III- 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						
AIC301	Applications of Mathematics in Engineering-I	30	30	30	10	60	25	--	--	--	125
AIC302	Discrete Structures and Graph Theory	20	20	20	10	45	--	--	--	--	75
AIC303	Data Structure	30	30	30	10	60	--	--	--	--	100
AIC304	Digital Logic & Computer Architecture	30	30	30	10	60	--	--	--	--	100
AIC305	Computer Graphics	30	30	30	10	60	--	--	--	--	100
AIL303	Data Structure Lab	--	--	--	--	--	25	--	--	25	50
AIL304	Digital Logic & Computer Architecture Lab	--	--	--	--	--	25	--	--	--	25
AIL305	Computer Graphics Lab	--	--	--	--	--	25	--	--	25	50
AIPR31	Project Based Learning- Mini Project Lab-I	--	--	--	--	--	25	--	--	25	50
AIXS33	Skill Based Learning-III	--	--	--	--	--	25	--	--	--	25
AIXS34	Skill Based Learning-IV	--	--	--	--	--	25	--	--	--	25
INT 32	Internship-2	--	--	--	--	--	--	--	--	--	--
Total		--	--	**140**	**50**	**285**	**175**	--	--	**75**	**725**

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

Semester-III- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC301	Applications of Mathematics in Engineering-I	3–0–1	04	3–0–1	04	**BS**
AIC302	Discrete Structures and Graph Theory	2–0–0	02	2–0–0	02	PC
AIC303	Data Structure	3–0–0	03	3–0–0	03	PC
AIC304	Digital Logic & Computer Architecture	3–0–0	03	3–0–0	03	PC
AIC305	Computer Graphics	3–0–0	03	3–0–0	03	PC
AIL303	Data Structure Lab	0–2–0	02	0–1–0	01	PC
AIL304	Digital Logic & Computer Architecture Lab	0–2–0	02	0–1–0	01	PC
AIL305	Computer Graphics Lab	0–2–0	02	0–1–0	01	PC
AIPR31	Project Based Learning- Mini Project Lab-I	0–2–0	02	0–1–0	01	PBL
AIXS33	Skill Based Learning-III	0-2*-0	02	0-1-0	01	SAT
AIXS34	Skill Based Learning-IV	0-2*-0	02	0-1-0	01	SAT
INT 32	Internship-2	--	--	--	--	INT
Total		**14–12–1**	**27**	**14-6-1**	**21**	

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

PBL - Mini 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-III- 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						
AIC301	Applications of Mathematics in Engineering-I	30	30	30	10	60	25	--	--	--	125
AIC302	Discrete Structures and Graph Theory	20	20	20	10	45	--	--	--	--	75
AIC303	Data Structure	30	30	30	10	60	--	--	--	--	100
AIC304	Digital Logic & Computer Architecture	30	30	30	10	60	--	--	--	--	100
AIC305	Computer Graphics	30	30	30	10	60	--	--	--	--	100
AIL303	Data Structure Lab	--	--	--	--	--	25	--	--	25	50
AIL304	Digital Logic & Computer Architecture Lab	--	--	--	--	--	25	--	--	--	25
AIL305	Computer Graphics Lab	--	--	--	--	--	25	--	--	25	50
AIPR31	Project Based Learning- Mini Project Lab-I	--	--	--	--	--	25	--	--	25	50
AIXS33	Skill Based Learning-III	--	--	--	--	--	25	--	--	--	25
AIXS34	Skill Based Learning-IV	--	--	--	--	--	25	--	--	--	25
INT 32	Internship-2	--	--	--	--	--	--	--	--	--	--
Total		--	--	**140**	**50**	**285**	**175**	--	--	**75**	**725**

Course Code	Course Name	Credits (TH+P+TUT)
AIC301	Applications of Mathematics in Engineering-I	(3+0+1)

Prerequisite:	1.Engineering Mathematics-I 2.Engineering Mathematics-II
Course Objectives:	1. To learn the Laplace Transform, Inverse Laplace Transform of various functions, its applications. 2. To understand the concept of Fourier Series, its complex form and enhance the problem-solving skills. 3. To understand the concept of complex variables, C-R equations with applications. 4. To understand the basic techniques of statistics like correlation, regression, and curve fitting for data analysis, Machine learning and AI. 5. To understand some advanced topics of probability, random variables with their distributions and expectations.
Couse Outcomes:	On successful completion, of course, learner/student will be able to: 1. Solve the real integrals in engineering problems using the concept of Laplace Transform. 2. Analyze engineering problems through the application of inverse Laplace transform of various functions. 3. Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems. 4. Solve the problems of obtaining orthogonal trajectories and analytic functions by means of complex variable theory and application of harmonic conjugate. 5. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI. 6. Analyze the spread of data and distribution of probabilities by the concepts of probability and expectation.

