B.S. Abdur Rahman®
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2025
Curriculum and Syllabi
(As approved by the 24th Academic Council)
August - 2025

M.Tech.
(Artificial Intelligence & Data Science)

B.S. Abdur Rahman® Crescent Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2025

CURRICULUM AND SYLLABI (I & II Semesters)

(As approved by 24th Academic Council)

August - 2025

M.TECH. ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

(Integrated with LTI Mindtree)

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio- Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION AND MISSION

VISION

The vision of the Department of Computer Science and engineering is to impart quality education, inculcate professionalism and enhance the problem solving skills of the students in the domain of Computer Science and Engineering with a focus to make them industry ready, involve in possible areas of research, to pursue and have continual professional growth.

MISSION

- To equip the students with strong fundamental concepts, analytical capability, programming and problem solving skills.
- To create an academic environment conducive for higher learning through faculty training, self-learning, sound academic practices and research endeavors.
- To provide opportunities in order to promote organizational and leadership.
- Skills in students through various co-curricular and extra – curricular activities.
- To make the students industry ready and to enhance their employability through training and internships.
- To improve department industry collaboration through interaction including participation in professional society activities, guest lecturers and industrial visit.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M. Tech. (Artificial Intelligence and Data Science)

PROGRAMME EDUCATIONAL OBJECTIVES:

- Applying the knowledge acquired in the Computational models, Knowledge Engineering to develop intelligent and Smart systems for the industrial problems.
- Design solutions for real world problems that involve acquiring variety of data from multiple sources using Data Science.
- Imbibing a scientific perspective to pursue research in Artificial Intelligence and Data Science using Mathematical, Engineering, and Computational tools.

PROGRAMME OUTCOMES:

On successful completion of the programme, the graduates will be able to

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to assess, design, and implement ethical, long-term solutions in the discipline of Artificial Intelligence and Data Science.

PO5: Students should be able to apply problem-solving skills and programming concepts to build a variety of solutions in an interdisciplinary domain.

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS 2025

M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)

ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.

iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **“Academic Council”** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare, conduct of co-curricular, extra-curricular events and discipline in the campus.

viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **"Dean of the School"** means the Dean of the School of the department concerned.

x) **"Head of the Department"** means the Head of the Department concerned.

2.0 ADMISSION REQUIREMENTS

2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 BRANCHES OF STUDY

3.1 The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

3.2 Programmes offered

S. No.	Name of the Department	Programmes offered
1.	Aeronautical Engineering	M.Tech. (Avionics)
2.	Civil Engineering	M.Tech. (Structural Engineering)
		M. Tech. (Construction Engineering and Project Management)
3.	Mechanical	M.Tech. (CAD/CAM)

S. No.	Name of the Department	Programmes offered
	Engineering	
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)
		M.Tech. (Artificial Intelligence and Data Science)
7.	Information Technology	M.Tech. (Information Technology)
8.	Computer Applications	MCA
9.	Mathematics	M.Sc. (Actuarial Science)
10.	Physics	M.Sc.(Physics)
11.	Chemistry	M.Sc.(Chemistry)
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology
		M.Sc. Biotechnology
		M.Sc. Microbiology
		M.Sc. Stem Cell Technology
		M.Sc. Clinical Embryology
		M.Tech. Biotechnology
		M.Tech. Food Biotechnology
13.	Commerce	M.Com
14.	Arabic and Islamic Studies	M.A. Islamic Studies

3.3 Eligible entry qualifications for admission to programmes

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.
	M. Tech. (Construction Engineering and Project Management)	B.Tech. in Mechanical / Civil / Electrical and Electronics / Geo Informatics / B Plan / B. Des, and B.Arch.
3.	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
	M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
7.	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2level or equivalent degree in relevant field.
9.	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Stem Cell Technology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		field.
	M.Sc. Clinical Embryology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
	M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.
13. .	M.Com	B.Com. / BBA
14. .	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with Aalim Sanad / Diploma / Certificate in Arabic or Islamic Studies.

4.0. STRUCTURE OF THE PROGRAMME

4.1. The PG. programmes consist of the following components as prescribed in the respective curriculum:

i. Core courses
ii. Elective courses
iii. Laboratory integrated theory courses
iv. Project work
v. Laboratory courses

vi. Open elective courses
vii. Seminar
viii. Mini Project
ix. Industry Internship
x. MOOC courses (NPTEL- Swayam, Coursera etc.)
xi. Value added courses

4.1.1. The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

4.1.2. For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

4.1.3. The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	**Range of credits**
M.Tech.	80 - 86
MCA	80 - 86
M.Sc.	80 - 85
M.Com.	80 - 88
M.A.	80 - 84

4.1.4. Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester.
- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

4.1.5. The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of

Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

4.1.6 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

4.1.7 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

4.1.8 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, alter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

4.1.9. Online courses

Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

Students shall undergo project related online course on their own with the mentoring of the project supervisor.

3.5 Project work

3.5.1 Project work shall be carried out by the student under the supervision of a

faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work and shall re-register in the subsequent semester.

5.0 DURATION OF THE PROGRAMME

5.1. The minimum and maximum period for completion of the programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

5.2 Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.

5.3 Medium of instruction, examinations and project report shall be in English.

6.0 REGISTRATION AND ENROLLMENT

6.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

6.2 Change of a Elective Course

A student can change an enrolled elective course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

6.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

6.4 A student can enroll for a maximum of 36 credits during a semester including Redo / Predo courses.

7.0 BREAK OF STUDY FROM PROGRAMME

7.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

7.1.1 Medical or other valid grounds

7.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

7.1.3 Debarred due to any act of indiscipline

7.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

7.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic

affairs).

7.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

8.0 CLASS ADVISOR AND FACULTY ADVISOR

8.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

8.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

9.0 COURSE COMMITTEE

9.1 Each common theory / laboratory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme

of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

10.0 CLASS COMMITTEE

10.1 A class committee comprising faculty members handling the courses, student representatives and a senior faculty member not handling any courses for that class as chairman will be constituted in every semester:

10.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department

ii) Faculty members of all courses of the semester

iii) All the students of the class

iv) Faculty advisor and class advisor

v) Head of the Department – Ex officio member

10.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

10.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi of courses.

10.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and

shall be presented to the class committee(s) by the concerned course coordinator.

11.0 CREDIT REQUIREMENTS TO REGISTER FOR PROJECT WORK

11.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

11.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightage of Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each

course in semester end examination for the successful completion of the course.

12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.4 Laboratory Integrated Theory (LIT) Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component (for a 4 credit LIT Course). Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

Component	Maximum Marks	Weightage for Final Grade	Mode of Assessment
Theory Component	100	75%	CAT1 (25%) + CAT2 (25%) + SEE (50%)
Practical Component	100	25%	Continuous assessment only
Final Grade Basis	Consolidated	100%	75% Theory + 25% Practical
Pass Requirement	-	-	Minimum 40% in Semester-End Theory Exam (SEE)

Note:

1. Proportionate weightage shall be assigned to LIT courses based on their credit value, whether 2 or 3 credits.
2. In Lab-Integrated Professional Elective courses, the laboratory component shall be assessed by the course faculty.

12.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.6 Industry Internship

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

Mini project work, shall be carried out individually or as a group activity involving a maximum of three students.

Each group shall identify a suitable topic within their domain, either disciplinary or interdisciplinary, based on the students' abilities and in consultation with the faculty mentor. The topic must lead to the development of a small-scale system or application.

The progress of the mini project shall be evaluated through three periodic reviews: two interim reviews and one final review. A project report shall be submitted by the end of the semester. The reviews shall be conducted by a committee of faculty members constituted by the Head of the Department / Dean of the School.

An oral examination (viva voce) shall be conducted as the semester-end examination by an internal examiner approved by the Controller of Examinations, based on the project report.

The weightage for assessment shall be as follows:

• Periodic Reviews: 50%

- 25% by the Project Guide
- 25% by the Review Committee

• Project Report: 20%

• Viva Voce Examination: 30%

The Project shall be carried out individually or as a group activity, involving a maximum of two or three students.

A committee of faculty members, constituted by the Head of the Department / Dean of the School, shall conduct three periodic reviews during the semester to monitor and assess the progress of the project.

At the end of the semester, students shall submit a project report, based on which a semester-end oral examination (viva voce) shall be conducted by an external examiner approved by the Controller of Examinations.

The assessment weightage shall be as follows:

• Periodic Reviews – 50%

- 25% by the Project Guide
- 25% by the Review Committee

• Project Report – 20%

• Viva Voce Examination – 30%

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end

examination for theory component. **There shall be no arrear or improvement examination for lab components**.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

14.1 A student shall earn 100% attendance in the scheduled contact hours (such as lectures, tutorials, labs, etc.) for that course. However, a relaxation of up to 25% in attendance may be granted to account for valid reasons such as medical emergencies, participation in co-curricular or extracurricular activities with prior approval, or other genuine circumstances.

If a student's attendance falls below 75% in a particular course, even after considering the permissible relaxation, they will not be allowed to appear for the semester-end examination in that course. Instead, the student will be awarded an “I” grade (Incomplete) for the course

14.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The

class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

14.3 If a student's attendance in any course falls between 65% and 75% due to medical reasons (e.g., hospitalization, illness) or participation in institution-approved events, they may be granted exemption from the minimum attendance requirement and allowed to appear for the semester-end exam. The student must submit valid documents to the class advisor upon rejoining, with approval from the HoD/Dean. Final approval for **condonation** will be granted by the Vice Chancellor based on the Dean (Academic Affairs)'s recommendation.

14.4 A student who has obtained an "I" grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall **repeat** all the courses of the semester in the subsequent academic year. However, he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

14.5 The student awarded "I" grade, shall enroll and repeat the course when it is offered next. In case of "I" grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

14.6 A student who is awarded "U" grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to **redo** the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains "U" grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of

arrear examination.

14.7 If a student with "U" grade, who **prefers to redo** any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier "U" grade and continuous assessment marks shall continue.

15.0 REDO / PRE-DO COURSES

15.1 A student can register for a maximum of three redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the concerned department, based on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

15.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is **no provision for any substitute examination and withdrawal from a redo course**.

15.3 A student shall be permitted to pre-do a course offered by the concerned department, provided it does not affect the regular semester class schedule. Such permission shall be granted based on the availability of faculty members, the maximum permissible credit limit of the semester, and the student's fulfillment of the necessary prerequisites for the course. The proposal shall be recommended by the Dean of the School and the Head of the Department, and shall require final approval from the Dean (Academic Affairs).

16.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

16.1 All assessments of a course shall be made on absolute marks basis. The class committee without the student members shall meet to analyse the performance of students in all assessments of a course and award letter grades following the relative grading system. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-
I	-
PA	-
FA	-

"W"- denotes withdrawal from the course

“I” - denotes “Incomplete” ie. inadequate attendance in the course and prevention from appearance of semester end examination

“U” - denotes unsuccessful performance in the course.

“PA” - denotes the ‘Pass’ of the zero credit courses.

“FA” - denotes the ‘Fail’ of the zero credit courses.

16.2 A student who earns a minimum of five grade points (‘E’ grade) in a course is declared to have successfully completed the course. Such a course cannot be **repeated by the student for improvement of grade**.

16.3 Upon awarding grades, the results shall be endorsed by the chairman of the class committee and Head of the Department / Dean of the School. The Controller of Examinations shall further approve and declare the results.

16.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee, through proper application to the Controller of Examinations. Subsequently, the

Head of the Department / Dean of the School offered the course shall constitute a revaluation committee consisting of chairman of the class committee as convener, the faculty member of the course and a senior faculty member having expertise in that course as members. The committee shall meet within a week to revalue the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

16.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from the first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course,

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I”, "W", “PA” and **“FA”** grades are excluded for calculating GPA.

"U", “I”, "W", “PA” and **“FA”** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks shall be as follows:

Percentage equivalent of marks = CGPA X 10

16.6 After successful completion of the programme, the degree shall be awarded to the students with the following classifications based on

CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the prescribed period of 8 semesters for all students (except lateral entry students) and 6 semesters for lateral entry students
First Class	6.50 and above and completing the programme within a maximum of 10 semesters for all students (except lateral entry students) and 8 semesters for lateral entry students
Second Class	Others

16.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the UG programme within the minimum prescribed period of study (except clause 7.1.1)

16.6.2 Eligibility for First Class

- A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 7.1.1)

16.6.3 The students who do not satisfy clause 16.6.1 and clause 16.6.2 shall be classified as second class.

16.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

17.0 SUPPLEMENTARY EXAMINATION

Final year students and passed out students can apply for

supplementary examination for a maximum of **three** courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of **three** courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

18.0 DISCIPLINE

18.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

18.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the Head of the Department / Dean of the School concerned shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

19.0 MULTI ENTRY AND MULTI EXIT (MEME) FRAMEWORK *

In accordance with the provisions of the National Education Policy (NEP) 2020, the programme shall support a Multi Entry – Multi Exit (ME-ME) framework to provide flexibility in the academic pathway of students.

***At present (AY 2025-26), it is applicable only for all M.Tech. Programmes.**

19.1. Exit Option:

19.1.1 Credit Requirement for Award of M.Tech. Degree

To qualify for the award of a M.Tech. degree from the Institute, a student must successfully complete the total credit requirements as prescribed in the approved curriculum of the respective programme. The specific credit requirements are determined by the programme curriculum.

19.1.2 Provision for Multiple Exit

In alignment with NEP 2020 guidelines, the Institute provides students enrolled in postgraduate programmes with the option of multiple exits,

subject to the following conditions:

a. Exit at the End of First Year

Students may choose to exit the programme at the end of the first year, provided they have fulfilled the prescribed academic requirements.

b. Application for Exit

A student intending to exit must submit a formal written application in the prescribed format at least **eight weeks prior to the scheduled end of the academic year.**

c. Departmental Recommendation

1. Upon receipt of the application, the concerned Department shall evaluate the academic record of the student and recommend the award of a **Post Graduate Diploma**, based on the credits earned.

2. In the case of arrear courses, the post graduate diploma will be conferred only after successful clearance of all pending arrears.

d. Notification of Completion

Once a student has fulfilled the requirements for the award of post graduate diploma, the Department shall notify the same to controller of examinations for further processing and issuance.

19.1.3 Award of Qualifications under Multiple Exit Scheme

Post graduate diploma: Awarded after successful completion of the first year, subject to earning the prescribed cumulative credits as per the respective programme curriculum (e.g., 44 credits from the first year) along with 3 credits of Skill Based Courses.

19.1.4 Conditions Governing Exit

1. The multiple exit facility is intended strictly for **genuine and exceptional circumstances,** such as prolonged illness, or securing an employment opportunity necessitating a temporary withdrawal from the programme.

2. Students opting for a temporary exit after the first year must obtain **prior approval from the Registrar through Dean (Academics),** based on the recommendation of the respective Head of the Department.

19.1.5 Expectation of Programme Continuity

While the option for multiple exits exists, it is generally expected that students admitted to a post graduate programme shall pursue their studies continuously until completion of the final degree requirements.

19.2. Entry Option:

Students seeking re-entry into the programme (multi-entry) must submit an application through the proper channel at the beginning of the odd semester. Admission shall be subject to fulfilment of institutional guidelines, credit mapping, and availability of seats.

19.3. Credits Requirement for the Certifications

Name of the Certificate Programme	Required Credits
Post graduate Diploma (Level 6.5 as per NEP 2020)	40* - 45

* The minimum number of credits that a student must earn (as per the respective curriculum) in order to get the above certification program

20.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

20.1 A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the maximum period of 8 semesters from the date of admission, including break of study.
ii. No disciplinary action is pending against him/her.
iii. Enrolled and completed at least one value added course.
iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

20.2 The award of the degree must have been approved by the Institute.

21.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

REGULATIONS 2025

CURRICULUM & SYLLABI FOR

M. TECH. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)

(Integrated with LTI Mindtree)

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MAF 6185	Statistical Methods for Data Science	3	1	0	4
2.	PCC	AIF 6101	Programming for Data Science	3	0	0	3
3.	PCC	AIF 6102	Applied Machine Learning	3	0	0	3
4.	PCC	AIF 6103	Data Engineering	3	0	0	3
5.	PEC		Professional Elective 1	3	0	0	3
6.	PCC	AIF 6104	Data Science Lab	0	0	4	2
7.	PCC	AIF 6105	Applied Machine Learning Laboratory	0	0	4	2
			Credits				**20**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	ES	GEF 6201	Research Methodology and IPR for Engineers	2	0	0	2
2.	PCC	AIF 6201	Artificial Intelligence and Deep Learning	3	0	0	3
3.	PCC	AIF 6202	Generative AI with Large Language Models	3	0	2	4
4.	PCC	AIF 6203	Generative Adversarial Networks	3	0	0	3
5.	PEC		Professional Elective 2	3	0	0	3
6.	PEC		Professional Elective 3	3	0	0	3
7.	PCC	AIF 6204	Large Language Models Laboratory	0	0	2	1

8.	HS	ENF 6281	Professional Communication	0	0	2	1
9.	PROJ	AIF 6205	Mini Project	0	0	6	3
			Credits				**23**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	OEC		Open Elective	3	0	0	3
2.	Internship	AIF 7101	Industry Internship *	0	0	4	2
3.	PROJ	AIF 7102	Project Work (Phase I)	0	0	28	14#
4.			MOOC Course				
			Credits				**5**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PROJ	AIF 7102	Project Work (Phase II)	0	0	36	18
			Credits	**14 + 18 = 32**			

Overall Total Credits – 80

* Industrial training will be undertaken during first year summer vacation for 30 days. The credit will be awarded in the 3rdSemester.