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.Laplace Transform	1.1. Definition of Laplace transforms Condition of Existence of Laplace transform.	CO1	01	07
	1.2 Laplace Transform (L) of Standard Functions like eat, sin(at), cos(at), sinh(at), cos*h*(at) and tn, n ≥ 0.		02	
	1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scales Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof).		02	
	1.4 Evaluation of integrals by using Laplace		02	

	Transformation			
2.Inverse Laplace Transform	2.1 Definition of Inverse Laplace Transform, Linearity property, Inverse Laplace Transform of standard functions, Inverse Laplace Transform using derivatives.	CO2	02	06
	2.2 Partial fractions method to find inverse Laplace Transform.		02	
	2.3 Inverse Laplace transform using Convolution theorem (without proof).		02	
3. Fourier Series	3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	CO3	01	07
	3.2 Fourier series of periodic function with period 2 and 2l.		02	
	3.3 Fourier series of even and odd functions.		02	
	3.4 Fourier Transform-Fourier sine transform and Fourier cosine transform.		02	
4.Module: Complex Variables	4.1Function f(z) of complex variable, Limit, Continuity and Differentiability off(z), Analytic function: Necessary and sufficient conditions for f(z) to be analytic (without proof).	CO4	01	07
	4.2Cauchy-Riemann equations in Cartesian coordinates (without proof).		02	
	4.3Milne-Thomson method to determine analytic function f(z) when real part(u) or Imaginary part (v) or its combination (u+v or u-v) is given.		02	
	4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories.		02	
5. Statistical Techniques	5.1 Karl Pearson's coefficient of correlation (r)	CO5	01	06
	5.2 Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks)		01	
	5.3 Lines of regression		02	
	5.4 Fitting of first- and second-degree curves.		02	
6.Probability	6.1Definition and basics of probability, conditional probability.	CO6	01	06
	6.2Total Probability theorem and Bayes' theorem.		01	
	6.3Discrete and continuous random variable with probability distribution and probability density function.		02	
	6.4Expectation, Variance, Moment generating function, Raw and central moments up to 4^{th} order.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**
Books:				
Text Books	1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.			

<table>
<tr><td></td><td>2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.</td></tr>
<tr><td>Reference Books</td><td>1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication.
2. Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
3. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum’s Outline Series.</td></tr>
<tr><td colspan="2">Continuous Assessment:</td></tr>
<tr><td colspan="2">● 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</td></tr>
<tr><td colspan="2">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</td></tr>
<tr><td colspan="2">Term work:</td></tr>
<tr><td colspan="2">1. Each Student has to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.
3. The distribution of Term Work marks will be as follows –
<table>
<tr><td>1.</td><td>Class Tutorials on entire syllabus</td><td>15 marks</td></tr>
<tr><td>2.</td><td>Mini Project Presentation</td><td>10 marks</td></tr>
</table>
</td></tr>
</table>

Course Code	Course Name	Credits (TH+P+TUT)
AIC302	Discrete Structures and Graph Theory	(3+0+0)

Prerequisite:	Discrete Mathematics
Course Objectives:	1. To cultivate clear thinking and creative problem solving. 2. To thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies. 3. To apply graph theory in solving practical problems. 4. To thoroughly prepare for the mathematical aspects of other Artificial Intelligence and Data Science courses.
Couse Outcomes:	On successful completion, of course student will be able to: 1. Analyze to the reason logically. 2. Apply the relations, functions, Diagraph and Lattice. 3. Apply the notion of mathematical thinking, mathematical proofs and to apply them in problem solving. 4. Identify problems concepts of graph theory in solving real world problems. 5. Examine the groups and codes in Encoding-Decoding. 6. Analyze a complex computing problem and apply principles of discrete mathematics to identify 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. Logic	1.1 Propositional Logic, Predicate Logic, Laws of Logic, Quantifiers, Normal Forms, Inference Theory of Predicate Calculus, Mathematical Induction.	CO1	04	04
2. Relations and Functions	2.1 Basic concepts of Set Theory.	CO2	01	04
	2.2 Relations: Definition, Types of Relations, Representation of Relations, Closures of Relations, Warshall's algorithm, Equivalence relations and Equivalence Classes.		02	
	2.3 Functions: Definition, Types of functions, Composition of functions, Identity and Inverse function.		01	
3. Posets and Lattice	3.1 Partial Order Relations, Poset, Hasse Diagram, Chain and Antichains, Lattice, Types of Lattice, Sub lattice.	CO3	04	04

4. Counting	4.1 Basic Counting Principle- , Product Rule, Inclusion-Exclusion Principle, Pigeon hole Principle.	CO4	02	04
	4.2 Recurrence relations, Solving recurrence relations.		02	
5. Algebraic Structures	5.1 Algebraic structures with one binary operation: Semi group, Monoid, Groups, Subgroups, Abelian Group, Cyclic group, Isomorphism.	CO5	02	05
	5.2 Algebraic structures with two binary operations: Ring.		01	
	5.3 Coding Theory: Coding, binary information and error detection, decoding and error correction.		02	
6. Graph Theory	6.1 Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs, Eulerand Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex, Applications.	CO6	05	05
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	**28**

Books:

Text Books	1.Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem -ur Rehman, "Discrete Mathematical Structures", Pearson Education. 2. C.L.Liu" Elements of Discrete Mathematics", second edition 1985, McGraw-Hill Book Company. Reprinted 2000. 3.K.H.Rosen, "Discrete Mathematics and applications", fifth edition2003, Tata McGraw Hill Publishing Company.
Reference Books	1. Y N Singh," Discrete Mathematical Structures", Wiley-India. 2. J.L.Mott, A.Kandel, T.P.Baker," Discrete Mathematics for Computer Scientists and Mathematicians", Second Edition 1986, Prentice Hall of India. 3. J.P.Trembley, R.Manohar" Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Publishing Company 4. Seymour Lipschutz, Marc Lars Lipson, "Discrete Mathematics" Schaum"s Outline, McGraw Hill Education. 5. Narsing Deo, "Graph Theory with applications to engineering and computer science", PHI Publications. 6. P.K. Bisht , H.S.Dhami, "Discrete Mathematics", Oxford press.

Useful Links:

1.https://www.edx.org/learn/discrete-mathematics

2.https://www.coursera.org/specializations/discrete-mathematics

3.https://nptel.ac.in/courses/106/106/106106094/

4.https://swayam.gov.in/nd1_noc19_cs67/preview

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (10Marks): Test-1 and Test-2 consists of two class tests of 10 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 45 Marks.
- Duration of End Semester Exam shall be 02 Hours.

Course Code	Course Name	Credits (TH+P+TUT)
AIC303	Data Structure	(3+0+0)

Prerequisite:	1.Computer Programming 2.Computer Programming Laboratory
Course Objectives:	1. To discuss types of different data structures and concept of Abstract Data Type. 2. To discuss the concept of stack and queue and apply them to various applications. 3. To describe the concept of link list and apply it to various applications 4. To introduce the different kinds of trees. 5. To discuss graph related concepts and traversals along with application. 6. To teach various searching techniques.
Couse Outcomes:	After successful completion of the course students will be able to: 1. Describe types of data structure and related terminologies and its types and operations on data structures. 2. Implement linear data structures using arrays and linked lists. 3. Implement nonlinear data structures like graphs and trees 4. Perform various operations like searching, insertion, deletion and traversals on a given data structures. 5. Implement appropriate searching techniques for a given problem 6. Choose suitable data structure and apply it to solve a given problem.

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 Data Structures	1.1 Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear,	CO1	01	02
	1.2 Operations on Data Structures.		01	
2.Arrays and linked lists	2.1 Arrays and array operations implementation of List, Traversing, Insertion, Deletion, Applications of arrays (sorting, searching, polynomial representation).	CO2, CO4, CO6	03	08
	2.2 Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Singly Linked List Application-Polynomial Representation and polynomial addition.		05	
3.Stack	3.1 Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Stack using Singly Linked List Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion.	CO2, CO4, CO6	05	05
4.Queues	4.1 Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Queue using Singly Linked List .	CO2, CO4, CO6	04	06
	4.2Types of Queue-Circular Queue, Priority Queue, Introduction of Double Ended Queue, Applications of Queue.		02	

5.Trees	5.1Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree.	CO3, CO4, CO6	05	10
	5.2Applications of Binary Tree-Expression Tree, Huffman Encoding, AVL, rotations in AVL Tree, operations on AVL Tree, Search Trees -Introduction of B Tree, B+ tree.		05	
6.Graphs	6.1Introduction, Graph Terminologies, Representation of Graph, Graph Traversals- Depth First Search (DFS) and Breadth First Search (BFS).	CO3, CO5, CO4	03	04
	6.2Graph Application- Topological Sorting.	CO5, CO6	01	
7.Searching Techniques	Linear Search, Binary Search, Hashing-Concept, Hash Functions, Collision resolution Techniques	CO5	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", Pearson Publication. 2. Reema Thareja, "Data Structures using C", Oxford Press. 3. Richard F. Gilberg and Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2ndEdition, CENGAGE Learning. 4. Jean Paul Tremblay, P. G. Sorenson, "Introduction to Data Structure and Its Applications", McGraw-Hill Higher Education 5. Data Structures Using C, ISRD Group, 2ndEdition, Tata McGraw-Hill.
Reference Books	1. Prof. P. S. Deshpande, Prof. O. G. Kakde, "C and Data Structures", DreamTech press. 2. E. Balagurusamy, "Data Structure Using C", Tata McGraw-Hill Education India. 3. Rajesh K Shukla, "Data Structures using C and C++", Wiley-India 4. GAV PAI, "Data Structures", Schaum's Outlines. 5. Robert Kruse, C. L. Tondo, Bruce Leung, "Data Structures and Program Design in C", Pearson Edition

Useful Links:

1.https://learndsa.kjsieit.in/

2. https://nptel.ac.in/courses/106/102/106102064/

3. https://www.coursera.org/specializations/data-structures-algorithms

4. https://www.edx.org/course/data-structures-fundamentals

5. https://swayam.gov.in/nd1_noc19_cs67/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)
AIL303	**Data Structure Lab**	**(1+0)**