Credits for Project Work Phase I to be accounted along with Project Work Phase II in IV Semester

LIST OF PROFESSIONAL ELECTIVE COURSES

Sl. No.	Course Code	Course Title	L	T	P	C
		SEMESTER I				
1.	AIFY 01	Application Architecture and Deployment	3	0	0	3
2.	AIFY 02	SQL for Data Science	3	0	0	3
3.	AIFY 03	Cloud Computing	3	0	0	3
4.	AIFY 04	Exploratory Data Analytics	3	0	0	3
5.	AIFY 05	Business Intelligence	3	0	0	3
6.	AIFY 06	Data Visualization	3	0	0	3
		SEMESTER II				
1.	AIFY 11	Ethics in Data Science	3	0	0	3
2.	AIFY 12	Computer Vision	3	0	0	3
3.	AIFY 13	Natural Language Processing	3	0	0	3
4.	AIFY 14	Security for Data Science	3	0	0	3
5.	AIFY 15	Soft Computing Techniques	3	0	0	3
6.	AIFY 16	Artificial Neural Networks	3	0	0	3
7.	AIFY 17	Distributed, Parallel and Spatial Databases	3	0	0	3
8.	AIFY 18	Intelligent Information Retrieval	3	0	0	3
9.	AIFY 19	Knowledge Representation and Reasoning	3	0	0	3
10.	AIFY 20	Risks and Decision Making for Data Science and Artificial Intelligence	3	0	0	3
11.	AIFY 21	Robotics and Intelligent Systems	3	0	0	3
12.	AIFY 22	Social Network Analysis and Mining	3	0	0	3
13.	AIFY 23	Edge Engineering for Internet of Things Systems	3	0	0	3

SEMESTER I

MAF 6185	STATISTICAL METHODS FOR DATA	L	T	P	C
SDG: 4	SCIENCE	3	1	0	4

COURSE OBJECTIVES:

COB1: To understand relationships between variables through correlation and regression analysis.

COB2: To introduce parametric hypothesis testing for comparing population parameters.

COB3: To explore non-parametric tests for hypothesis testing without distributional assumptions

COB4: To impart knowledge of experimental designs for analyzing factor effects and interactions.

COB5: To develop skills in monitoring and improving quality using statistical process control tools.

MODULE I CORRELATION AND REGRESSION 9+3

Bi-variate data – Correlation and Regression coefficients and their relation, properties – Effect of change of origin and scale on correlation coefficient, Linear regression, Association and Independence of attributes.

MODULE II PARAMETRIC TEST 9+3

Parametric tests – One sample and two sample tests for means and proportions of large samples (z-test) – One sample and two sample tests for means of small samples (t-test) – F-test for two sample standard deviations.

MODULE III NON PARAMETRIC TEST 9+3

Chi-square test for single sample standard deviation – Chi-square tests for independence of attributes and goodness of fit – Sign test for paired data – Rank sum test – Kolmogorov-Smirnov test for goodness of fit – Mann-Whitney U test and Kruskal Wallis test – One sample run test.

MODULE IV DESIGN OF EXPERIMENTS 9+3

Basic principles of experimental design – Randomization, replication, and local control –

Analysis of variance (ANOVA) – One-way classification – Completely Randomized Design (CRD) – Two-way classification – Randomized Block Design (RBD) – Latin Square Design (LSD) – Factorial experiments – Confounding and interaction effects – Applications in quality control and business decision-making.

MODULE V STATISTICAL QUALITY CONTROL 9+3

Quality improvement and statistics – Statistical quality control – Statistical process control – Control charts – Design of control charts – Analysis of patterns on control charts – $\bar{X}$ chart, R chart and S chart – Process and product control – Attribute charts – p, np and c charts – Control charts performance.

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. S.C Gupta, “Fundamentals of Statistics”, Himalayan Publication House, 8th edition, 2024.
2. T. Veerarajan, “Probability and Statistics”, 3rd Edition, Tata McGraw-Hill, New Delhi, 2008.
3. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences”, 10th Edition, Cengage Learning, New Delhi, 2022/2025.

REFERENCES:

1. Walpole R.E, K.E. Ye and R.H. Myers, “Probability and Statistics for Engineers and Scientists”, 9th Edition, Pearson, 2016.
2. Peter Bruce, Andrew Bruce and Peter Gedeck, “Practical Statistics for Data Scientists”, 2nd Edition, O’Reilly Media Publisher, 2020.
3. P.N. Arora and Sumeet Arora, “Compressive Statistical Methods”, 1st Edition, S. Chand, New Delhi 2010.

COURSE OUTCOMES: At the end of the course students will be able to

CO1: correlate the data and compute regression lines.

CO2: conduct z, t, and F-tests for means, proportions, and variances under parametric assumptions.

CO3: perform non-parametric tests such as Chi-square, sign, rank-sum, and run tests for various data types.

CO4: design and analyze experiments using ANOVA, CRD, RBD, LSD, and factorial methods including confounding effects.

CO5: construct and interpret control charts for variables and attributes in quality control applications.

Board of Studies (BOS):
17th BOS of Department of Mathematics and Actuarial Science held on 23.06.2025.

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	L	M
CO2	H	L	H	L	M
CO3	H	L	H	L	M
CO4	H	M	H	M	H
CO5	H	M	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4 – Quality Education: Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Learning of statistical methods will lead to knowledge of solving problems in data science.

AIF 6101	PROGRAMMING FOR DATA SCIENCE	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the fundamental syntax and semantics of Python programming essential for data science applications.

COB2: Learn foundational data analysis concepts using Python's scientific computing libraries.

COB3: Explore real-world datasets and perform exploratory data analysis using visualization libraries.

COB4: Understand the core concepts of regression and classification techniques with key evaluation metrics.

COB5: Focus on various unsupervised and advanced machine learning techniques to extract hidden insights and make data-driven decisions.

MODULE I PYTHON DATA STRUCTURES 9

Data Structures Overview – Arrays and Array-Based Structures – Dictionaries, Sets, and Multisets – Stacks and Queues – Data Transfer Objects – Strings and Concatenation in Python – Object-Oriented Programming – Polymorphism – Object-Oriented Design Principles – Core Python Libraries – Exploratory Data Analysis (EDA) in Python – Machine Learning with Python – Web Scraping: Scrapy and Django

MODULE II PYTHON LIBRARIES 9

Basic Data Types and Variables – Lists and Arrays – Stacks and Queues using Lists – Strings and String Operations – Functions and Data Transfer Objects- Class Design Basics – Using Python Libraries -NumPy, Pandas – Basic Data Analysis with Pandas – Introduction to Web Scraping-Scrapy Basics.

MODULE III VISUALIZATION 9

Introduction to Matplotlib – Matplotlib: Figures and Axes Basics – Customizing Figures and Axes in Matplotlib – Styling and Aesthetics in Matplotlib-Colors- Legends- Styles – Advanced Plotting with Matplotlib – Introduction to Seaborn – Seaborn: Scatter and Distribution Plots – Seaborn- Distribution Plots – Categorical Plots in Seaborn: Overview and Plot Types – Categorical Plots: Statistics within Categories – Categorical Plots: Distributions within

Categories – Seaborn: Comparison, Grid, and Matrix Plots.

MODULE IV REGRESSION AND CLASSIFICATION 9

Introduction to Linear Regression and Cost Functions – Gradient Descent and Simple Python Implementation – Scikit-Learn Overview and Model Interpretation – Polynomial Regression: Theory- Features and Evaluation – Bias-Variance Trade-Off and Polynomial Degree Selection – Feature Scaling and Cross Validation Basics – Regularization: Ridge- Lasso and Elastic Net – Feature Engineering and Data Preparation – Handling Missing Data and Outliers – Encoding Categorical Data and Grid Search Optimization – Introduction to Logistic Regression and Model Training – Logistic Regression: Classification Metrics and Evaluation.

MODULE V UNSUPERVISED AND ADVANCED MACHINE LEARNING 9

Introduction to K-Nearest Neighbors (KNN) - Choosing K and Python Implementation – Introduction to Support Vector Machines (SVM) – Hyperplanes, Kernels, and Mathematics – SVM with Scikit-Learn - Classification and Regression – Introduction to Decision Trees and Gini Impurity – Decision Tree Construction and Python Coding – Introduction to Random Forests and Hyper parameters – Random Forest: Classification – Principal Component Analysis (PCA)

L – 45; Total Hours: 45

TEXT BOOKS:

1. Ozdemir, S. “Principles of Data Science,” Third edition, Packt Publishing,” ISBN 978-1837636303, 2024.
2. Damji, J. S., Wenig, B., Das, T., & Lee, D. “Learning Spark: Lightning-fast data analytics,” Second edition, O’Reilly Media. ISBN: 978-1492050049,2020

REFERENCES:

1. Motwani, B. “Data Analytics Using Python,” Wiley India. ISBN-13: 978-8126502950, 2020.
2. Fuentes, A. “Become a Python data analyst: Perform exploratory data analysis and gain insight into scientific computing using Python,” First edition, Packt Publishing, ISBN 978-1789531701, 2018.

COURSE OUTCOMES:

CO1: Utilize Python's built-in data structures to efficiently manage and manipulate data.

CO2: Identify data analysis techniques to summarize and interpret datasets.

CO3: Apply real-time datasets and visualize insights using Python libraries.

CO4: Evaluate different regression and classification models to determine the most appropriate solution for a given problem.

CO5: Create integrated machine learning solutions by applying unsupervised and advanced techniques to real-world challenges.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	-	M	-	H
CO2	M	L	M	-	L
CO3	M	M	M	-	H
CO4	H	L	H	-	M
CO5	H	L	H	L	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:
Design and implement data pipelines and analytical models that can be applied in sectors such as smart manufacturing, urban infrastructure, and transport, aligning technological advancement with sustainable development.

AIF 6102	APPLIED MACHINE LEARNING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To provide strong foundation in supervised learning, enabling them to implement and analyze regression and classification models

COB2: To develop students' ability to design, implement, and optimize neural networks for binary and multiclass classification using TensorFlow.

COB3: To equip with techniques for managing and learning from real-world datasets, including cross-validation, data augmentation, and regularization.

COB4: To introduce unsupervised learning techniques including clustering, anomaly detection, and recommender systems.

COB5: To develop skills in designing and evaluating recommender systems using collaborative filtering, content-based methods, and reinforcement learning.

MODULE I SUPERVISED LEARNING 9

Machine learning and its types-Supervised machine learning-Unsupervised machine learning -Hybrid machine learning-Activation functions-Cost function and gradient descent for multiple linear regression –implement machine learning models - learning curve - feature engineering –apply polynomial regression - logistic regression model for classification - logistic regression –Implement the cost function and gradient descent for logistic regression - overfitting - regularization - regression and classification models. Tests-and-Visualization-Histograms - Box Plots - use of frequency distributions – mean comparisons - cross tabulation - statistical inferences using chi square - t-test and ANOVA - Outlier Analysis and Detection - outlier analysis - density based and distance based.

MODULE II ADVANCED LEARNING ALGORITHMS 9

Neural network for binary classification of handwritten digits using TensorFlow – Implement Neural network in Python - neural network computations: parallel processing and prediction –build neural network to perform multi-class classification of handwritten digits in TensorFlow - categorical cross- entropy loss functions - activation functions – ReLu - linear - sigmoid - SoftMax in neural network - advanced Adam optimizer.

MODULE III LEARNING WITH DATA **9**

Data set - cross-validation - test datasets - techniques - regularization - performance - bias-variance in deep learning - Andrew Ng's in neural networks - machine learning - train - evaluate - tune - Apply data-centric AI - data synthesis or data augmentation –Build decision trees and tree ensembles - random forest and XGBoost - boosted trees - predictions - neural network or tree ensemble models.

MODULE IV UNSUPERVISED LEARNING **9**

Unsupervised learning techniques. - clustering and anomaly detection –Build Recommender systems - collaborative filtering approach - content-based deep learning method - Deep reinforcement learning model - Implement K-mean clustering - Implement anomaly detection - supervised learning or anomaly detection.

MODULE V RECOMMENDER SYSTEMS **9**

Build a recommender system - collaborative filtering - content-based deep learning method - deep reinforcement learning model (Deep Q Network)." - Histograms - Box Plots - use of frequency distributions – mean comparisons - cross tabulation - statistical inferences using chi square - t-test and ANOVA - Outlier Analysis and Detection - outlier analysis - density based and distance based.

L – 45; Total Hours: 45

TEXT BOOK:

1. D. Forsyth, Applied Machine Learning, 1st ed. Cham, Switzerland: Springer, ISBN: 978- 3-030-18114-3,2019.

REFERENCES:

1. H. Li, Machine Learning Methods. Singapore: Springer Nature Singapore, ISBN: 978-981-99-1850-8,2023

2. R. Nageswara Rao, Machine Learning in Data Science Using Python, 1st ed. Hyderabad, India: Dreamtech Press Wiley India imprint, ISBN-10: 9391540465; ISBN-13: 978-9391540463. 2022.

COURSE OUTCOMES:

CO1: Implement multiple linear and logistic regression models using gradient descent.

CO2: Implement basic neural networks in Python.

CO3: Apply cross-validation and regularization techniques to prevent overfitting.

CO4: Design recommender systems using collaborative filtering and deep learning approaches.

CO5: Build basic recommender systems using collaborative and content-based filtering.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	H	M
CO2	M	L	H	H	M
CO3	H	L	H	M	H
CO4	H	M	H	H	H
CO5	M	L	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: Applied machine learning enables industries to become more efficient, innovative, and sustainable. Students learn to develop intelligent systems, such as recommender systems and predictive models, which foster innovation and support modern infrastructure. It enables industries to become more efficient, innovative and sustainable.

AIF 6103	DATA ENGINEERING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand and differentiate various data types and formats.

COB2: Explore data ingestion techniques.

COB3: Perform data profiling and visualization.

COB4: Examine storage and retrieval strategies.

COB5: Analyze data lineage and migration.

MODULE I DATA TYPES AND FORMATS 9

Introduction to Data Types and Formats - Types of Data - Structured vs. Unstructured Data - Formats of Data - Semi Structured Data - Data Type Conversion and Transformation - Data Serialization - Choosing the Right Data Type and Format - Tools and Technologies for Data Types and Formats.

MODULE II DATA INGESTION TECHNIQUES 9

Introduction to Data Ingestion - Data-Integration versus Data-Ingestion - Streaming Data Ingestion - Batch Data Ingestion - Hybrid Data Ingestion - Data Ingestion vs. Data Integration - Data Ingestion Challenges - Tools and Solutions for Data Ingestion - StreamSets DataOps Platform - Benefits of Data Ingestion - Data Ingestion Framework.

MODULE III DATA PROFILING - VISUAL REPRESENTATION USING TOOLS 9

Data Profiling and Visualization- Exploratory Data Analysis (EDA) with Pandas- Market Analysis with EDA- Data Analytics Overview- Data Analytics with Python- Business Intelligence Tools- Data Retrieval & Cleaning- Feature Engineering & EDA- Inferential Statistics - Hypothesis Testing- Descriptive Statistics- Populations- Samples & Variables- Statistical Methods for Data Description, Real-World Applications of Descriptive Statistics- Handling Missing Data.

MODULE IV STORAGE AND RETRIEVAL METHODS 9

Introduction to Storage and Retrieval - Types of Data and Storage Methods - Local vs. Distributed Storage & Retrieval - Hardware Aspects of Storage & Retrieval - Choosing Storage Methods - Data Partitioning and Sharing - Data Replication and Redundancy - Data Compression and Encoding - Data Archiving and Retrieval - Backup and Disaster Recovery - Data Lifecycle Management. Data Duplication: Introduction and Impact on Storage Efficiency.

MODULE V DATA LINEAGE ANALYSIS 9

Introduction to Data Lineage Analysis - Building a Data Flow - ETL (Extract, Transform, Load) Process - Usage of Data Warehouse - Edge Intelligence in Data Flow - Understanding Data Lineage – Working of Data Lineage - Benefits of Data Lineage - Data Lineage Tool Features. Data Migration – Introduction, Techniques and Use Cases.