Lab Prerequisite:	1. Computer Programming 2. Computer Programming Laboratory
Lab Objectives:	1. To implement basic data structures such as linked lists, stacks and queues 2. To solve problem involving graphs and trees 3. To choose appropriate data structure and apply it to various problems
Lab Outcomes (LOs):	1. Implement linear data structures & be able to handle operations like insertion, deletion, searching and traversing on them. 2. Implement nonlinear data structures & be able to handle operations like insertion, deletion, searching and traversing on them 3. Choose appropriate data structure and apply it in various problems 4. Select appropriate searching techniques for given problems. 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs. /Lab
Star (*) marked experiments are compulsory.			
I.	Lab Prerequisite	---	02
1.	Implement Stack ADT using array.	LO1, LO5	02
2.	Convert an Infix expression to Postfix expression using stack ADT.		02
3.	Evaluate Postfix Expression using Stack ADT		02
4*.	At least 2 applications of Stack from the useful links/any other given below.	LO1, LO3, LO5	02
5.	Implement Linear Queue ADT using array.	LO1, LO5	02
6.	Implement Circular/Double ended Queue ADT using array.		02
7.	Implement Priority Queue ADT using array.		02
8.	Implement Singly Linked List ADT.		02
9.	Implement Circular Linked List ADT.		02
10.	Implement Doubly Linked List ADT.		02
11.	Implement Stack / Linear Queue ADT using Linked List.		02
12*.	Implement Binary Search Tree ADT using Linked List.	LO2, LO3, LO5	02
13*.	Implement Graph Traversal techniques: a) Depth First Search b) Breadth First Search.		02
14*.	At least 2 applications of Binary Search Technique from the useful links/any other given below	LO4, LO5	02

Useful Links:

1. www.leetcode.com
2. www.hackerrank.com
3. www.cs.usfca.edu/~galles/visualization/Algorithms.html
4. www.codechef.com

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Structure".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

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

Course Code	Course Name	Credits (TH+P+TUT)
AIC304	Digital Logic & Computer Architecture	(3+0+0)

Prerequisite:	1. Knowledge of number systems 2. Knowledge of Basic computer organizations 3. Basic electrical and electronics engineering
Course Objectives:	1. To have the basic awareness about structure and operation of digital circuits and digital computer. 2. To discuss in detail arithmetic operations in digital system. 3. To discuss generation of control signals and different ways of communication with I/O devices. 4. To study the hierarchical memory and principles of advanced computing.
Course Outcomes:	After successful completion of course student will be able to: 1. Describe the fundamentals of Digital Logic Design and basic structure of computer systems. 2. Demonstrate the data representation and arithmetic algorithms. 3. Explain the basic concepts of digital components and processor organization. 4. Demonstrate control unit operations. 5. Categories memory organization and explain the function of each element. 6. Describe the concepts of parallel processing and different Buses.

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. Computer fundamentals	1.1 Introduction to Number System and Codes	CO1	01	05
	1.2 Number Systems: Binary, Octal, Decimal, Hexadecimal,		01	
	1.3 Codes: Grey, BCD, Excess-3, ASCII, Boolean Algebra.		01	
	1.4 Logic Gates: AND, OR, NOT, NAND, NOR, EX-OR		01	
	1.5 Overview of computer organization and architecture		01	
	1.6 Basic Organization of Computer and Block Level functional Units, Von-Neumann Model.		01	
2.Data representation and Arithmetic algorithms	2.1 Binary Arithmetic: Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's and 2's compliment, BCD and Hex Arithmetic Operation.	CO2	05	08
	2.2 Booths Multiplication Algorithm, Restoring and Non-restoring Division Algorithm.		03	
	2.3 IEEE-754 Floating point Representation. (Single & Double precision.) Floating point Arithmetic: Addition, Subtraction			
3.Processor Organization and Architecture	3.1 Introduction of Combinational Logic: Half adder, Full adder, MUX, DMUX, Encoder, Decoder (IC level).	CO3	03	08
	3.2 Introduction of Sequential Logics: Introduction		03	