L – 45; Total Hours:45

TEXT BOOKS:

1. Reis, J., & Housley, M. Fundamentals of Data Engineering: Plan and Build Robust Data Systems. O'Reilly Media. ISBN 978-1098108304, 2022.
2. McKinney, W. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter 3rd edition. O'Reilly Media. ISBN 978-1098104030, 2022.

REFERENCES:

1. Charles M. Judd, Data Analysis: A Model Comparison Approach to Regression, ANOVA, and Beyond ,3rd edition, Routledge, ISBN: 978-1138892286, 2017.
2. Pierre-Yves Bonnefoy, Emeric Chaize, Raphaël Mansuy, & Mehdi Tazi, The Definitive Guide to Data Integration ,1st edition, Packt Publishing, ISBN: 978-1805123668, 2024.

COURSE OUTCOMES:

CO1: Classify different data types, formats, and structures, and select suitable conversion, transformation, and serialization techniques.

CO2: Implement streaming, batch, and hybrid data ingestion techniques using appropriate tools and frameworks.

CO3: Analyze datasets using exploratory data analysis (EDA) and descriptive statistics to derive meaningful insights.

CO4: Evaluate storage and retrieval strategies for efficiency, scalability, and fault tolerance in different data environments.

CO5: Design data lineage workflows and migration strategies to maintain data integrity and traceability.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	-	M	-	L
CO2	M	-	H	-	H
CO3	H	M	H	-	H
CO4	M	-	H	M	M
CO5	H	M	M	H	L

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:
Promotes scalable and real-time data infrastructure for modern industries and smart systems and encourages robust data storage systems to ensure industry resilience and innovation in IT infrastructure

AIF 6104	DATA SCIENCE LABORATORY	L	T	P	C
SDG: 9		0	0	4	2

COURSE OBJECTIVES:

COB1: To introduce hands-on data analysis using Python-based tools and libraries.

COB2: To explore real-world datasets and perform data preprocessing, cleaning, and transformation.

COB3: To learn statistical and visualization techniques for exploratory data analysis.

COB4: To overview basic GAN models using deep learning libraries.

COB5: To focus on various advanced data science and machine learning applications in research and industry.

LIST OF EXPERIMENTS

Case Study 1

Present different techniques employed to do outlier analysis, handling missing data, feature engineering, feature importance and improving the accuracy of the model both from a classifier as well as a regressor. Use any sample data and present it in a well-structured presentation.

Sample Dataset: UCI Housing Dataset, Titanic, Kaggle's Telco Customer Churn

Case Study 2

Present the findings on different activation functions used and methods to improve the accuracy of the model using neural networks. Clearly articulate the advantages and disadvantages of each activation function. Use any sample data and present the view point in a well-structured presentation.

Sample Dataset: MNIST, Boston Housing, Fashion-MNIST

Case Study 3

Present the findings on different techniques of anomaly detection and k means clustering. Use any sample data and present the POV in a well-structured presentation

Sample Dataset: Network intrusion detection dataset, credit card fraud dataset, Iris dataset

Case Study 4

Present on how to generate synthetic data using GANs. Assume a sample dataset from an IOT enabled machine where the failure rates are minimal. Dataset: Simulated IoT sensor data, NASA turbofan engine dataset

Sample Dataset: Simulated IoT sensor data, NASA turbofan engine dataset

Case Study 5

Present on Style related GANS. Explore the earliest models to the current models. Articulate the successive improvements in the models. Articulate the future of GANs in generating realistic images.

Sample Dataset: FFHQ dataset (for human faces),

Case Study 6

Present the POV on GANs used for Deep Fakes. Articulate how to identify the Deep Fake from the original.

Sample Dataset: Face Forensics++, Deepfake Detection Challenge dataset

P – 60; Total Hours: 60

TEXT BOOKS:

1. A. L. Muddana and S. Vinayakam, “Python for Data Science”, 1st ed. Springer International Publishing, ISBN 978-3031524721, 2024.

COURSE OUTCOMES:

CO1: Utilize techniques for detecting and handling outliers and missing values to improve data quality.

CO2: Identify the role and effectiveness of various neural network activation functions in different learning contexts.

CO3: Apply synthetic data generation pipelines using generative adversarial networks for rare-event modeling in IoT-enabled systems.

CO4: Evaluate the performance of regression and classification models using accuracy metrics and model tuning methods

CO5: Create comprehensive presentations that communicate the application of data science and generative modeling techniques to real-world datasets

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	L	M
CO2	L	L	H	L	M
CO3	H	M	H	M	H
CO4	H	M	H	M	H
CO5	M	H	H	M	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The Data Science fosters innovation by developing advanced analytical solutions, promoting industry–academia collaboration, and building robust digital infrastructure to support sustainable industrial growth and technological advancement.

AIF 6105	APPLIED MACHINE LEARNING LABORATORY	L	T	P	C
SDG: 4		0	0	4	2

COURSE OBJECTIVES:

COB1: Provide students with practical exposure to real-world machine learning workflows.

COB2: Perform data preprocessing, exploratory data analysis, feature engineering, model building and evaluation.

COB3: Handle real-life challenges like imbalanced data and overfitting.

COB4: To gain hands-on experience with diverse datasets, machine learning tools, and model evaluation strategies.

COB5: Explore ML techniques to real-world business and technical problems.

PRACTICALS **P: 60**

List of Experiments

Case Study 1 – Mobile Price Prediction

1. Analyze “Mobile Price" dataset by doing feature analysis, perform outlier and missing data analysis towards building a refined dataset. Data is available at: https://www.kaggle.com/datasets/iabhishekofficial/mobile-price-classification/data
2. Build machine learning models to predict the actual price of the new mobile based on other given features like RAM, Internal Memory.
3. Calculate the prediction accuracy of the models used in Experiment 2 and do comparative analysis among them to identify the best technique.

Case Study 2 –Second hand Car Price Prediction

4. Analyze "Second Hand Car Prediction Price" dataset by doing feature analysis. Data is available at: https://www.kaggle.com/datasets/sujithmandala/second-hand-car-price prediction.
5. Perform data preprocessing step on the above dataset: perform outlier and missing data analysis towards building a refined dataset.
6. Perform Feature Engineering towards building new features. Build machine learning models to predict the price of the car based on other given features like Brand, Model, Year, Fuel Type.

7. Calculate the prediction accuracy of the models used in Experiment 6 and do comparative analysis among them to identify the best technique.
8. Plot the features (actual price and predicted price) in a scatter plot to understand the variation.

Case Study 3 - Marketing Campaign Positive Response Prediction

9. Analyze all the features in "Marketing Campaign Positive Response Prediction" dataset.
10. Handle outliers, missing data, visualize using box plot/statistical tools. Data is available at: https://www.kaggle.com/datasets/sujithmandala/marketing-campaign-positive-response prediction
11. Find the numerical and categorical features.
12. Perform Feature Engineering towards building new features which are more impactful than the existing ones. Build the correlation matrix and show visually the relationship among various features.
13. Build machine learning model/s to predict the result of marketing campaign based on other given features like customer details, gender, annual income.
14. Compare prediction accuracy of the models used in Experiment 13.
15. Check for imbalanced classes, overfitting, and apply data bias in the above two datasets. and apply SMOTE/under sampling/cost sensitive learning, cross validation, regularization etc.

P – 60; Total Hours: 60

TEXT BOOK:

1. Dudek, G. (Ed.). “Applied Machine Learning II”. MDPI. ISBN 978-3-7258-0073-5, 2024.

COURSE OUTCOMES:

CO1: Perform exploratory data analysis and feature analysis on real-world datasets.

CO2: Execute data cleaning, outlier detection, and missing data treatment to create high-quality datasets for machine learning tasks.

CO3: Apply feature engineering techniques to create new features and build correlation matrices to evaluate feature relationships.

CO4: Analyze machine learning models for classification and regression problems using appropriate features and algorithms.

CO5: Compare the machine learning techniques.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	L	M	M	M
CO2	M	L	M	M	M
CO3	M	L	H	M	H
CO4	H	M	H	H	H
CO5	M	M	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement:
Development of ML-driven educational platforms and resources enhances learning experiences and accessibility. It also provides opportunities for students and researchers to engage in cutting-edge ML projects, fostering skill development.

SEMESTER II

GEF 6201	RESEARCH METHODOLOGY AND IPR FOR	L	T	P	C
SDG: 4, 8, 9	ENGINEERS	2	0	0	2

COURSE OBJECTIVES:

COB1: To apply a perspective on research

COB2: To select the appropriate statistical techniques for hypothesis construction and methods of data analysis and interpretation

COB3: To analyze the research design by using optimization techniques.

COB4: To describe the research findings as research reports, publications, copyrights Patenting and Intellectual Property Rights.

MODULE I RESEARCH PROBLEM FORMULATION AND RESEARCH DESIGN **8**

Research - objectives – types - Research process, solving engineering problems -Identification of research topic - Formulation of the research problem, literature survey and review. Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle, Design of experimental setup, Mathematical modeling - Simulation, validation, and experimentation.

MODULE II DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA **8**

Sources of Data, Use of the Internet in Research, Types of Data - Research Data Processing and analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision –limitations, Application of Computer in Research- Importance of statistics in research - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays.

MODULE III OPTIMIZATION TECHNIQUES **6**

Use of optimization techniques - Traditional methods – Evolutionary Optimization Techniques. Multivariate analysis Techniques, Classifications, Characteristics,

Applications - correlation and regression, Curve fitting.

MODULE IV INTELLECTUAL PROPERTY RIGHTS 8

The Research Report - Purpose of the written report - Synopsis writing - preparing papers for International Journals, Software for paper formatting like LaTeX/MS Office, Reference Management Software, Software for detection of Plagiarism – Thesis writing, - Organization of contents - style of writing- graphs, charts, and Presentation tool - Referencing, Oral presentation, and defense - Ethics in research - Patenting, Intellectual Property Rights - Patents, Industrial Designs, Copyrights, Trade Marks, Geographical Indications-Validity of IPR, Method of Patenting, procedures, Patent Search

L – 30; Total Hours: 30

TEXT BOOKS:

1. Ganesan R., “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
2. George E. Dieter., “Engineering Design”, McGraw Hill – International edition, 2020.
3. Kothari C.R., “Research Methodology” – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2020.
4. Kalyanmoy Deb., “Genetic Algorithms for optimization”, Kangal report, No.2001002.
5. Rajkumar S. Adukia, “Handbook on Intellectual Property Rights in India”, TMH Publishers, 2020.

REFERENCES:

1. Holeman, J.P., ”Experimental methods for Engineers, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2.Govt. of India, ”Intellectual Property Laws; Acts, Rules & Regulations”, Universal Law Publishing Co. Pvt. Ltd., New Delhi 2020.
3. R Radha Krishnan & S Balasubramanian, “Intellectual Property Rights”. 1st Edition, Excel Books, 2012.
4.Derek Bosworth and Elizabeth Webster. “The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2013

COURSE OUTCOMES:

At the end of the course, the student should be able to:

COB1: Formulate the research problem

COB2: Design and Analyse the research methodology

COB3: Analyse and interpret the data to construct and optimize the research hypothesis

Board of Studies (BoS) : 20th BoS of Civil held on 08.07.2025

Academic Council: 24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	**I**	**2**	**1**
CO2	2	3	**3**	**2**
CO3	3	2	2	3
CO4	**1**	3	2	**2**

Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4: Analysis and design of core field design promotes engineering skills and quality education.

Statement: This course enables the student to analyze the existing technology for further solution and its qualitative measures in terms of societal requirements.

SDG 8: Development of new technologies with core field design provides sustainable economic growth and productive employment.

Statement: To apply the hybrid techniques and concepts for different applications provides sustainable economic growth and productive employment.

SDG 9: Creative and curiosity of core field design fosters innovation and sustainable industrialization.

Statement: This course plays major roles through innovative ideas in industry towards modern infrastructures and sustainability.

AIF 6201	ARTIFICIAL INTELLIGENCE AND DEEP	L	T	P	C
SDG: 9	LEARNING	3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the basics of deep learning, its history, key maths, and neural network structures.

COB2: Apply CNN and RNN models to solve image, text, and time-based problems.

COB3: Analyze model results and improve them using tuning, regularization, and optimization methods.

COB4: Evaluate different deep learning frameworks for suitability in specific application domains.

COB5: Create complete AI projects using transfer learning, multi-task learning, and proper project steps.

MODULE I INTRODUCTION TO DEEP LEARNING 9

Introduction to the Evolution of AI Techniques – Perceptron Concept and Simulation using Predicate Logic and Inference Techniques – Forward and Backward Chaining – Introduction to Neural Networks and Deep Learning – Artificial Neurons – Neural Network Architecture – Forward and Backpropagation – Loss Functions – Regularization – Training Deep Networks – Linear Algebra – Calculus and Statistics – Probability – Optimization Techniques – Discrete Mathematics – Advanced Math Concepts – TensorFlow Introduction – PyTorch Introduction – Keras Introduction – Comparative Study of Frameworks – Applications: Computer Vision – NLP – Audio and Speech – Reinforcement Learning – Financial Forecasting – Healthcare and Medical Imaging – Industrial Anomaly Detection.

MODULE II CONVOLUTIONAL NEURAL NETWORKS 9

Introduction to Convolutional Layers – Pooling Layers – Activation Functions – CNN Architecture – Overfitting and Generalization – CNN Applications – Early Models – AlexNet – VGGNet – GoogleNet – ResNet – Advanced Architectures – Development Setup – Data Processing – Lab: CNN Model Building – Training and Fine-Tuning – Evaluation and Optimization – Deployment – Gradient Descent – Advanced Optimizers – Regularization – Hyperparameter Tuning – Learning Rate

Schedules – Momentum and Adaptive Learning – CNNs in Medical Imaging – Autonomous Vehicles and Robotics – Video and Event Analysis – AR/VR – Object Detection and Segmentation – CNNs for Disaster and Climate Analysis

MODULE III RECURRENT NEURAL NETWORKS 9

Fundamentals of RNNs – Training Challenges – Basic Applications – RNN Architectures – Introduction to LSTM – Long Short-Term Memory (LSTM) – Gated Recurrent Units (GRUs) – Bidirectional RNNs – Attention Mechanisms – Advanced RNN Applications – Development Setup – Optimization and Regularization – Advanced RNN Techniques – Deploying RNN Models – Diagnosing Performance Issues – Advanced Gradient Techniques – Hyperparameter Tuning – Regularization Strategies – Deployment Troubleshooting – Model Robustness and Scalability – Text Generation and NLP – Financial Time Series Prediction – Health Monitoring and Diagnosis – Speech Recognition – Video Analysis and Surveillance

MODULE IV IMPROVING DL NETWORKS 9

Bias and Variance – Regularization- Overfitting – Dropout regularization – data augmentation – Normalizing inputs – exploding gradients – derivative computation – gradient checking – gradient descent – exponentially weighted average– optimization algorithms – hyperparameter and its tuning – batch normalization- multiclass classification – DL framework.

MODULE V MACHINE LEARNING PROJECTS 9

ML strategy, Orthogonalization - Metrics and classifications - distributors - data sets - Bias and variance - Human level performance - Model performance - error analysis - Training and testing - mismatched data distributions - Transfer learning - multi-task learning - end-to-end deep learning.

L – 45; Total Hours:45

TEXT BOOKS:

1. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.), O'Reilly Media, ISBN: 978-1098125973, 2022.
2. Ian Goodfellow, Yoshua Bengio, & Aaron Courville, Deep Learning, MIT Press, ISBN: 978-0262035613, 2016.

REFERENCES:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing AG, ISBN: 978-3031455295, 2023.
2. J. Lavika Goel, Artificial Intelligence: Concepts and Applications, Wiley, ISBN: 978-9390394793, 2021.

COURSE OUTCOMES:

CO1: Demonstrate understanding of the architecture and mathematical foundations of deep neural networks, covering forward/backward propagation and optimization.

CO2: Apply CNN, RNN, LSTM, and GRU models to solve problems in image, video, text, and time-series domains.

CO3: Analyze model performance using regularization, optimization, normalization, and hyperparameter tuning techniques.

CO4: Evaluate and select appropriate deep learning frameworks and tools for specific applications, supported by error analysis.

CO5: Create complete deep learning projects using advanced methods such as transfer learning, multi-task learning, and reinforcement learning.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	L	H	L	M
CO2	M	L	H	M	H
CO3	H	M	H	M	H
CO4	M	M	H	M	H
CO5	H	H	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

Design and develop deep learning models and intelligent systems for domains such as computer vision, NLP, Healthcare and autonomous systems, applying modern AI frameworks and optimization techniques to deliver sustainable, efficient and innovative solutions.

AIF 6202	GENERATIVE AI WITH LARGE LANGUAGE MODELS	L	T	P	C
SDG: 9		3	0	2	4

COURSE OBJECTIVES:

COB1: Introduce the fundamentals of Generative AI and LLMs

COB2: Study RAG and the pretraining challenges of LLMs.

COB3: Gain knowledge on instruction fine-tuning and evaluation methods for LLMs.

COB4: Understand reinforcement-based fine-tuning along with deployment optimization techniques.

COB5: Explore the deployment of LLMs in real-world applications

MODULE I INTRODUCTION TO GENERATIVE AI 9

Introduction to NLP for Language Modelling - Word to Vector - Bag of Words to Embedding Transition - Small Language Models - Context Engineering and Prompt Engineering - Introduction to Generative AI & LLMs - LLM Use Cases and Tasks - Text Generation Before Transformers - Transformer Architecture - Generating Text with Transformers - Prompting and Prompt Engineering LLM Cost Estimation - Design and Implementation Challenges - LLaMA-based Model Deployment - LLM Runtime and Deployment Essentials.

MODULE II RAG AND LARGE LANGUAGE MODELS 9

RAG Technique for Retrieval - Generative Configuration - Generative AI Project Lifecycle - Pre-training Large Language Models - Computational Challenges of Training LLMs.

MODULE III FINE TUNING AND EVALUATION 9

Instruction fine-tuning - Fine-tuning on a single task - multi-task instruction fine-tuning - Model evaluation – Benchmarks - Parameter efficient fine-tuning (PEFT) - PEFT techniques 1: LoRA - PEFT techniques 2: Soft prompts.

MODULE IV REINFORCEMENT LEARNING 9

Aligning models with human values - Reinforcement learning from human feedback (RLHF) - RLHF: Obtaining feedback from humans - Reward model - Fine-tuning with reinforcement learning - Model optimizations for deployment.

MODULE V LLM-POWERED APPLICATIONS 9

Generative AI Project Lifecycle - Using the LLM in applications - Interacting with external applications - Helping LLMs reason and plan with chain-of-thought - Program-aided language models (PAL) - ReAct: Combining reasoning and action - LLM application architectures.

L –45; P – 30; TOTAL HOURS –75

PRACTICALS

LIST OF EXPERIMENTS

1. Effect of Temperature, Top-P, and Max Tokens on Output Variability in Large Language Models.
2. Response Evaluation Framework for Large Language Models Based on Ethical Metrics.
3. Implementation of Keyword-Based Search Algorithm for Text Retrieval from Files.
4. Embedding-Based Semantic Search Using Vector Databases and Pre-trained Language Models.
5. Automated Extraction and Metadata Analysis of Medical Reports from File System.
6. Designing and Storing LLM-Driven Query Set for Information Retrieval from Medical Reports.
7. Implementation of Retrieval-Augmented Generation (RAG) for Question Answering from Medical Reports Using LLMs.
8. Evaluation of Retrieval-Augmented Generation Using the RAG-Triad: Impact of Context on Output Optimization.
9. Intelligent Software Development Using LLMs: A Case Study with PaLM 2.
10. Image Generation from Text Prompts Using Diffusion Models.
11. Performance Comparison of Zero-Shot, One-Shot, and Few-Shot Prompting Using Large Language Models.
12. Enhancing Output Accuracy with Chain-of-Thought (CoT) Prompting: A Comparative Study with Standard Prompting.
13. Instruction-Based Fine-Tuning of a Foundation Model Using a Custom Dataset.

14. Performance Evaluation of a Foundation Model Before and After Instruction-Based Fine-Tuning.
15. Exploration and Construction of Task-Specific Benchmark Datasets for Language Model Evaluation.

TEXT BOOKS:

1. Sinan Ozdemir, “Generative AI with Python and TensorFlow 2: Build next-generation generative models using Python and TensorFlow 2”, Packt Publishing, 1st Edition, Birmingham, ISBN: 9781805125644, 2023.
2. Jakub Langr, Vladimir Bok, “GANs in Action: Deep Learning with Generative Adversarial Networks”, Manning Publications, 1st Edition, Shelter Island, ISBN: 9781617295560, 2019.
3. John Hany, “Hands-On Generative Adversarial Networks with PyTorch 1.x”, Packt Publishing, 1st Edition, Birmingham, ISBN: 9781838555072, 2019.

REFERENCES:

1. Foster Provost, Tom Fawcett, “Data Science for Business”, O'Reilly Media, 2nd Edition, Sebastopol, ISBN: 9781098104014, 2023.
2. Sebastian Raschka, Yuxi Liu, Vahid Mirjalili, “Machine Learning with PyTorch and Scikit-Learn”, Packt Publishing, 2nd Edition, Birmingham, ISBN: 9781801819318, 2022.

COURSE OUTCOMES:

CO1: Apply prompting techniques for effective text generation.

CO2: Analyze the computational challenges involved in training LLMs while using Retrieval-Augmented Generation (RAG) techniques.

CO3: Evaluate the effectiveness of LoRA and soft prompts in customizing LLMs for domain-specific tasks.

CO4: Implement fine-tuning of LLMs using Reinforcement Learning and optimize models for efficient deployment.

CO5: Design LLM-powered applications using advanced reasoning strategies like Chain-of-Thought (CoT), Program-Aided Language Models (PAL), and React.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	L	M	M	M
CO2	H	M	H	M	M
CO3	M	M	H	M	H
CO4	H	L	H	H	H
CO5	H	M	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

Scalable AI architectures like Transformers and Retrieval-Augmented Generation (RAG), the course promotes the development of resilient and efficient information systems supporting industrial digitalization.

AIF 6203	GENERATIVE ADVERSARIAL NETWORKS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Introduce the fundamentals of GANs and their architecture.

COB2: Study advanced GAN architectures like WGANs and cGANs.

COB3: Understand GAN evaluation methods and advanced models like StyleGAN.

COB4: Learn GANs for data augmentation and privacy.

COB5: Explore paired and unpaired image-to-image translation.

MODULE I FUNDAMENTALS OF GENERATIVE ADVERSARIAL NETWORKS (GANS) **9**

Overview of GenAI - Introduction to GANs - Applications of GANs-Basic GAN with PyTorch- Deep Convolutional GAN – Advanced DCGAN- Activation functions - Batch normalization – Transposed convolutions to tune GAN architecture and to build an advanced DCGAN specifically for processing images.

MODULE II ADVANCED GAN ARCHITECTURES - CONTROl TECHNIQUES **9**

Challenges in Traditional GAN Training - Wasserstein GANs (WGANs) with Normalization - WGANs to mitigate unstable training and mode collapse with a W-Loss and Lipschitz Continuity - Conditional and Controllable GANs - Conditional GAN for Class-based Image Synthesis.

MODULE III EVALUATION BIAS AND ADVANCEMENTS IN GANS **9**

Evaluation Challenges in GANs - GAN Performance Metrics - GAN Disadvantages and Bias - StyleGAN and Its Advancements - State-of-the-art GAN with powerful capabilities.

MODULE IV GANS FOR DATA AUGMENTATION AND PRIVACY **9**

GANs for Data Augmentation - GANs for Privacy and Anonymity - Image-to-Image

Translation with GANs - Text-to-Image - Image-to-Text and Multimodal Translation with GANs - Data Augmentation Pipelines with GANs.

MODULE V IMAGE-TO-IMAGE TRANSLATION WITH GANS 9

Paired Image-to-Image Translation: Pix2Pix - Overview of Paired Translation Tasks - Pix2Pix Architecture - U-Net based Generator Design - PatchGAN Discriminator - Satellite Image to Map Route Translation - Unpaired Image-to-Image Translation: CycleGAN - Architecture with Dual Generators and Discriminators-Horse-to-Zebra Image Translation - Comparison of Paired and Unpaired Translation.

L – 45; Total Hours:45

TEXT BOOK:

1. Jakub Langr, Vladimir Bok, “GANs in Action: Deep Learning with Generative Adversarial Networks”, Manning Publications, 1st Edition, Shelter Island, ISBN: 9781617295560, 2019.
2. John Hany, “Hands-On Generative Adversarial Networks with PyTorch 1.x”, Packt Publishing, 1st Edition, Birmingham, ISBN: 9781838555072, 2019.
3. David Foster, “Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play,” O’Reilly Media, 2nd Edition, Sebastopol, ISBN: 9781098104717, 2023.

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 1st Edition, Cambridge, ISBN: 9780262035613, 2016.

COURSE OUTCOMES:

CO1: Implement both basic and Deep Convolutional GAN (DCGAN) models for image generation tasks.

CO2: Implement Wasserstein GANs (WGANs) to improve training stability and Conditional GANs for generating category-specific outputs.

CO3: Evaluate GAN performance using Fréchet Inception Distance (FID) and state-of-the-art architectures like StyleGAN.

CO4: Apply GANs for generating synthetic data, enhancing downstream models, and understanding privacy-preserving use cases.

CO5: Build paired and unpaired image-to-image translation GANs (Pix2Pix, CycleGAN) for real-world applications.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	H	M
CO2	H	L	H	H	M
CO3	H	M	H	M	M
CO4	H	M	H	M	H
CO5	H	L	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:
Promotes innovation in AI-driven image processing and drives innovation across domains like healthcare, geospatial analysis, and manufacturing.

AIF 6204	LARGE LANGUAGE MODELS LABORATORY	L	T	P	C
SDG: 9		0	0	2	1

COURSE OBJECTIVES:

COB1: Study the historical progression, architecture evolution, and expanding applications of LLMs.

COB2: Explore various fine-tuning approaches used to adapt LLMs to specific tasks.

COB3: Understand the foundational concepts of Constitutional AI and compare it with reinforcement learning from human feedback (RLHF).

COB4: Evaluate various quantization techniques and their impact on the performance of LLMs.

COB5: Explore emerging transformer architectures and principles of responsible AI.

List of Experiments:

1. Study of Architectural Trends and Application Landscape of Large Language Models in AI.
2. Implementation of different Fine-tuning Approaches for LLMs: Full Fine-tuning, Adapter-based, and Parameter-Efficient Methods.
3. Analysis of working Principles and Differences between Constitutional AI and RLHF.
4. Quantization Techniques for Large Language Models: Methods, Performance Impact, and Comparison with Original Models.
5. Designing and Evaluating Efficient Transformer Architectures: Mixture of Experts, Sparse Attention, and Novel Design Proposals.
6. Exploring the Principles and Practices of Sustainable, Ethical, and Trustworthy AI.

P – 30; Total Hours: 30

TEXT BOOKS:

1. Sebastian Raschka, Yuxi (Hayden) Liu, Vahid Mirjalili,"Machine Learning with PyTorch and Scikit-Learn: Develop Machine Learning and Deep Learning Models with Python", Packt Publishing, 2nd Edition, Birmingham, ISBN: 9781801819312, 2022.

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 1st Edition, Cambridge, ISBN: 9780262035613, 2016.
2. Andrey Kurenkov, "Transformers for Machine Learning: A Deep Dive", Addison-Wesley, 1st Edition, Boston, ISBN: 9780138088173, 2024.

COURSE OUTCOMES:

CO1: Describe the evolution of Large Language Models.

CO2: Differentiate between full fine-tuning, instruction tuning and parameter-efficient techniques.

CO3: Analyze the working principles of Constitutional AI and RLHF.

CO4: Compare quantized models with original LLMs in terms of speed, memory, and accuracy.

CO5: Apply AI principles to build responsible intelligent systems.

Board of Studies (BoS):

25th BoS of CSE held on 07.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	-	M	-	L
CO2	M	L	M	-	M
CO3	M	L	H	H	L
CO4	H	L	H	-	M
CO5	H	L	H	H	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

This course promotes innovation in AI by focusing on building scalable models, using efficient tuning methods, following ethical practices, saving resources, and deploying Large Language Models effectively.

ENF 6281	PROFESSIONAL COMMUNICATION	L	T	P	C
SDG: 4 & 8		0	0	2	1

COURSE OBJECTIVES:

COB1: To introduce the fundamentals of professional communication in workplace contexts.

COB2: To develop structured presentation and public speaking skills.

COB3: To develop students' proficiency in written correspondence, including emails, and reports.

COB4: To enhance awareness and use of body language in professional settings

COB5: To instil appropriate workplace etiquette and digital professionalism.

MODULE I COMMUNICATION AT THE WORKPLACE P: 6

Language and communication fundamentals, Types of workplace communication, Formal and informal Communication, Direction and flow of Communication-Organizational communication and interpersonal dynamics, 7 Cs of Communication - Ethical use of AI assisted communication tools

MODULE II PRESENTATION & PUBLIC SPEAKING SKILLS P: 6

Importance of presentation skills, Managing public speaking anxiety, Structured planning and delivery of presentations, Use of visual aids and technology - Interactive tools

MODULE III CORRESPONDENCE AT WORK P: 9

Digital correspondence - Email Writing and Etiquette, Report Writing: Incident Reports, Feasibility Reports, and Executive Summaries

MODULE IV BODY LANGUAGE P: 5

Fundamentals of body language in professional communication, Types of non-verbal cues, posture -Interpreting and responding to non-verbal signals in interpersonal and group contexts, Cultural variations in body language and their implications in global communication

MODULE V WORKPLACE ETIQUETTE P: 4

Workplace etiquette, Cultural sensitivity in globalized work environments, Gender

sensitivity and inclusivity, DEI, Netiquette and digital professionalism - video conferencing, Professional networking (Social media, LinkedIn, etc.), Virtual team dynamics

P – 30; Total Hours:30

TEXT BOOKS:

1. Course material by the Department of English

REFERENCES:

1. Bovee, C. L., & Thill, J. V. *Business Communication Today* (14th ed.). Pearson, 2021.
2. Cardon, P. W., & Marshall, B. The hype and reality of social media use for work collaboration and team communication. *International Journal of Business Communication*, 52(3), 2015, 273–293.
3. Guffey, M. E., & Loewy, D. *Essentials of Business Communication* (11th ed.). Cengage Learning, 2020.
4. Jones, D. A., & Pittman, M. The digital professionalism paradox: Workplace norms and expectations in the era of online communication. *Journal of Applied Communication Research*, 49(3), 2021, 283–301.
5. Keyton, J., & Smith, F. L. M. Communication practices of work teams: Task, social, and identity functions. *Journal of Business Communication*, 46(4), 2009, 402–426.
6. Krizan, A. C., Merrier, P., Logan, J., & Williams, K. *Business Communication* (9th ed.). Cengage Learning, 2016.
7. Lesikar, R. V., Flatley, M. E., Rentz, K., & Lentz, P. *Lesikar's Business Communication: Connecting in a Digital World* (13th ed.). McGraw-Hill Education, 2019.
8. Madlock, P. E. The link between leadership style, communicator competence, and employee satisfaction. *Journal of Business Communication*, 45(1), 2008, 61–78.
9. Raman, M., & Sharma, S. Technical communication: Principles and practice (3rd ed.). Oxford University Press, 2015.
10. Robles, M. M. Executive perceptions of the top 10 soft skills needed in today's workplace. *Business Communication Quarterly*, 75(4), 2012, 453–465. https://doi.org/10.1177/1080569912460400

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Demonstrate clarity in professional communication by selecting appropriate modes and formats for workplace interactions.

CO2: Deliver structured presentations with confidence, using relevant verbal and visual communication techniques.

CO3: Produce clear and effective written correspondence, including emails, and formal reports.

CO4: Interpret and apply non-verbal communication cues appropriately in professional contexts.

CO5: Exhibit workplace etiquette, digital conduct, and cultural sensitivity in professional environments.

Board of Studies (BoS):

18th BoS of the Department of English held on 04.06.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	H	M	M	L
CO2	L	H	M	L	L
CO3	L	H	M	M	L
CO4	L	M	M	M	L
CO5	L	M	M	H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Statement: This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: This course equips students with the competencies required for employment in a dynamic global workforce.

AIF 6205	MINI PROJECT	L	T	P	C
SDG: 9		0	0	6	3

COURSE OBJECTIVE:

COB1: To enhance knowledge in the design, development and evaluation of computational systems.

COB2: To ascertain Computer Science and Engineering problems through a comprehensive literature review.

GENERAL GUIDELINES:

The Mini Project will feature a mid-semester presentation and an end-semester presentation. The mid-semester presentation will cover the identification of a problem statement based on current trends in Computer Science and Engineering, along with a brief literature review and analysis of existing methods and algorithms using different techniques.

Students can select minor issues in the Computer Science and engineering domain for their mini project. The work may include creating or improving algorithms, building software applications, exploring and analyzing data, experimenting with machine learning models, evaluating how well a system performs, studying security aspects, understanding and using existing tools and frameworks to solve real-world computing problems.

The end-semester presentation must be accompanied by a project report that includes the identification of the topic for the work and the methodology used for the analysis / design and detailing of the complete system.

The departmental committee will monitor the continuous assessment of the Design Project.

COURSE OUTCOMES:

At the end of the mini project, the students will be able to

CO1: Identify issues in emerging areas of Computer Science and Engineering.

CO2: Apply appropriate analytical and experimental methods to solve identified problems.

CO3: Design, implement and evaluate computational solutions using modern software tools and platforms.