	to Flip Flop: SR, JK, D, T, Types of counters (Synchronous and Asynchronous)			
	3.3 Register Organization, Instruction Formats, Addressing modes, Instruction Cycle, Interpretation and sequencing.		02	
4.Control Unit Design	4.1 Hardwired Control Unit: State Table Method, Delay Element Methods.	CO4	03	06
	4.2 Microprogrammed Control Unit: Micro Instruction-Format, Sequencing and execution, Micro operations, Examples of microprograms. Introduction to RISC and CISC architectures and design issues.		03	
5.Memory organization	5.1 Introduction and characteristics of memory, Types of RAM and ROM, Memory Hierarchy, 2-level Memory Characteristic,	CO5	01	05
	5.2 Cache Memory: Concept, locality of reference, Design problems based on mapping techniques, Cache coherence and write policies. Interleaved and Associative Memory.		04	
6.Principle of Advanced Processor and Buses	6.1 Basic Pipelined Data path and control, data dependencies, data hazards, branch hazards, delayed branch, and branch prediction, Performance measures-CPI, Speedup, Efficiency, throughput, Amdhal's law.	CO6	03	07
	6.2 Flynn's Classification, Instruction pipelining, pipeline hazards, Introduction to multicore architecture.		02	
	6.3 Introduction to buses: ISA, PCI, USB. Bus Contention and Arbitration.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. R. P. Jain, "Modern Digital Electronic", McGraw-Hill Publication, 4th Edition. 2. William Stalling, "Computer Organization and Architecture: Designing and Performance", Pearson Publication 10th Edition. 3. John P Hayes, "Computer Architecture and Organization", McGraw-Hill Publication, 3RD Edition. 4. R. M. Usha and T. S. Shrikanth, "Computer system Architecture and Organization", Wiley publication. 5. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw-Hill. 6. John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Fourth Edition (2008).
Reference Books	1. Andrew S. Tanenbaum, "Structured Computer Organization", Pearson Publication. 2. B. Govindarajalu, "Computer Architecture and Organization", McGraw-Hill Publication. 3. Malvino, "Digital computer Electronics", McGraw-Hill Publication, 3rdEdition. 4. Smruti Ranjan Sarangi, "Computer Organization and Architecture", McGraw-Hill Publication. 5. Ronald J. Tocci, Neal S. Widmer, "Digital Systems Principles and Applications",

	Eighth Edition, PHI (2003) 6. Thomas L. Floyd, "Digital Fundamentals", Pearson Prentice Hall, Eleventh Global Edition (2015).

Useful Links:

1.https://learnabout-electronics.org/Digital/dig20.php

2.https://nptel.ac.in/courses/117/106/117106086/

3.https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824

4.https://nptel.ac.in/courses/106/103/106103068/

5.https://www.coursera.org/learn/comparch

6.https://www.edx.org/learn/computer-architecture

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)
AIL304	**Digital Logic & Computer Architecture Lab**	**(1+0)**

Lab Prerequisite:	1. C Programming Language
Lab Objectives:	1. To discuss basic concepts of digital logic design. 2. To Design and simulate different digital circuits. 3. To implement operations of the arithmetic unit using algorithms. 4. To design memory subsystem including cache memory. 5. To demonstrate CPU and ALU design.
Lab Outcomes (LOs):	1. The student will be able explain the basics of digital components. 2. The student will be able implement different digital circuits. 3. The student will be able design the basic building blocks of a computer: ALU, registers, CPU and memory. 4. The student will be able recognize the importance of digital systems in computer architecture. 5. The student will be able implement various algorithms for arithmetic operations. 6. The student will be able to write accurate documentation for experiments performed.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	To verify the truth table of various logic gates using ICs.	LO1,LO6	02
2.	To realize the gates using universal gates	LO2, LO6	02
3.	Code conversion.		02
4.	To realize half adder and full adder.		02
5.	To implement logic operation using MUX IC.		02
6.	To implement logic operation decoder IC.		02
7.	Study of flip flop IC.		02
8.	To implement ripple carry adder.	LO4, LO6	02
9.	To implement carry look ahead adder.		02
10.	To implement Booth's algorithm.	LO5, LO6	02
11.	To implement restoring division algorithm.		02
12.	To implement non restoring division algorithm.	LO4, LO6	02
13.	To implement ALU design.	LO3, LO6	02
14.	To implement CPU design.		02
15.	To implement memory design.		02
16.	To implement cache memory design.		02
17.	To study MASM (Micro Assembler).	LO5, LO6	02
18.	A program to simulate the mapping techniques of Cache memory. 18.1 Direct Mapped cache 18.2 Associative Mapped cache 18.3 Set Associative Mapped cache	LO3, LO6	02

Virtual Lab Links:
1. http://vlabs.iitkgp.ac.in/dec/exp3/index.html#
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/dldesignlab/experimentlist.html
3. http://vlabs.iitkgp.ac.in/coa/
Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Digital Logic & Computer Architecture". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks),

Course Code	Course Name	Credits (TH+P+TUT)
AIC305	Computer Graphics	(3+0+0)

Prerequisite:	Basic Mathematics
Course Objectives:	1.To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics. 2.To emphasize on implementation aspect of Computer Graphics Algorithms. 3.To prepare the student for advance areas and professional avenues in the field of Computer Graphics.
Couse Outcomes:	At the end of the course, the students should be able to, 1. Describe the basic concepts of Computer Graphics. 2. Demonstrate various algorithms for basic graphics primitives. 3. Apply 2-D geometric transformations on graphical objects. 4. Use various Clipping algorithms on graphical objects. 5. Apply 3-D geometric transformations, curve representation techniques and projections methods. 6. Explain visible surface detection techniques and Animation.