CO4: Exhibit proficient communication and report writing skills.

Board of Studies (BoS):

25th BOS of CSE held on 07.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO 5
CO1	M	H	-	-	M
CO2	M	H	-	H	H
CO3	-	M	H	M	H
CO4	-	H	-	M	-

-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: Encouraging students to identify real-world computing problems through literature review and develop innovative, efficient, and scalable software solutions that contribute to technological advancement, digital infrastructure, and sustainable industrial growth.

AIF 7101	INDUSTRY INTERNSHIP	L	T	P	C
SDG: 9		0	0	4	2

COURSE OBJECTIVE:

COB1: To expose students to real-world industrial environments and enabling them to learn practical skills with industry readiness in Artificial Intelligence and Data Science.

COURSE DESCRIPTION:

1. Completion of industrial training for a minimum duration of 15 days in a single continuous slot is mandatory for the award of credits for this course. The training is to be undertaken during the summer vacation of the first year, and the credits are awarded in the third semester.
2. Internship training is permitted only in reputed companies, research laboratories or academic institution. The internship coordinator identifies suitable organizations aligned with the core engineering domain during the second semester and provides guidance to students throughout the process of securing internship opportunities.
3. To ensure focused and effective internship participation, no two students are permitted to undergo training at the same site.
4. The internship coordinator continuously monitors the performance of students during the internship through regular interaction with the respective industry organizations where the training is undertaken.
5. For an industry internship, the student is required to submit an internship report, which will be evaluated along with an oral examination conducted by a committee of faculty members appointed by the Head of the Department.
6. Students are required to submit the industry completion certificate at the time of the presentation. Student performance is evaluated by both the industry and the University and the final grade is awarded based on the aggregated evaluations. The evaluation carries 50% weightage from the industry and 50% weightage from the evaluation conducted by the committee of faculty members.
7. The 50 % weightage of evaluation done at the department comprises of (a) 20/50 for viva-voce, (b) 20/50 for the Intern report and (c) 10/50 for poster presentation.

COURSE OUTCOMES:

At the end of the internship, the student will be able to:

CO1: Apply concepts of Artificial Intelligence and Data Science to address real-world problems encountered in industrial environments.

CO2: Analyze industrial workflows, datasets and systems using AI and data science techniques relevant to the application domain.

CO3: Adapt to industry-standard tools, platforms and practices used in AI and Data Science development and deployment.

CO4: Prepare technical documentation and deliver presentations that clearly explain AI models, data insights, and outcomes developed during the internship.

CO5: Assess skill gaps and career pathways in the field of Artificial Intelligence and Data Science based on hands-on industrial exposure.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	H	L	M	M	H
CO2	H	L	H	M	H
CO3	M	L	H	M	H
CO4	L	H	M	L	M
CO5	M	L	H	M	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

AIF 7102	**Project Work– Phase I (III Sem)**	**L**	**T**	**P**	**C**
		0	**0**	**16**	**8**
	Project Work– Phase II (IV Sem)	**L**	**T**	**P**	**C**
SDG: 9		**0**	**0**	**36**	**18**

COURSE OBJECTIVES:

COB1: To Learn the ideas of research or industry-oriented project in the domain of Artificial Intelligence and Data Science.

COB2: To Explore existing literature, tools and techniques with research gaps for innovative AI and Data Science solutions.

COB3: To understand practical workflows, methodologies and challenges encountered in AI and Data Science projects.

COB4: To expose effective communication, documentation and presentation skills for technical reporting of project outcomes

COB5: To gain hands-on experience in developing, testing and evaluating AI and Data Science models.

COURSE DESCRIPTION

Project work is to be carried out individually by each student under the supervision of a faculty member from the department. In certain cases, a student may be permitted to undertake the project in collaboration with other departments or within an Industrial/Research Organization, subject to the recommendation of the Head of the Department. In such instances, the project will be jointly supervised by a departmental faculty member and either a faculty member from the collaborating department or an engineer/scientist from the organization. The student is required to meet the supervisor periodically and participate in scheduled progress review sessions.

The project will undergo three continuous assessment reviews and a final review with viva voce at the end of the semester. The Project Report, prepared according to the approved guidelines and duly signed by the supervisor(s) and the Head of the Department, must be submitted to the concerned department. Additionally, the research findings are expected to be published in a conference or journal.

COURSE OUTCOMES:

At the end of the project work, the student will be able to:

CO1: Identify and formulate research or industry-oriented problems in the domain of Artificial Intelligence and Data Science.

CO2: Analyse existing solutions, tools, and techniques to identify gaps and opportunities for innovation in AI and Data Science applications.

CO3: Develop AI and Data Science models, workflows, and systems to address practical and research problems.

CO4: Demonstrate critical thinking, problem-solving and decision-making skills through systematic execution of project work.

CO5: Communicate technical ideas effectively through well-documented project reports and oral presentations.

Board of Studies (BoS):

25th BoS of CSE held on 07.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	H	L	M	M	H
CO2	H	L	H	M	H
CO3	H	M	H	M	H
CO4	M	L	H	M	H
CO5	L	H	M	L	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

PROFESSIONAL ELECTIVES (SEMESTER – I)

AIFY 01	APPLICATION ARCHITECTURE AND	L	T	P	C
SDG: 9	DEPLOYMENT	3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the fundamental concepts of software architecture, focusing on monolithic and microservices architectures.

COB2: Explore the concepts, types, protocols, and testing methods of APIs, including authentication, authorization, and role-based access control.

COB3: Learn containerization fundamentals and gain hands-on knowledge of Docker and container orchestration tools.

COB4: Explore Kubernetes architecture, deployment, scaling, and resource management using YAML.

COB5: Understand the role of MLOps in machine learning model deployment, lifecycle management, and integration with software development practices.

MODULE I MONOLITHIC VS MICROSERVICES 9

Introduction to Software Architecture and its types - Monolithic Architecture and its Importance – Characteristics and Limitations of Monolithic Architecture - Microservices - Working of Microservices - Microservices Architecture - Advantages of Microservices - Monolithic vs Microservices - Real World Example of Microservices - Challenges in Microservices.

MODULE II APPLICATION PROGRAMMING INTERFACE 9

Definition and working of APIs – Types of APIs- Web APIs, Local APIs, and Program APIs – Overview of SOAP and REST APIs – Characteristics of REST APIs – HTTP methods (GET, POST, PUT, DELETE) – Status codes and URI structure – Comparison between SOAP and REST – API Testing in the context of LTIM – Types of API testing – Tools used for API testing – Authentication mechanisms – Authorization mechanisms – Role-Based Access Control (RBAC).

MODULE III CONTAINERS **9**

Concept of Virtualization – Role of Virtualization in Cloud Computing – Introduction to Containerization – Container Lifecycle – Comparison between Virtualization and Containerization – Security aspects of Containers – Serverless Containers – Overview of Docker – Docker Architecture – Key Components of Docker – Concept of Docker Images – Common Docker Commands – Benefits of using Docker – Introduction to Container Orchestration Tools.

MODULE IV KUBERNETES **9**

Overview of Kubernetes (K8s) – Need for Kubernetes beyond Docker – Core Components of Kubernetes – Node and Control Plane – Kubernetes Networking Concepts – Kubernetes Resources: Pod, Deployment, Service, Volume, Namespace, Node, Cluster – Storage Management in Kubernetes – Security in Kubernetes Environments – Monitoring, Logging, and Scaling in Kubernetes – Writing and Managing YAML Configuration Files.

MODULE V MACHINE LEARNING ENGINEERING FOR PRODUCTION (MLOps) **9**

Introduction to ML Operations – Overview of Software Development Life Cycle (SDLC) – Various Stages of SDLC – Waterfall Model – Agile Model – Iterative Model – Significance of Each Software Development Model – Model Training Process – Model Deployment Process.

L – 45; Total Hours: 45

TEXT BOOKS:

1. Newman, S. “Building Microservices “,2nd ed. O’Reilly Media. ISBN 978-1492034025,2021.
2. Davis, A. “Bootstrapping Microservices with Docker, Kubernetes, and Terraform”. Manning Publications. ISBN 978-1617297212,2021.

REFERENCES:

1. Scott Surovich, & Marc Boorshtein, “Kubernetes and Docker”, Packt Publishing,ISBN: 9781801073530,2021.

2. Mark Treveil, Nicolas Omont, & Clément Stenac, “Introducing MLOps: How to Scale Machine Learning in the Enterprise”, Grayscale Indian Edition, Shroff/O'Reilly,ISBN: 9789352139383,2020.

COURSE OUTCOMES:

CO1: Differentiate monolithic and microservices architectures and identify their characteristics, advantages, and challenges.

CO2: Implement APIs using appropriate protocols, authentication, and testing methods for secure and efficient communication.

CO3: Apply containerization techniques using Docker and compare them with traditional virtualization methods.

CO4: Manage Kubernetes resources, networking, storage, and security for container orchestration.

CO5: Implement MLOps practices for machine learning lifecycle, model training, deployment, and integration with SDLC models.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	-	H	L	M
CO2	M	M	M	L	H
CO3	M	-	H	L	H
CO4	H	-	H	M	H
CO5	H	M	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

Promotes development of scalable and modular software systems that drive industrial digital transformation and enhances secure and interoperable communication between applications, crucial for modern digital services and infrastructure.

AIFY 02	SQL FOR DATA SCIENCE	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: Learn structured query language (SQL) to an intermediate/advanced level.

COB2: Explore the data retrieval queries and evaluate the result set.

COB3: Understand the structure and design of relational databases.

COB4: Understand the importance and major issues of database security and the maintenance of data integrity.

COB5: Provide expertise to plan, organize, direct, and lead full-scale data analytics projects and business ventures.

MODULE I UNDERSTANDING AND DESCRIBING DATA 9

Introduction to data exploration - Types of data and distributions - Descriptive statistics - Introduction to relational databases - SQL fundamentals and data types - DDL and DML commands - Creating - Updating and deleting tables and records - Exploratory data analysis using SQL - Data profiling and data quality checks - Integrating SQL with Python.

MODULE II SQL FOR DATA PREPARATION 9

Data assembly and preprocessing for AI pipelines - Connecting and merging tables using different joins - Nested and correlated subqueries - Set operations- Data transformation and derived columns - Common Table Expressions (CTE) and temporary tables - Data cleaning operations using SQL - Use of indexes to improve query performance.

MODULE III AGGREGATE FUNCTIONS AND DATA ANALYSIS 9

Aggregate functions - Grouping and filtering with GROUP BY and HAVING - Advanced analytical queries - Statistical summaries using SQL - Importing and exporting data - Automating data analysis with stored procedures - Introduction to query optimization and performance tuning.

MODULE IV ANALYTICS USING COMPLEX DATA TYPES 9

Date and time data types for time-series analysis - Geospatial data types and functions in PostgreSQL- Location-based queries and distance calculations - ARRAY and JSON data types in PostgreSQL - Nested JSON parsing and transformation - Text analytics and sentiment tagging using SQL and JSON - Introduction to semi-structured data processing in SQL.

MODULE V DATA WRANGLING 9

Data wrangling techniques using SQL and Python - Reshaping data using pivot/unpivot operations - Advanced string processing and regular expressions in SQL - Web scraping basics using Python - Integration of scraped data into databases - Data validation and testing - Performance benchmarking - End-to-end case study: SQL-based data preparation and analysis for a machine learning pipeline.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Jun Shan, Matt Goldwasser, Upom Malik & Benjamin Johnston, “SQL for Data Analytics: Harness the Power of SQL to Extract Insights from Data”, Packt Publishing, 3rd Edition, Mumbai, ISBN: 9781801812870, 2024.
2. Steve Hughes and Dennis Neer, “SQL Query Design Patterns and Best Practices”, Packt Publishing, 1st Edition, ISBN: 9781837633289, 2023.
3. Cathy Tanimura,”SQL for Data Analysis: overview of SQL”, O Really Media publisher, 5th Edition, ISBN: 9781492088783, 2021.
4. Upom Malik, Matt Goldwasse and Benjamin Johnston,” SQL for Data Analytics Perform Fast and Efficient Data Analysis with the Power of SQL”, Packet Publishing,1st Edition Mumbai, ISBN: 9781789803846, 2019.

REFERENCES:

1. Rafael. Airizarry., “Introduction to Data science: Data Analysis and prediction algorithm with R,” CRCP press Publisher, US, ISBN :9780429341830, 2019.

COURSE OUTCOMES:

CO1: Identify the knowledge and understanding of Database analysis and design.

CO2: Develop programming and software Engineering Skills and techniques using SQL and PL/SQL.

CO3: Design and develop a SQL Data Environment according to the benchmarks

CO4: Analyze the data using various statistical methods.

CO5: Integrate SQL with tools like Python for data wrangling, string processing, and scraping.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	-	M	M	L
CO2	M	L	M	H	M
CO3	M	L	M	H	M
CO4	M	M	H	M	H
CO5	H	M	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4: Quality Education

Statement:

This course equips learners with essential data literacy and analysis skills, promoting inclusive and equitable quality education and lifelong learning opportunities.

AIFY 03	CLOUD COMPUTING	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the concepts of Cloud Computing and its Evolution

COB2: Provide the knowledge on various virtualization concepts

COB3: Explore the different types of Cloud computing models

COB4: Understand the concepts of capacity planning and Resource management.

COB5: Provide the cloud security concepts and development tools in cloud computing

MODULE I INTRODUCTION 9

Introduction – Cloud Computing - Service delivery models - Deployment Models Characteristics and Benefits of Cloud computing- Cloud computing platforms and technologies – Distributed and Parallel Computing – Distributed computing and its properties, Performance consideration in distributed Computing, Parallel Computing, performance consideration in parallel computing - Amdahl's law- Flynn's classical taxonomy- Classes of parallel computers – Multi core Architecture - Multi cores in cloud computing, Classes of parallelism, Limitations.

MODULE II VIRTUALIZATION 9

Virtualization – Defining virtualization, Virtualization models, Server virtualization models, Desktop virtualization, Application virtualization Hardware Maximization – shared storage - Architectures- Manage virtualization.

MODULE III CLOUD COMPUTING MODELS 9

Infra structure-as-a-Service (IaaS)-IaaS in cloud - Benefits, Management of VMs in IaaS - IaaS Providers - Key to successfully moving to IaaS - Challenges of Iaas – SaaS and PaaS in cloud – Characteristics- implementation - advantages and disadvantages of SaaS - Characteristics, implementation - advantages and disadvantages of PaaS.

MODULE IV CAPACITY PLANNING, SLA MANAGEMENT AND RESOURCE MANAGEMENT 9

Cloud capacity models, probabilistic auto-scaling for capacity planning – SLA Management

– Components of SLA - Life Cycle of SLA, SLA Management system in Cloud – Resource Management in Cloud – Significant resources, Issues and Solutions.

MODULE V CLOUD COMPUTING SECURITY & DEVELOPMENT **9**

Cloud security – Data Security - Encryption techniques in Cloud, Infra Structure security - PaaS Application security - SaaS Application security, Securing virtual servers, Cloud Security controls - Cloud computing Development - Kernel Virtual Machine, Delta Cloud, Eucalyptus, OpenStack, Salt Stack, Apache Cloud Stack, AWS Cloud Development Kit (AWS CDK), Windows Azure SDK.

L- 45; Total Hours- 45

TEXT BOOKS:

1. R. Agarwal and D. K. Prasad, “Cloud Computing for Everyone: Understanding principles, architecture, security, data, and green practices”, 1st ed. BPB Publications, ISBN 978-93-6589-276-5, 2025.
2. Manvi, Sunil Kumar, and Gopal Shyam. “Cloud Computing Concepts and Technologies:”. 1st ed., CRC Press, ISBN 978-1000337952, 2023.

REFERENCES:

1. D. Gupta, “The Cloud Computing Journey”. Packt Publishing, ISBN 978-1805122289, 2024.

COURSE OUTCOMES:

CO1: Articulate the main concepts of cloud computing.

CO2: Illustrate the concepts of virtualization.

CO3: Apply suitable Cloud computing models for real time applications.

CO4: Develop the ability to understand Capacity planning, SLA management and Resource Management.

CO5: Explain the use of various cloud computing development tools.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	M	H	L	L
CO2	L	L	H	L	M
CO3	M	L	H	M	H
CO4	M	M	H	H	M
CO5	L	M	H	L	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

Statement: By learning “Cloud Computing” the students will be able to discuss economic models and future visions of economy and society critically and to communicate them in public spheres.

AIFY 04	EXPLORATORY DATA ANALYTICS	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the fundamentals of Exploratory Data Analysis

COB2: To know the Data Transformation techniques

COB3: To provide the knowledge on Descriptive Statistics

COB4: To learn the correlation analysis and Time series analysis

COB5: To understand the model development and evaluation

MODULE I EXPLORATORY DATA ANALYSIS FUNDAMENTALS 9

EDA in the data science lifecycle - Importance of EDA in model performance - Comparing EDA with classical and Bayesian analysis - EDA using Python - Data cleaning and sanity checks - Visual Aids for EDA - Introduction to automated EDA tools - Interactive dashboards using Streamlit or Plotly Dash.

MODULE II DATA TRANSFORMATION 9

Technical foundations and Python integration - Merging and joining relational-style data frames - Handling missing data - Imputation techniques - Advanced transformation techniques - Detecting and handling outliers - Feature engineering - Permutation-shuffling- bootstrapping - Scaling data for machine learning - Benefits of data transformation.

MODULE III DESCRIPTIVE STATISTICS & GROUPING DATASETS 9

Descriptive Statistics - Understanding statistics - Measures of central tendency - Measures of dispersion - Grouping Datasets - Understanding group by() – Group by mechanics - Data aggregation - Pivot tables and cross-tabulations.

MODULE IV CORRELATION & TIME SERIES ANALYSIS 9

Correlation and Causation - Visual correlation matrices - Detecting multicollinearity -

Simpson's paradox with real-life examples - Multivariate analysis using real-world datasets - Feature selection using correlation thresholds - Time Series fundamentals - Parsing dates and time zone conversion - Rolling windows and smoothing - Decomposition of time series - Time series anomaly detection.

MODULE V MODEL DEVELOPMENT AND EVALUATION 9

Understanding regression - Model development and evaluation – Model Hypothesis Testing and Regression - Hypothesis testing - p hacking - Development and Evaluation - Types of machine learning - Understanding supervised learning - Understanding unsupervised learning - Understanding reinforcement learning - Unified machine learning workflow - EDA on Wine Quality Data Analysis - Disclosing the wine quality dataset - Analyzing red wine - Analyzing white wine - Model development and evaluation.

L - 45; Total Hours– 45

TEXT BOOKS:

1. Tirthajyoti Sarkar, "Practical Time Series Analysis – Master Time Series Data Processing, Visualization, and Modeling using Python", Independently Published, Bengaluru. ISBN: 9798321673297, 2024.
2. Daniel Y. Chen, "Pandas for Everyone: Python Data Analysis", Pearson Education, 2nd Edition, Chennai, ISBN: 9780137891160, 2023.
3. Alvaro Fuentes, "Hands-On Exploratory Data Analysis with Python", Packt Publishing, 1st Edition, Mumbai, ISBN: 9781788628112, 2020.
4. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python Perform EDA Techniques to Understand, Summarize, and Investigate Your Data", Packt Publishing, ISBN:9781789535624, 2020.

REFERENCES:

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly Media, 2nd Edition, ISBN: 9781098104030, 2023.
2. Peter Bruce, Andrew Bruce, "Practical Statistics for Data Scientists", O'Reilly Media, ISBN:9781491952917, 2017.

COURSE OUTCOMES:

CO1: Examine the fundamentals of Exploratory Data Analysis.

CO2: Comprehend the data transformation techniques.

CO3: Apply descriptive statistics to derive meaningful insights from data.

CO4: Perform correlation analysis and time series analysis using real world datasets.

CO5: Develop machine learning models using regression, classification, and clustering approaches.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	-	M	M	L
CO2	M	L	M	M	M
CO3	M	L	H	M	H
CO4	H	M	H	M	H
CO5	H	M	H	H	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 8: Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, and innovation.

Statement: By learning “Exploratory Data Analysis,” the students can develop and evaluate ideas for sustainability-driven innovation and entrepreneurship

AIFY 05	BUSINESS INTELLIGENCE	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce foundational and emerging concepts in data analytics and business intelligence.

COB2: To familiarize students with models, tools, and frameworks for data-driven decision-making.

COB3: To explore advanced analytics on unstructured and web-based data using modern tools.

COB4: To apply real-time analytics, visualization, and dash boarding for executive reporting.

COB5: To develop hands-on expertise in applying BI applications in industry-based scenarios.

MODULE I INTRODUCTION **9**

Ubiquity of Data and Digital Transformation - Decision Making - Analytics in Business and Society - Evolution of Big Data - Cloud-based Data Warehousing - Analytical Thinking - Introduction to Data Mining Process- AI and ML in BI Platforms - Overview of Modern Technologies.

MODULE II MODELS AND METHODS **9**

Supervised Segmentation - Visualizing Segmentation - Classification and Regression - Time Series - Association Rules - Clustering - Generalization - Fitting and Overfitting - Cross-validation - Advanced Segmentation Techniques - Ensemble Methods - Feature Engineering - Causal Inference - Visualizing Model Outputs - Explainable AI.

MODULE III TEXT AND WEB ANALYTICS **9**

Natural Language Processing - Topic Modeling - Named Entity Recognition - Sentiment Analysis - Chatbot Analytics and Conversational AI - Web Usage Mining - User Behavior Tracking- Social Network Analysis - Real-time Web Analytics - Ethical Aspects and Privacy in Web Mining.

MODULE IV DATA VISUALIZATION **9**

Principles of Data Visualization - Heat Maps - Tree Maps - Bullet Graphs - Polar Charts - Geospatial Visualization with GIS - Interactive Dashboards - Integration with Big Data Platforms - KPI Design and Storytelling - Visual Analytics for Executive Decision Making - Real-time Monitoring Systems - Accessibility and Inclusive Visual Design.

MODULE V BI APPLICATIONS **9**

Modern BI Architecture and Cloud BI - AI-powered BI Tools - Applications in Relational Marketing Customer Retention - Churn Prediction - Salesforce and CRM Analytics - Supply Chain Forecasting and Optimization - Data Envelopment Analysis - Fraud Detection Systems - HR Analytics - Responsible AI in BI Systems - Industry 4.0 BI Use Cases - Case Studies - Healthcare - Finance - E-Commerce and Smart Cities.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Ramesh Sharda, Dursun Delen, Efraim Turban, “Business Intelligence, Analytics, and Data Science: A Managerial Perspective”, Pearson Education, 5th Edition, Mumbai, 2024, ISBN: 9789356063974, 2024.
2. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and Its Applications”, Wiley, 2nd Edition, Chennai, ISBN: 9781119805368, 2023.
3. Foster Provost and Tom Fawcett, “Data Science for Business”, O’Reilly Media, Inc., 1st Edition, ISBN 978-1-449-36132-7, 2013.

REFERENCES:

1. Drew Bentley, “Business Intelligence and Analytics”, Library Press, Inc., 1st Edition, ISBN 978-1-9789-2136-8, 2017.
2. Carlo-Vercellis, “Business Intelligence Data Mining and Optimization for Decision-Making”, Wiley Publications, 1st Edition, ISBN 978- 8126541881, 2013.

COURSE OUTCOMES:

CO1: Explain the role of data analytics in decision making and describe core

BI technologies.

CO2: Apply appropriate models for classification, regression, clustering, and forecasting.

CO3: Perform analytics on text, web, and social media data using modern tools and methods.

CO4: Create and interpret interactive dashboards and advanced data visualizations.

CO5: Analyze the BI strategies and solutions in various domain-specific applications

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	L	M	M	M
CO2	M	L	H	M	H
CO3	H	M	H	M	H
CO4	L	H	M	M	M
CO5	M	M	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement:

The course promotes digital and data-driven innovation through real-world BI applications across industries.

AIFY 06	DATA VISUALIZATION	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Study the basic elements in data visualization

COB2: Impart the learning of visualizing distributions and proportions

COB3: Understand the visualization methods for data related to associations, time series and trends.

COB4: Learn the functionalities in python for visualizing data.

COB5: Expose the visualization techniques for images, shapes, and spatial data.

MODULE I FUNDAMENTALS OF DATA VISUALIZATION 9

From Data to Visualization – Mapping data to Aesthetics – Coordinate System and Axes – Color Scales – Directory of visualizations – Visualizing amounts – Bar plots – Grouped and Stacked bars – Dot plots and Heatmaps

MODULE II DISTRIBUTIONS AND PROPORTIONS 9

Histograms and density plots – Visualizing single and multiple distributions – Empirical Cumulative Distribution Functions - Highly Skewed Distributions - Quantile-Quantile Plots - Visualizing distributions along vertical and horizontal axes – Visualizing proportions – Pie charts – Side-by-side bars – stacked bars and stacked densities.

MODULE III ASSOCIATION AND TRENDS 9

Visualizing associations – Scatterplots – Correlograms - Dimension Reduction - Paired Data – Visualizing Time Series - Individual Time Series Multiple Time Series and Dose–Response Curves - Time Series of Two or More Response Variables – Visualizing Trends – Smoothing - Showing Trends with a Defined Functional Form - Detrending and Time-Series Decomposition.

MODULE IV VISUALIZATION IN PYTHON 9

Introduction to Python – Python Scripting Basics - Exploring Jupyter Notebook – Getting Started with Pandas – Scientific Python Ecosystem and Numpy – Data Visualization with Leather – Data Visualization with Numpy and Matplotlib.

MODULE V VISUALIZING IMAGES AND SHAPES 9

Visualizing Images and 3D shapes – Visualizing graphs and networks – Visualization with Seaborn– Spatial visualization and analysis in python in folium –Geospatial Visualization.

L – 45; Total Hours– 45

TEXT BOOKS:

1. N. Yau, “Visualize This: The FlowingData Guide to Design, Visualization, and Statistics”, 2nd ed. Wiley, ISBN 978-1394214860, 2024.
2. M. Cremonini, “Data Visualization in R and Python”, Wiley, ISBN 978-1394289486, 2024.

REFERENCE:

1. D. Abbott, “Everyday Data Visualization”, Manning Publications, ISBN 978-1633438408, 2024.

COURSE OUTCOMES:

CO1: Investigate the basic elements regarding the data visualization

CO2: Analyze the methods needed for visualizing distributions and proportions

CO3: Apply the visualization of associations, time series data and trends.

CO4: Perform basic visualization of data using Python.

CO5: Implement the functionalities of python to visualize images, shapes, and spatial Data

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	M	H	L	L
CO2	M	L	H	L	M
CO3	M	L	H	M	H
CO4	L	M	H	L	H
CO5	M	M	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The practice of translating information into a visual context, such as a map or graph, aids to make the data easier for the human brain to understand and draw insights, which results in the construction of resilient software and remarkable innovations.

PROFESSIONAL ELECTIVES (SEMESTER – II)

AIFY 11	ETHICS IN DATA SCIENCE	L	T	P	C
SDG: 9,16		3	0	0	3

COURSE OBJECTIVES:

COB1: Provide students with a comprehensive understanding of ethical theory.

COB2: Equip students with a strong foundation in the principles, methods, and ethical responsibilities.

COB3: Understand about the security concepts on data ownership.

COB4: Introduce the core dimensions of responsible and ethical AI.

COB5: Impart the Red Teaming approach to identify vulnerabilities in Large Language Models (LLMs).

MODULE I INTRODUCTION AND PHILOSOPHICAL FRAMEWORKS FOR ASSESSING FAIRNESS **9**

Foundations of ethics - Early theories of fairness - Contemporary theories of fairness - Significance of ethics in data science - Ethics vs. law/compliance/public relations - Cultural relativism - Professional ethics - Individuals vs. Collectives.

MODULE II RESEARCH ETHICS **9**

Data driven research - Methods of collection of data - Different types of data - Qualitative and Quantitative - Overview of ethical issues in data-driven organizations - Ethical data analysis - Responsible use of research data - Plagiarism - Fake data and Fabrication of data - Creation of database.

MODULE III DATA OWNERSHIP, PRIVACY, AND ANONYMITY **9**

Understanding the difference between data ownership - Data privacy and Data anonymity - Understanding the idea behind data surveillance - Data privacy vs. data security.

MODULE IV ALGORITHMIC FAIRNESS **9**

Barriers to effective listening - Tarts of Speech and its usage - Subject - Verb Agreement

- Basic conversation skills - Sentence construction - SVO -Various dimensions of Responsible AI - Dimensions of Ethical AI - Bias Mitigation Techniques - Constitutional AI - Rules of Constitutional AI - Create Constitutional AI complaint system - Model fine tuning for Constitutional AI.

MODULE V POLICIES ON DATA PROTECTION 9

DPDP-Digital Personal Data Protection Act-Rules-Guidelines- EU's general data protection rules - GDPR - Digital India policy - Personal data protection bill - 2019 - PDP Bill ethical issues on data privacy in context with India - Case studies - Red Teaming on LLM & Case study on vulnerabilities - Red Teaming attack .

L – 45; Total Hours– 45

TEXT BOOK:

1 Anne L. Washington, "Ethical Data Science: Prediction in the Public Interest", Oxford University Press,1st Edition, ISBN:978-0197693025,2023.

REFERENCES:

1. David Martens, "Data Science Ethics: Concepts, Techniques, and Cautionary Tales", Oxford University Press,1st Edition, ISBN:978-0192847263,2022.
2. John K. Smith, "Ethics in Data Science: A Guide to Responsible Practice", Springer,1st Edition, ISBN: 978-3030678901,2021.

COURSE OUTCOMES:

CO1: Apply ethical reasoning, demonstrating the ability to identify ethical risks, propose mitigation strategies, and communicate decisions effectively.

CO2: Demonstrate responsible use of research data, including correct data handling, storage, and sharing practices in line with ethical and legal standards.

CO3: Differentiate between data ownership, data privacy, and data anonymity, and explain the implications of each in various data contexts.

CO4: Describe the core principles of Ethical AI, and analyze their relevance in real-world AI applications.

CO5: Analyze ethical issues related to data privacy, focusing on challenges in real time.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	M	M	H	L
CO2	M	M	M	H	L
CO3	L	L	M	H	L
CO4	M	L	H	H	L
CO5	M	L	M	H	L

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:
Ensures industrial innovation and infrastructure development are both technologically advanced and socially responsible.

SDG 16: Building trust in digital institutions and ensuring that data is used responsibly and ethically.

Statement:
Ensures privacy, preventing discrimination, and ensuring accountability in data practices, all of which contribute to peaceful and just societies

AIFY 12	COMPUTER VISION	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Introduce fundamental techniques of image processing and image generation.

COB2: Impart knowledge on feature extraction, object detection, and image analysis methods.

COB3: Explore machine learning models used in computer vision applications.

COB4: Expose 3D computer vision techniques and their applications.

COB5: Discuss advanced and emerging trends in computer vision across industries.

MODULE I IMAGE PROCESSING TECHNIQUES 9

Introduction to image processing - Types of image processing - Visualization - Recognition - Sharpening and Restoration - Pattern Recognition - Retrieval - Image Transformation Techniques - Image Enhancement Techniques - Histogram Equalization - Contrast Stretching - Adaptive Enhancement - Image Restoration Methods - Deblurring - Denoising - Inpainting - Linear Filtering - Convolution - Gaussian Filtering - Edge Detection - Independent Component Analysis (ICA) - Pixelation and Its Applications - Image Generation Techniques- Procedural Image Generation- Fractal Generation - Noise-based Generation - Generative Adversarial Networks (GANs) for Image Generation - Introduction to GANs - Architecture and Training Process - Image-to-Image Translation and style transfer - Applications of Image Generation Techniques - Data Augmentation - Creative Applications.

MODULE II FEATURE EXTRACTION AND IMAGE ANALYSIS 9

Feature Detection - Introduction to feature detection - Object recognition techniques - Image segmentation algorithms - Frequency domain processing - Feature extraction methods (SIFT, SURF) - Object Description - Introduction to fundamentals of moving object detection - Moving object description techniques - Optical flow - Background subtraction - Camera geometry for object description - Camera calibration - Pose estimation.

MODULE III MACHINE LEARNING FOR COMPUTER VISION **9**

Image Classification - Introduction to machine learning for computer vision - Image classification models - CNNs - Transfer Learning - Object detection with machine learning -YOLO -SSD - Labeling images for machine learning - Annotation Tools - Data Augmentation.

MODULE IV 3D COMPUTER VISION **9**

Depth Perception - Comparison of 2D and 3D computer vision - Real-world applications and trends in 3D computer vision - Classification of 3D data - Point clouds - Meshes.

MODULE V ADVANCED CV AND FUTURE TRENDS **9**

Advanced Computer Vision Applications - Brain Tumor Detection - Integrating Computer Vision in Autonomous Driving Systems - Computer Vision Applications in the Food Industry - Case study - Object Detection and Recognition - Visual Tracking - Semantic Segmentation - Human Recognition.

L – 45; Total Hours:45

TEXT BOOKS:

1. V Kishore Ayyadevara & Yeshwanth Reddy, “Modern Computer Vision with PyTorch “,Packt Publishing,1st Edition, ISBN: 978-1838823621,2020.
2. Simon J.D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press,2nd Edition, ISBN: 978-1108473907,2022.

REFERENCES:

1. Richard Szeliski,“Computer Vision: Algorithms and Applications “,Springer, ISBN: 978-3030925236,2022.
2. Rajalingappaa Shanmugamani,“Deep Learning for Computer Vision”,Packt Publishing,2nd Edition, ISBN: 978-1801077476,2021.