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 and Overview of Graphics System	1.1 Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, Rasterization and Rendering.	CO1	01	03
	1.2 Raster scan & Random scan displays, Architecture of Raster graphics system with display processor, Architecture of Random scan systems. Self-Learning Topics: Display devices like Plasma Display, 3D Display.		02	
2.Output Primitives:	2.1 Scan conversions of point, line, circle and ellipse: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected).	CO2	08	12
	2.2 Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).		01	
	2.3 Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm.		03	
3.Two Dimensional Geometric	3.1 Basic transformations: Translation, Scaling, Rotation	CO3	01	04

Transformations	3.2 Matrix representation and Homogeneous Coordinates.		01	
	3.3 Composite transformation.		01	
	3.4 Other transformations: Reflection and Shear.		01	
4.Two-Dimensional Viewing and Clipping	4.1 Viewing transformation pipeline and Window to Viewport coordinate transformation.	CO4	02	06
	4.2 Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton.		04	
5.Three Dimensional Geometric Transformations, Curves and Fractal Generation	5.1 3D Transformations: Translation, Rotation, Scaling and Reflection	CO5	01	08
	5.2 Composite transformations: Rotation about an arbitrary axis		01	
	5.3 Projections – Parallel, Perspective. (Matrix Representation)		02	
	5.4 Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve. Self-learning topics: Piano Curve, Hilbert Curve.		04	
6.Visible Surface Detection and Animation	6.1 Visible Surface Detection: Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method, Area Subdivision method.	CO6	03	06
	6.2 Animation: Introduction to Animation, Traditional Animation Techniques, Principles of Animation, Key framing: Character and Facial Animation, Deformation, Motion capture.		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. Hearn & Baker, "Computer Graphics C version", 2nd Edition, Pearson Publication 2. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2nd Edition, Pearson Publication 3. Samit Bhattacharya, "Computer Graphics", Oxford Publication
Reference Books	1. D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications 2. Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Outlines McGraw-Hill Education 3. Rajesh K. Maurya, "Computer Graphics", Wiley India Publication. 4. F. S. Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications
Useful Links:	
1. https://onlinecourses.nptel.ac.in/noc21_cs97/preview	

2. https://nptel.ac.in/courses/106/106/106106090/
3. https://www.classcentral.com/course/interactivegraphics-2067
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)
AIL305	**Computer Graphics Lab**	**(1+0)**

Lab Prerequisite:	C Programming Language**.**
Lab Objectives:	1. Understand the need of developing graphics application. 2. Learn algorithmic development of graphics primitives like line, circle, polygon etc. 3. Learn the representation and transformation of graphical images and pictures.
Lab Outcomes (LOs):	Students will be able to: 1. Implement various output and filled area primitive algorithms. 2. Apply transformation, projection and clipping algorithms on graphical objects. 3. Perform curve and fractal generation methods. 4. Develop a Graphical application/Animation based on learned concept. 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Implement DDA Line Drawing algorithm (dotted/dashed/thick)	LO1, LO5	02
2.	Implement Bresenham's Line algorithm (dotted /dashed/ thick)		02
3.	Implement midpoint Circle algorithm.		02
4.	Implement midpoint Ellipse algorithm.		02
5.	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.		02
6.	Implement Scan line Polygon Filling algorithm.		02
7.	Implement Curve: Bezier for n control points, B Spline (Uniform) (at least one)	LO3, LO5	02
8.	Implement Fractal generation method (any one)		02
9.	Character Generation: Bit Map method and Stroke Method	LO1, LO5	02
10.	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.	LO2, LO5	02
11.	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.		02
12.	Implement polygon clipping algorithm (at least one)		02
13.	Program to perform 3D transformation.		02

14.	Perform projection of a 3D object on Projection Plane: Parallel and Perspective.		02
Virtual Lab Links:			
http://vlabs.iitb.ac.in/vlabs-dev/labs/cglab/experimentlist.html			
Term work:			
1. Term work should consist of a minimum of 8 experiments 2. Journal must include at least 2 assignments on content of theory and practical of the course "Computer Graphics". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)			
P&O: P&O examination will be based on experiment list and performance of experiment.			

Project Based Learning Code	Project Based Learning	Credits (P+TUT)
AIPR31	**Mini Project Lab-I**	**(1+0)**
PBL Prerequisites:	**---**	
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:	At the end of the course, the student will be able to: 1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Analyze the impact of solutions in societal and environmental context for sustainable development. 5. Excel in written and oral communication. 6. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 7. Demonstrate project management principles during project work.	

Guidelines for Mini Project:	
1.	Project based learning Mini Project Lab-1 should be implemented using Java programming (AIXS33)
2.	Students shall form a group of 2 to 4 students, while forming a group shall not be allowed less than two or more than three students, as it is a group activity.
3.	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/internal committee of faculties.
4.	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
5.	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6.	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
7.	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
8.	Students shall convert the best solution into working model using Java programming.
9.	The solution to be validated with proper justification and report to be compiled in

	standard format of the college.
10.	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.
11	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work:

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

Distribution of Term work marks for both semesters shall be as below		**Practical Marks**
1.	Marks awarded by guide/supervisor based on implementation	10
2.	Peer assessment by team members	05
3.	Marks awarded by review committee	05
4.	Quality of Project report	05

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

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

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

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

5.	Project report
Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1.	Report should be prepared as per the guidelines.
2.	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners.
3.	Students shall be motivated to participate in poster, project competition on the work in students' competitions.
Mini Project shall be assessed based on following points.	
1.	Quality of problem and Clarity
2.	Innovativeness in solutions
3.	Cost effectiveness and Societal impact
4.	Full functioning of working model as per stated requirements
5.	Effective use of skill sets
6.	Effective use of standard engineering norms
7.	Contribution of an individual's as member or leader
8.	Clarity in written and oral communication
P&O: P&O examination will be based on mini project implementation.	