COURSE OUTCOMES:

CO1: Apply various image processing techniques for image manipulation and analysis.

CO2: Analyze feature detection, segmentation, object recognition, and motion analysis techniques for image understanding.

CO3: Evaluate machine learning models like CNNs, YOLO, and SSD for image classification and object detection tasks.

CO4: Compare and apply 2D and 3D vision techniques for depth perception and 3D data classification in real-world scenarios.

CO5: Explore emerging applications of computer vision in healthcare, autonomous vehicles, and industrial sectors, focusing on human recognition and visual tracking.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	-	M	-	M
CO2	H	-	H	-	H
CO3	H	L	H	-	H
CO4	M	-	M	-	L
CO5	M	M	H	H	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: Web analytics is to analyze the behavior of website visitors. This engages tracking, reviewing, and reporting data to measure web activity. Thus, learning the various web analytics strategies helps in promoting inclusive and sustainable industrialization and foster innovation.

AIFY 13	NATURAL LANGUAGE PROCESSING	L	T	P	C
SDG:4		3	0	0	3

COURSE OBJECTIVES:

COB1: Provide students with a comprehensive understanding of Natural Language Processing (NLP), covering its key components.

COB2: Understand text classification, including its benefits, various types, and challenges.

COB3: Learn model design, unique strengths, applications in solving complex NLP tasks.

COB4: Explore various fine-tuning techniques, with pre-trained models for specific tasks.

COB5: Explore acoustic modeling , error correction methods to improve recognition accuracy.

MODULE I NLP AND REAL-WORLD APPLICATIONS 9

NLP and its components - Phases of NLP - Challenges of natural language - Applications of NLP - Industries using NLP - NLP programming languages - NLP libraries and Development environments - Use of AI in NLP - Basic Text Processing and Linguistic Concepts - Tokenization - Stemming - Lemmatization - Part-of-Speech Tagging.

MODULE II TEXT CLASSIFICATION 9

Benefits of Text Classification - Types of Text classification - Challenges in text classification - Applications of text classification.

MODULE III DEEP LEARNING FOR NLP 9

Convolutional Neural Networks for NLP - Recurrent Neural Networks (RNNs) for NLP - Recursive Neural Networks - Hybrid Models for NLP.

MODULE IV TRANSFER LEARNING FOR NLP 9

Benefits of Transfer Learning for NLP - Fine Tuning techniques - Fine-Tune BERT for

Spam Classification.

MODULE V VOICE RECOGNITION 9

Basics of Voice Recognition - Difference between speech and voice recognition - Use of NLP in voice recognition and transformation - Speech recognition using NLP models - HMM - DTW - Acoustic modelling - Error correction in voice recognition.

Total Hours:45

TEXT BOOKS:

1. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta Harshit Surana, Practical Natural Language Processing –Shroff/O'Reilly,1st Edition, ISBN-13: 978-1492054054,2020.
2. Uday Kamath, John Liu & James Whitaker, Deep Learning for NLP and Speech Recognition – Springer 1st edition, ISBN-13: 978-3030145958,2019.

REFERENCES:

1. Christopher D. Manning and Hinrich Schütze, “Foundations of Statistical Natural Language Processing”, MIT PRESS, 1st Edition, ISBN-13: 978-0262133609,1999.
2. Denis Rothman, ”Transformers for Natural Language Processing”,1st Edition, ISBN-13: 978-1800565791,2021.

COURSE OUTCOMES:

CO1: Describe the fundamental components and phases of Natural Language Processing

CO2: Explain the benefits and importance of text classification in data analysis and natural language processing.

CO3: Analyze and evaluate hybrid neural network models that combine CNNs, RNNs, and other architectures for enhanced NLP performance.

CO4: Evaluate the performance improvements gained through Transfer Learning and fine-tuning in NLP tasks.

CO5: Apply Natural Language Processing in voice recognition and transformation.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	L	-	M	-	L
CO2	M	L	M	-	M
CO3	H	L	H	-	M
CO4	H	L	H	-	M
CO5	M	L	M	-	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4: Quality Education.

This course enables to build Language models for automated feedback, language translation for global access to educational resources.

Statement: Understanding student emotions and feedback through NLP sentiment analysis helps improve course design and learning environments.

AIFY 14	SECURITY FOR DATA SCIENCE	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the fundamentals of Cyber Security.

COB2: Acquire knowledge in data governance and compliance frameworks

COB3: Provide an overview of data privacy and protection

COB4: Equip students with the skills to utilize Security Information and Event Management

COB5: Promote ethical and legal awareness and policies in Data Science

MODULE I CYBER SECURITY AND DATA SCIENCE 9

Overview of Cyber Security and Data Science - Definitions and Concepts - Intersection of Cyber Security and Data Science - Cyber Threat Landscape - Types of Cyber Threats - Attack Vectors and Techniques - Impact of Cyber Attacks on Data Science Processes - Foundations of Data Science - Data Collection and Sources - Data Storage and Management - Data Processing and Analysis Techniques.

MODULE II CYBER SECURITY CONCEPTS 9

Principles of Cyber Security - Confidentiality, Integrity, and Availability (CIA) - Authentication and Authorization - Encryption and Cryptography - Secure Data Handling - Data Classification and Sensitivity - Data Masking and Anonymization - Secure Data Transfer and Sharing - Data Privacy and Compliance - Privacy Regulations (GDPR, HIPAA) - Data Governance and Compliance Frameworks - Ethical Considerations in Data Science and Cyber Security.

MODULE III DATA PRIVACY AND PROTECTION 9

Data Privacy and Protection -Secure Data Sharing and Transfer - Secure File Transfer Protocols - Secure Data Exchange Platforms - Securing Data Collection Systems - Best Practices for Secure Data Storage - Cloud Security and Data Privacy - Secure Data Transfer and Backup Strategies - Data Retention Policies and Compliance.

MODULE IV THREAT DETECTION AND INCIDENT RESPONSE **9**

Threat Detection and Incident Response - Security Information and Event Management (SIEM) - Log Management and Analysis - Real-time Threat Detection - Incident Response Frameworks - Preparation, Identification, Containment, Eradication, Recovery - Forensic Analysis Techniques - Machine Learning for Cyber Security – Threat Prediction and Classification - Behavioural Analysis and User Profiling.

MODULE V ETHICAL AND LEGAL CONSIDERATIONS **9**

Advanced Topics in Cyber Security for Data Science - Adversarial Machine Learning - Evasion Attacks – Defence Mechanisms - Secure Machine Learning Models - Privacy-Preserving Machine Learning - Federated Learning – Ethical and Legal Considerations - Bias and Fairness in Cyber Security - Ethical Hacking and Responsible Disclosure.

L – 45; Total Hours: 45

TEXT BOOKS:

1. Robert Thibadeau & Bradley Schatz “Cybersecurity and Data Science”, Elsevier, ISBN: 9780323906625, 2023.

2. William Stallings, Lawrie Brown “Computer Security: Principles and Practice”,4th Edition, Pearson, ISBN: 9780137964265,2023.

REFERENCES:

1. Mohammad Hammoudeh, Kevin Curran- Privacy Preserving Machine Learning, Springer,2021

2. Charu Agarwal, Data Privacy: Foundations, New Developments and the Big Data Challenge, Springer 2021

3. Clarence Chio, David Freeman- Machine Learning and Security: Protecting Systems with Data and Algorithms, O’Rielly Media,2018

COURSE OUTCOMES:

CO1: Identify the threats and vulnerabilities and its impact on Data Science.

CO2: Implement secure data handling practices

CO3: Analyze security risks in Data Science projects

CO4: Apply tools and framework for Threat Detection and Response strategies.

CO5: Design Ethical and Privacy-Preserving Data Science Solutions

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	H	L	M	M	L
CO2	M	L	H	M	H
CO3	H	M	M	M	M
CO4	M	L	H	M	H
CO5	M	M	M	H	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: Ensuring security in data science protects sensitive information, promotes trust, and enables responsible innovation across industries. It supports strong institutions by safeguarding data integrity, preventing misuse, and enabling ethical decision-making in AI-driven systems.

AIFY 15	SOFT COMPUTING TECHNIQUES	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

COB1: Provide an overview of constituents of soft computing.

COB2: Gain knowledge about the concepts of fuzzy logic systems.

COB3: Illustrate various architectures of artificial neural networks.

COB4: Explore the historical development of Genetic Algorithms.

COB5: Analyse the applications of soft computing and implementation using Mat lab.

MODULE I INTRODUCTION TO SOFT COMPUTING 9

Introduction – Hard Computing and Soft Computing – Constituents of Soft Computing – Fuzzy logic – Crisp and Fuzzy sets – Fuzzy logic and inference rules – Fuzzy inference System.

MODULE II ARTIFICIAL NEURAL NETWORK 9

Biological Neurons – Artificial Neural Network – Perceptron – Multi layer Feed Forward Neural Network – Radial Basis Function Neural Network – Recurrent Neural System – Neuro Fuzzy System.

MODULE III EVOLUTIONARY COMPUTING 9

Evolutionary algorithm – Swarm Intelligence – Genetic algorithm process – Ant Colony Optimization.

MODULE IV GENETIC ALGORITHM 9

Genetic Algorithm - History of Genetic Algorithms - Working Principle - Various Encoding methods- Fitness function - GA Operators- Reproduction - Crossover - Mutation - Convergence of GA -Bit wise operation in GA - Multi-level Optimization.

MODULE V PROGRAMMING AND APPLICATIONS 9

Implementation of Soft computing techniques using Matlab– Soft computing applications in engineering and health.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Saroj Kaushik, Sunita Tiwari, “Soft Computing “, McGraw-Hill Education, ISBN:9789353160678, 9353160677, 2018.

2. Millie Pant, Kanad Ray, Anirban Bandyo padhyay,” Soft Computing Applications”, Springer Singapore, ISBN: 9789811080494, 9811080496, 2018.

REFERENCES:

1. S.A. Mohiuddine, Pradip Debnath, “Soft Computing Techniques in Engineering, Health, Mathematical and Social Sciences”, CRC Press, ISBN: 9781000409819, 1000409813, 2021.

2. Snehashish Chakravarty, “Concepts of Soft Computing”, Springer Singapore, ISBN: 9789811374302, 9811374309, 2019.

COURSE OUTCOMES:

CO1: Comprehend the various concepts of soft computing.

CO2: Design neuro fuzzy systems through the knowledge of fuzzy logic and neural networks.

CO3: Apply evolutionary computing algorithms.

CO4: Design and implement fitness functions to obtain optimal solution.

CO5: Implement the soft computing techniques using MATLAB programming.

Board of Studies (BoS):	**Academic Council:**
25th BoS of CSE held on 07.07.2025	24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	-	M	-	L
CO2	H	L	H	L	M
CO3	H	-	M	-	H
CO4	H	L	M	-	H
CO5	M	M	M	-	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 8: Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, and innovation.

Statement:

By learning the course, the students can design soft computing system applications thereby promoting sustainable economic growth and productive employment.

AIFY 16	ARTIFICIAL NEURAL NETWORKS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: Learn the neural network terminologies and process.

COB2: Realize the biological neural network and to model equivalent neuron models.

COB3: Understand the back propagation methods.

COB4: Discuss self-organization maps and learning algorithms.

COB5: Explore neuro dynamics models in artificial neural networks.

MODULE I INTRODUCTION & LEARNING PROCESS 9

A Neural Network - Human Brain, Models of a Neuron - Neural Networks viewed as Directed Graphs - Network Architectures - Knowledge Representation - Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning - Memory Based Learning - Hebbian Learning – Competitive - Boltzmann Learning - Credit Assignment Problem – Memory – Adaption - Statistical Nature of the Learning Process.

MODULE II SINGLE AND MULTI LAYER PERCEPTRONS 9

Adaptive Filtering Problem - Unconstrained Organization Techniques - Linear Least Square Filters - Least Mean Square Algorithm - Learning Curves - Learning Rate Annealing Techniques - Perceptron - Convergence Theorem - Relation Between Perceptron and Bayes Classifier for a Gaussian Environment. Multilayer Perceptron: Back Propagation Algorithm XOR Problem – Heuristics - Output Representation and Decision Rule - Computer Experiment - Feature Detection.

MODULE III BACK PROPAGATION 9

Back Propagation and Differentiation - Hessian Matrix – Generalization - Cross Validation - Network Pruning Techniques - Virtues and Limitations of Back Propagation Learning - Accelerated Convergence - Supervised Learning.

MODULE IV SELF-ORGANIZATION MAPS (SOM) 9

Two Basic Feature Mapping Models - Self-Organization Map - SOM Algorithm - Properties of Feature Map - Computer Simulations - Learning Vector Quantization - Adaptive Pattern

Classification.

MODULE V NEURO DYNAMICS MODELS AND HOPFIELD 9

Dynamical Systems - Stability of Equilibrium States - Attractors - Neuro Dynamical Models- Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, Computer Experiment.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Rao, S. K. "Artificial Neural Networks: Advanced Applications". Discovery Publishing House Pvt Ltd. ISBN 9788119523146 1,2024.
2. H. Cartwright, Artificial Neural Networks. Springer US, ISBN: 978-1-0716-0826-7,2021.

REFERENCES:

1. Michael Zgurovsky, Victor Sine Glazov, Elena Chumachenko, Artificial Intelligence Systems Based on Hybrid Neural Networks: Theory and Applications, Springer International Publishing, 2021.
2. H. Cartwright, Artificial Neural Networks. Springer US, ISBN: 978-1-0716-0826-7,2021.

COURSE OUTCOMES:

CO1: Identify the knowledge of artificial neural networks and its applications.
CO2: Implement single-layer and multi-layer perceptrons.
CO3: Apply backpropagation and its variations to train neural networks,
CO4: Analyze the self-organization maps in artificial neural networks.
CO5: Apply the neuro dynamic and hop field model in artificial experiment systems.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	M	H	L	L
CO2	M	L	H	L	H
CO3	M	L	H	M	H
CO4	H	M	H	M	M
CO5	M	M	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4: Quality Education - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement: The students will play a key role in artificial neural network algorithms and societal progress through research, discovery, knowledge creation and dissemination. They educate and equip young people with the knowledge acquired by building various application models.

AIFY 17	DISTRIBUTED PARALLEL AND SPATIAL DATABASES	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand architectures and transaction principles of centralized, parallel, distributed, and cloud-based databases.

COB2: Explore partitioning, replication, indexing, and optimization in parallel and distributed query processing.

COB3: Analyze distributed transaction management, commit protocols, concurrency control, and consensus methods.

COB4: Comprehend spatial database concepts, standards, metadata, and warehousing.

COB5: Apply spatial database implementation, legal aspects, web solutions, and decision support systems.

MODULE I INTRODUCTION TO DISTRIBUTED AND PARALLEL DATABASES **9**

Centralized Database Systems - Server System Architectures - Parallel Systems - Distributed Systems – History of Distributed Database Systems - Transaction Processing in Parallel and Distributed Systems - Cloud-Based Services.

MODULE II PARALLEL AND DISTRIBUTED STORAGE AND QUERY PROCESSING **9**

Data Partitioning - Replication - Parallel Indexing - Distributed File Systems - Parallel Key-Value Stores - Parallel Sort - Parallel Join - Other Operations - Parallel Evaluation of Query Plans - Query Processing on Shared Memory - Architectures - Query Optimization for Parallel Execution - Parallel Processing of Streaming Data - Distributed Query Processing.

MODULE III PARALLEL AND DISTRIBUTED TRANSACTION PROCESSING **9**

Distributed Transactions - Commit Protocols - Concurrency Control in Distributed - Databases - Replication - Extended Concurrency Control - Protocols - Replication with Weak Degrees of Consistency - Coordinator Selection - Consensus in Distributed

Systems.

MODULE IV INTRODUCTION TO SPATIAL DATABASES 9

Database Principles And Architecture – Spatial Data - Representation Of Spatial Objects – Spatial Database Systems – Spatial Data Standards – Metadata – Spatial Data Sharing – Spatial Data Warehousing and Database Federation.

MODULE V SPATIAL DATABASE IMPLEMENTATION 9

DBMS Support for Geospatial Data - User Education and Legal Issues of Spatial Database Systems - User Needs Assessment and Multi-user Spatial Solutions - Project Management for Spatial Database Implementation – Web enabled Spatial Database Systems - Spatial Data Mining and Decision Support Systems - Trends of Spatial Database Systems.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, 7th Edition McGraw-Hill, ISBN 9780078022159, 2021.
2. M. Tamer Ozsu, Patrick Valduriez, Principles of Distributed Database Systems, 4th Edition Springer Nature, Switzerland AG, ISBN-10 1441988335, 2020.