Exposure (Skill Based Learning-III) Code	Exposure (Skill Based Learning-III)	Credits (P+TUT)
AIXS33	**Object Oriented Programming with Java**	**(1+0)**

Skill Prerequisite:	1. Structured Programming Approach
Skill Objectives:	1. To learn the basic concepts of object-oriented programming. 2. To study JAVA programming language. 3.To study various concepts of JAVA programming like multithreading, exception Handling, packages, etc. 4. To explain components of GUI based programming.
Skill Outcomes (SOs):	1. To apply fundamental programming constructs. 2. To implement the concept of classes and objects. 3. To implement the concept of strings, arrays , vectors and packages. 4. To implement the concept of inheritance and interfaces. 5. To implement the concept of exception handling and multithreading. 6. To develop GUI based application.

Module No.	Module Name	SO mapped	Hrs. /Module
1.	Introduction to Object Oriented Programming: Title: Write a program to implement basic programming constructs like branching and looping. Concepts: Introduction to Java, Object Oriented Concepts, Java Virtual Machine, Basic programming constructs: variables, data types, and operators, expressions, branching and looping. Objective: Objective of this module is to provide students an overview Object Oriented Concepts and Basic Java programming constructs.	SO1	01
2.	Class, Object, Packages and Input /output: Title: Write a program to demonstrate different ways of accepting user input in Java. Concepts: Class, object, data members, member functions, Command Line Argument, Input and output functions in Java, Buffered reader class, Scanner class. Objective: Students will learn how to use different ways to accept user input in Java. Title: Write a program to implement the concept of method overloading and Constructor overloading. Concepts: Introduction to Constructors, Constructor types, Constructor overloading, static members and functions Method overloading. Objective: Students will learn how to apply concept of constructor, constructor overloading, method overloading in Java.	SO2	02

3	Array, String, Vector and Packages: Title: Write a program implement the concept of 2D array and String Manipulation functions in Java. Concepts: Array, Strings, String Buffer Objective: Students will learn how to create and use 1D, 2D array and how to use different string manipulation functions.	SO3	03
	Title: Write a program to implement the concept of vector. Concepts: Introduction to Vector Objective: Students will learn how to create vector, how to add and delete elements in vector.		
	Title: Write a program to implement the concept of package. Concepts: Package, User defined packages Objective: Students will learn how to use inbuilt packages and user defined packages		
4.	Inheritance and Interface: Title: Write a program to implement the concept of Inheritance. Concepts: Inheritance, Types of inheritance, extends keyword, super keyword, Access Modifiers Objective: Students will learn how to use concept of inheritance and types of inheritance in java, Multiple inheritance using interface	SO4	04
	Title: Write a program to implement the concept of Method Overriding. Concepts: Method overriding Objective: Students will learn how to implement Method overriding		
	Title: Write a program to implement the concept of abstract class and abstract method. Concepts: Abstract class and abstract method Objective: Students will learn how to create and use Abstract class and abstract method.		
	Title: Write a program to implement the concept of Interface Concepts: Interface, how to create interface, How to extend interface. Objective: Students will learn how to create interface, How to extend interface.		
5.	Exception handling and Multithreading: Title: Write a program to implement the concept of Exception handling Concepts: Exception handling using try, catch, finally, throw and throws, Multiple try and catch blocks Objective: Students will learn how to apply Exception handling using try, catch, finally, throw and throws.	SO5	03
	Title: Write a program to implement the concept of user defined exception Concepts: User defined exception Objective: Students will learn how to create user defined exception		

	Title: Write a program to implement the concept of Multithreading Concepts: Thread lifecycle, thread class methods, creating threads using extends and implements keyword. Objective: Students will learn how to create Thread by extending Thread class and Implementation Runnable interface		
6.	GUI programming in JAVA: Title: Design form for Admission process management application system. Concepts: Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class. Event handling using event class AWT: working with windows, using AWT controls for GUI design Swing class in JAVA. Objective: Students will learn how to use AWT or SWING to design GUI.	SO6	02
	Title: Study and Implement the concept of JDBC and Perform CRUD Operation on the form created in 6.1 using Java Database Connectivity Concepts: Introduction to JDBC, JDBC-ODBC connectivity, JDBC architecture. Objective: Objective of this module is to provide students an overview JDBC.		

Books:

Textbooks	1.Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
	2.E. Balagurusamy, 'Programming with Java', McGraw Hill Education.
Reference Books	1."JAVA Programming", Black Book, Dream tech Press.
	2.Dietal and Dietal, "Java: How to Program", 8th Edition, PHI
	3.Ivor Horton, "Beginning JAVA", Wiley India.
	4."Learn to Master Java programming", Staredu solutions

Useful learning Links:

1. www.nptelvideos.in
2. www.w3schools.com
3. www.tutorialspoint.com
4. https://starcertification.org/Certifications/Certificate/securejava

Term Work:

Term work shall be awarded based on

1. Students 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.
4. Term work total 25 marks.

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
AIXS34	SAT – IV: Skill-Based Learning (Foreign and Indian Regional Languages-I)	-	01	-	01
SBL Objectives (SOBs):	1.Acquire reading and writing proficiency in the target language 2.Understand the common heritage of, and diversity among, countries that speak the target language. 3.Communicate and interact effectively with citizens of the target cultures.				
SBL Outcomes (SOs):	Upon completion of the course, the learners will be able to: 1.Demonstrate of communicative proficiency in the target language. 2.Write the target language in formal expository prose that impedes communication. 3.Learn through MOOC online courses to adopt hybrid mode of learning				
Guidelines for Skill-Based Learning (SBL):	Each student has to complete any one MOOC course from NPTEL/Coursera/Udemi sites as given in the list.				
Sr No.	Courses offered				
1	Introduction to Japanese Language and Culture				
2	German - I				
3	The Psychology of Language				
4	Spanish Vocabulary: Meeting People, Cultural Experience, Sports, Travel, and the Home, Careers and Social Events, Spanish Vocabulary Project				
5	A Bridge to the World: Korean Language for Beginners, First Step Korean, Learn to Speak Korean 1, The Korean Alphabet: An Introduction to Hangeul				
6	Complete French Course: Learn French for Beginners				
7	Complete German Course: Learn German for Beginners				
8	Spanish 1-4: Beginner, Elementary, Intermediate and Advanced				
9	Complete Japanese Course: Learn Japanese for Beginners				
10	Complete Korean Course: Learn Korean for Beginners				
11	The Complete Russian Language Course				
12	Spoken Sanskrit: Basic and Intermediate Levels				
13	Applied Linguistics				
14	Fundamental Concepts in Sociolinguistics				
15	Introduction to Basic Spoken sanskrit and intermediate level to Basic Spoken Sanskrit				

Online Resources:

Sr. No.	Courses Link
1	https://onlinecourses.nptel.ac.in/noc22_hs84/preview
2	https://onlinecourses.nptel.ac.in/noc22_hs88/preview
3	https://onlinecourses.nptel.ac.in/noc22_hs123/preview

4	https://www.coursera.org/learn/spanish-vocabulary-meeting-people https://www.coursera.org/learn/spanish-vocabulary-cultural-experience https://www.coursera.org/learn/spanish-vocabulary-sports-travel-home https://www.coursera.org/learn/spanish-vocabulary-careers https://www.coursera.org/learn/spanish-vocabulary-project
5	https://www.coursera.org/learn/korean-beginners https://www.coursera.org/learn/learn-korean https://www.coursera.org/learn/learn-speak-korean1 https://www.coursera.org/learn/the-korean-alphabet-an-introduction-to-hangeul
6	https://www.udemy.com/course/complete-french-course/
7	https://www.udemy.com/course/complete-german-course-learn-german-for-beginners/
8	https://www.udemy.com/course/spanish-101-beginning-spanish-spanish-for-beginners/
9	https://www.udemy.com/course/complete-japanese-course-learn-japanese-for-beginners-lvl-1/
10	https://www.udemy.com/course/complete-korean-course-learn-korean-for-beginners-level-1/
11	https://www.udemy.com/course/the-complete-russian-language-course/
12	https://onlinecourses.nptel.ac.in/noc22_hs114/preview
13	https://onlinecourses.nptel.ac.in/noc22_hs85/preview
14	https://onlinecourses.nptel.ac.in/noc22_hs139/preview

Course Code	Course Name	Hours/Duration
INT32	**Internship-II**	**2 -3 Weeks**
Prerequisite:	Fundamental knowledge of program specific tools, instruments, devices and programming languages etc.	
Course Objectives:	1. To get the exposure to Innovation/IPR/ Entrepreneurship/ Startup initiatives. 2. To participate & experience Incubation, Innovation & Business development culture.	
Couse Outcomes:	Upon completion of the course, students will be able to: 1. Learn innovation and entrepreneurial skills to supplement engineering knowledge. 2. Integrate theoretical aspects learned in classes with the practical world. 3. Develop an innovative idea to be processed as a start-up.	
Activity- Innovation/ IPR/ Entrepreneurship	**Supporting Activities to be completed under Internship**	
	1. Participation in Innovation related competitions e.g. Hackathons etc.	
	2. Development of new product/Business Plan/Registration of Start-up	
	3. Participation in all activities of IIC Cell, E-Cell, NISP, IPR Cell like ● IPR workshop/ ● Leadership Talk ● Idea Design ● Innovation/Business Competition	
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.	