REFERENCES:

1. Longley, Paul A., Goodchild, Michael F., Maguire, David J., & Rhind, David W. Geographic Information Science and Systems, Wiley, 5th Edition, ISBN: 111938152 9781119381525, 2021.
2. Kleppmann, Martin, Designing Data-Intensive Applications, O'Reilly Media, 1st Edition, ISBN 1449373321, 9781449373320, 2017.
3. Han, Jiawei, Kamber, Micheline & Pei,Jian, Data Mining: Concepts and Techniques, Elsevier Morgan Kaufmann, 4th Edition, ISBN: 0128181483, 9780128181487, 2022.

COURSE OUTCOMES:

CO1: Analyze the basics of parallel and distributed storage systems.

CO2: Implement the parallel and distributed database operations and query processing

techniques.

CO3: Apply the various transactions and methods for parallel and distributed databases.

CO4: Interpret the basics of spatial databases and implement them.

CO5: Develop spatial database storage systems and analyze them.

Board of Studies (BoS): 25th BoS of CSE held on 07.07.2025

Academic Council: 24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	-	M	-	L
CO2	H	-	H	-	H
CO3	H	-	H	L	H
CO4	M	L	M	M	L
CO5	H	M	H	H	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding to define, create, store, and maintain parallel, distributed, and spatial databases leads to construction of resilient infrastructure and sustainable industrialization.

AIFY 18	INTELLIGENT INFORMATION RETRIEVAL	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: Learn basics of information retrieval and the role of Artificial Intelligence.

COB2: Provide knowledge on IR models, TF-IDF weighting, indexing, and querying.

COB3: Learn Web Search Engine, crawling and XML.

COB4: Expose to Link Analysis, Hadoop, Map Reduce and Snippet.

COB5: Understand document text mining techniques and clustering algorithms.

MODULE I INTRODUCTION **9**

Introduction -History of IR- Components of IR - Issues –Open-source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence in IR – IR Versus Web Search - Components of a Search engine- Characterizing the web.

MODULE II INFORMATION RETRIEVAL **9**

Boolean and vector-space retrieval models- Term weighting - TF-IDF weighting cosine similarity – Preprocessing - Inverted indices - Efficient processing with sparse vectors – Language Model based IR - Probabilistic IR –Latent Semantic Indexing - Relevance feedback and query expansion.

MODULE III WEB SEARCH ENGINE – INTRODUCTION AND CRAWLING **9**

Web search overview - Web structure - User- Paid placement - Search engine optimization/ spam - Web size measurement – Web Search Architectures - Crawling - Meta-crawlers- Focused Crawling - Web indexes –- Near-duplicate detection - Index Compression - XML retrieval.

MODULE IV LINK ANALYSIS AND SPECIALIZED SEARCH **9**

Link Analysis – Hubs and authorities – Page Rank and HITS algorithms -Searching and Ranking – Relevance Scoring and ranking for Web – Similarity - Hadoop - Map Reduce

- Evaluation - Personalized search - Collaborative filtering - Content-based recommendation of documents and products – Handling invisible web - Snippet generation - Summarization - Question Answering - Cross- Lingual Retrieval.

MODULE V DOCUMENT TEXT MINING 9

Information filtering- Organization and relevance feedback – Text Mining -Text classification and clustering - Categorization algorithms - Naive Bayes - Decision trees - Nearest neighbor - Clustering algorithms - Agglomerative clustering - K means - Expectation maximization -Case study.

L – 45; Total Hours– 45

TEXT BOOKS:

1. C. Manning, P. Raghavan, and H. Schütze, “Introduction to Information Retrieval”, Cambridge University Press, ISBN-13: 978-0521865715,2008.
2. Ricardo Baeza -Yates and BerthierRibeiro - Neto, “Modern Information Retrieval: The Concepts and Technology behind Search”, 2nd Edition, ACM Press Books ,ISBN-13: 978-0321416919,2011.
3. Bruce Croft, Donald Metzler and Trevor Strohman, “Search Engines: Information Retrieval in Practice”, 1st Edition ,Addison Wesley,ISBN-13: 978-0321435972, 2009.
4. Mark Levene, “An Introduction to Search Engines and Web Navigation”, 2nd Edition Wiley, ISBN-13: 978-0470746479,2010.

REFERENCES:

1. Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, “Information Retrieval: Implementing and Evaluating Search Engines”, The MIT Press,ISBN-13: 978-0262014877,2010.
2. Ophir Frieder, “Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series “, 2nd Edition, Springer, ISBN-13: 978-1402077407,2004.
3. Manu Konchady, “Building Search Applications: Lucene, Ling Pipe”, and First Edition, Gate Mystery Publishing, ISBN-13: 978-0976367660 , 2008.

COURSE OUTCOMES:

CO1: Describe information retrieval in artificial intelligence.

CO2: Analyse IR models, TF-IDF weighting, indexing, and querying in

	Information retrieval.
CO3:	Design Web Search Engine with XML.
CO4:	Implement PageRank and HITS algorithms.
CO5:	Utilize Document text mining techniques and clustering algorithms.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	L	L	H	-	L
CO2	M	M	H	-	M
CO3	M	M	H	L	H
CO4	H	L	H	-	H
CO5	H	M	H	L	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4: Focused on quality education, can be significantly advanced through the use of intelligent information systems.

Statement: Adaptive learning platforms adjust the difficulty and content based on individual student needs, ensuring a more engaging and effective learning process.

AIFY 19	KNOWLEDGE REPRESENTATION AND	L	T	P	C
SDG: 9	REASONING	3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the foundations of KRR and the tradeoff between representation and reasoning

COB2: To expose knowledge-based techniques those are appropriate for tasks.

COB3: To highlight KRR systems to their research and challenging problems.

COB4: To learn about research papers related to knowledge representation

COB5: To create awareness on the limitations and complexity of reasoning algorithms applied in knowledge-based systems.

MODULE I FIRST ORDER LOGIC 9

Introduction to Representations and Reasoning – the role of logic – the language of first order logic: syntax, semantics, and pragmatics – expressing knowledge – resolution.

MODULE II REASONING WITH HORN CLAUSES AND PROCEDURAL CONTROL 9

Horn Clauses – SLD resolution – facts and rules of procedural control – rule formation and strategy – algorithm design – specifying goal order – committing to proof methods – controlling backtracking.

MODULE III RULES IN PRODUCTION SYSTEMS 9

Basic operations – working memory – production rules – examples – conflict resolution – making the production system more efficient – applications.

MODULE IV OBJECT ORIENTED REPRESENTATION 9

Objects and frames – basic frame formalization – structured descriptions – Inheritance – defaults – uncertainty.

MODULE V ACTIONS AND PLANNING 9

Situation calculus – simple solution to frame problem – complex actions – planning the situation calculus – planning as a reasoning task.

L – 45; Total Hours– 45

TEXT BOOK:

1. Cheng, K., & Sun, Y. “Knowledge Graph Reasoning: A NeuroSymbolic Perspective”. Springer Cham. Hardcover ISBN 9783031720079; eBook ISBN 9783031720086, 2024.

REFERENCES:

1. Hitzler, P., Dalal, A., Mahdavinejad, M. S., & Norouzi, S. S. (Eds.). Handbook on Neurosymbolic AI and Knowledge Graphs (Frontiers in Artificial Intelligence and Applications, Vol. 400). IOS Press. ISBN 978-1-64368-578-6, 2025.
2. F. Van Harmelen, V. Lifschitz, and B. Porter, Handbook of Knowledge Representation, vol. 1, Foundations of Artificial Intelligence. Elsevier Science, ISBN: 9780444522115. 2008.
3. Ronald J Brachman and Hector J Levesque, “Knowledge Representations and Reasoning”, ISBN-13: 978-1558609327, Morgan Kaufmann publishers, 2004.

COURSE OUTCOMES:

CO1: Realize the fundamental principles of logic-based knowledge representation

CO2: Design simple application domains in logic-based language

CO3: Comprehend the notion of a reasoning service.

CO4: Apply the fundamentals of the reasoning algorithms underlying current systems.

CO5: Create representing information about the world in a form that a computer system can use to solve complex tasks

Board of Studies (BoS):

25th BoS of CSE held on 07.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	H	-	H	-	M
CO2	H	-	H	-	H
CO3	M	-	M	-	M
CO4	M	L	M	L	L
CO5	H	L	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: To represent information about the world in a form that a computer system can use to solve complex tasks such as diagnosing a medical condition or having a dialog in a natural language.

AIFY 20	RISKS AND DECISION MAKING FOR	L	T	P	C
SDG: 9	DATA SCIENCE AND ARTIFICIAL INTELLIGENCE	3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce decision support frameworks and enabling technologies.

COB2: To understand predictive analytics including statistical concepts and inferences.

COB3: To emphasize the prescriptive analytics including optimization and simulation.

COB4: To discover personal assistants, chatbots and recommender systems.

COB5: To learn the security, privacy, risks and societal dimensions of Analytics and AI.

MODULE I DECISION SUPPORT SYSTEMS 9

Decision Making process – Data and analysis in Decision Making – Technologies for Data Analysis and Decision Support –Computerized Decision Support to Business Intelligence – Analytics overview – Artificial Intelligence overview – Convergence of Analytics and AI.

MODULE II PREDICTIVE ANALYTICS 9

Nature of Data – Data preprocessing – Statistical Modeling for Business Analytics – Business Reporting – Data Visualization – Predictive Analytics and Data Mining – Machine Learning Techniques for Predictive Analytics.

MODULE III PRESCRIPTIVE ANALYTICS 9

Model Based Decision Making – Structure of Mathematical Models for Decision Support – Certainty, Uncertainty and Risk – Decision Modeling with Spreadsheets – Mathematical Programming Optimization - Multiple goals – Sensitivity Analysis – Decision Analysis with Decision Tables and Decision Trees.

MODULE IV KNOWLEDGE SYSTEMS 9

Expert Systems and Recommenders – Concepts, Drivers, and Benefits of Chatbots

– Enterprise Chatbots – Virtual Personal Assistants – Robo Advisors – Implementation issues.

MODULE V CAVEATS OF ANALYTICS AND AI 9

Implementation issues – Legal Privacy and Ethical issues – Impacts of intelligent systems on organizations – Impact on decision making – Industrial restructuring – Impacts on Jobs and Works – Potential dangers of Robots, AI, and Analytical modeling – Risk Modeling - Risk Categorization/Classification Model - Predicting risk - Relevant Technology Trends – Future of Intelligent Systems.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Ramesh Sharda, Dursun Delen, & Efraim Turban, Analytics, Data Science, & Artificial Intelligence: Systems for Decision Support, 11th edition, Pearson, ISBN: 978-0136886028, 2023.
2. Foster Provost & Tom Fawcett, Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, 2nd edition, O'Reilly Media, ISBN: 978-1098104014, 2023.

REFERENCES:

1. Luiz Paulo Favero and Patricia Belfiore, “Data Science for Business and Decision Making”, Elsevier, ISBN-13: 9780128112168, 2019.
2. 2. Banasiewicz Andrew D, “Evidence-Based Decision-Making”, Taylor & Francis, 1st edition, March ISBN-13: 978-1138485198, 2019.

COURSE OUTCOMES:

CO1: Design classical knowledge driven decision support systems to solve real time problems.

CO2: Use predictive models to forecast inventory and manage resources.

CO3: Determine an optimal course of action to achieve organizational goals.

CO4: Implement different types of new generation expert knowledge systems

CO5: Analyze the risks and implementation issues of intelligent

systems.

Board of Studies (BoS):
25th BoS of CSE held on 07.07.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	–	M	L	L
CO2	H	M	H	-	H
CO3	H	M	H	L	H
CO4	M	-	M	M	M
CO5	M	H	M	H	-

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:
The holistic understanding of the decision-making processes for business analytics, data science and artificial intelligence can build intelligent decision support systems in customer relationship management, banking and finance, health care and medicine, sports, and entertainment and virtually every industry imaginable.

AIFY 21	ROBOTICS AND INTELLIGENT SYSTEMS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Introduce the components of robots, basic working concepts and types of robots.

COB2: Understand the various robot programming languages.

COB3: Enlighten the students with the robot design process.

COB4: Illustrate the intelligent algorithm used in robotics.

COB5: Expose the students to the fundamentals of AI and Intelligent systems and its application in Robotics.

MODULE I INTRODUCTION TO ROBOTICS 9

components of robotics – classification – workspace - work-envelop - motion of robotic arm - end-effectors and its types - service robot and its application - Artificial Intelligence in Robotics.

MODULE II ROBOT PROGRAMMING 9

Introduction to robot languages –VAL – RAPID – language - basic commands - motion instructions - pick and place operation using industrial robot - manual mode - automatic mode - subroutine command based programming - move master command language – introduction - syntax-simple problems.

MODULE III ROBOT DESIGN PROCESS 9

Image recognition process – Neural network – Picking up the toys - Task Analysis - Teaching the robot arm - Other robot arm machine learning approaches – Teaching a robot to listen - Robot Speech recognition.

MODULE IV ALGORITHM 9

A* algorithm - D* Algorithm - probabilistic roadmap algorithm - Zero Moment Point (ZMP) Algorithm - Proportional Integral Differential (PID) Control Algorithm - GPS path finding.

MODULE V INTELLIGENT SYSTEMS 9

Basic activities of Intelligent system – Interpretation – Prediction – Diagnosis – Design – Planning – Monitoring – Debugging – Repair – Instruction – Control - Basic aspects of Intelligent system – Acquisition module - Knowledge base – Production rules - semantic net – frames - Inference engine – Backward chaining and forward chaining - Explanatory interface. Applications of Expert System - Design Domain - Medical Domain - Monitoring Systems - Process Control Systems - Knowledge Domain - Finance/Commerce.

L – 45; Total Hours– 45

TEXT BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, 4th edition, Addison-Wesley, ISBN: 978-0133489796, 2018.
2. Bruno Siciliano & Oussama Khatib (Eds.), Springer Handbook of Robotics, 2nd edition, Springer, ISBN: 978-3319325521, 2016.

REFERENCES:

1. Tsuneo Yoshikawa, Foundations of Robotics: Analysis and Control, 2nd edition, MIT Press, ISBN: 978-0262240283, 2013.
2. Francis X. Govers, Artificial Intelligence for Robotics, 1st edition, Packt Publishing Ltd, UK, ISBN: 978-1788835442, 2018.

COURSE OUTCOMES:

CO1: Understand the basic concepts of robot working.

CO2: Ability to program the robot for the real time application.

CO3: Conduct and design the experiments for various robot operations.

CO4: Comprehend and analyze the algorithm for the given specific problem.

CO5: Familiarize the application of AI in robotics

Board of Studies (BoS):

25th BoS of CSE held on 07.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1	M	-	M	-	L
CO2	M	-	H	-	H
CO3	H	M	H	-	H
CO4	H	-	H	-	H
CO5	M	M	H	H	M

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 9: Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.

statement:

Upgrade infrastructure and retrofit industries to make them sustainable with the knowledge and understanding of advanced technology like robotics, Intelligent systems

AIFY 22	SOCIAL NETWORK ANALYSIS AND	L	T	P	C
SDG: 10	MINING	3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the components of the social network.

COB2: Model and visualize the social network.

COB3: Determine the users in the social network.

COB4: Understand the evolution of the social network.

COB5: Learn the applications in real time systems.

MODULE I INTRODUCTION 9

Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks - Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

MODULE II MODELING AND VISUALIZATION 9

Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix- Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

MODULE III MINING COMMUNITIES 9

Aggregating and reasoning with social network data - Advanced Representations – Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.

MODULE IV EVOLUTION 9

Evolution in Social Networks – Framework - Tracing Smoothly Evolving

Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks – Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

MODULE V APPLICATIONS 9

A Learning Based Approach for Real Time Emotion Classification of Tweets - A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments - Explaining Scientific and Technical Emergence Forecasting - Social Network Analysis for Biometric Template Protection-Case Study.

L – 45; Total Hours– 45

TEXT BOOK:

1. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel,Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 1st edition,ISBN-13::978-8132231578, 2012.

REFERENCES:

1. Giles, Mark Smith, John Yen, —Advances in Social Network Mining and Analysis, Springer,1st edition, ISBN-13. 978-3642149283,2010.
2. Guandong Xu, Yanchun Zhang and Lin Li, — Web Mining and Social Networking – Techniques and applications, Springer, 1st edition, ISBN-13. 978-1441977342,2012.

COURSE OUTCOMES:

Students who complete this course will be able to

CO1: Demonstrate the internals components of the social network.

CO2: Design various models and visualize the social network.

CO3: Analyze the behavior of the users in the social network.

CO4: Predict the possible next outcome of the social network.

CO5: Apply social networks in real time applications.

Board of Studies (BoS):
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	PO1	PO2	PO3	PO4	PO5
CO1	L	L	H	-	M
CO2	M	M	H	L	H
CO3	H	M	H	L	M
CO4	H	M	H	M	M
CO5	M	M	H	M	H

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 10: Build how social structures and relationships influence development, and how to leverage these networks for positive change.

Statement: Social network analysis can help identify and address inequalities within communities and organizations by revealing power structures and access to resources.