PONDICHERRY UNIVERSITY
(A CENTRAL UNIVERSITY)
SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE

REGULATIONS, CURRICULUM & SYLLABUS
(For Affiliated Colleges)

B.Sc. (Honors) DEGREE PROGRAMME

B.Sc. Artificial Intelligence and Machine Learning
(Honors with Research)

B.Sc. Artificial Intelligence and Machine Learning
(Honors)

(Under the National Education Policy 2020)
Effective from the Academic Year 2023 - 2024

November 2023

TABLE OF CONTENTS

1. PREAMBLE

Welcome to the undergraduate course on Artificial Intelligence and Machine Learning! This course offers an exciting and dynamic exploration of the cutting-edge field that is revolutionizing the way we interact with technology and understand the world around us.

Artificial Intelligence and Machine Learning are at the forefront of technological innovation, and this course is designed to equip you with the knowledge and skills necessary to understand, develop, and apply these transformative technologies.

This course is a comprehensive and in-depth introduction to the theory, practice, and application of Artificial Intelligence (AI) and Machine Learning (ML). In an era characterized by unprecedented data availability and computational power, the study of AI and ML has become essential for understanding how machines can learn, adapt, and make intelligent decisions.

2. PROGRAM OUTCOMES

After the completion of this program, the students will be able to:

1. **Understand the foundations of AI and ML**: Students will delve into the fundamental concepts that underpin AI and ML, including algorithms, data visualization, and mathematical prerequisites.

2. **Understand the basics of ML**: Gain a deep understanding of supervised and unsupervised learning, feature engineering, model selection, and the mathematics behind common ML algorithms.

3. **Apply the Deep Learning Concepts**: Explore neural networks, convolutional and recurrent networks, and discover the principles that enable the students to excel in tasks like image recognition, natural language processing, and beyond.

4. **Understand the scope of AI & ML**: Investigate the myriad ways in which AI and ML are used in practice, including autonomous vehicles, healthcare, finance, recommendation systems, and more.

5. **Analyze Ethical and Legal Issues in AI**: Analyze the ethical and legal implications and challenges associated with AI and ML, including issues related to bias, fairness, transparency, and accountability.

6. **Evaluate the emerging tools in AI**: The students will be able to evaluate the modern AI tools in solving their problems. They would be able to stay abreast of the latest developments, research, and trends in AI and ML, as the field continuously evolves.

7. **Create solutions for real-world problems**: Hone critical thinking and problem-solving abilities through practical assignments and projects that tackle real-world challenges. Students will learn to build predictive models using popular programming languages, libraries, and frameworks.

This course offers the student a unique opportunity to explore the frontiers of technology and be part of a global community of learners and innovators.

Whether the student aspires to be a researcher, developer, entrepreneur, or simply want to gain a deeper understanding of AI and ML, this course will provide the student with the foundation needed to excel in the chosen path.

3. DEFINITIONS

Terms used in the NEP Regulations shall have the meaning assigned to them as given below unless the context otherwise requires:

A. Credit: A credit is the number of hours of instruction required per week for the given subject in a given semester of 16-18 weeks. One credit is equivalent to 15 hours of teaching (lecture or tutorial) or 30 hours of practice or field work or community engagement and service per Semester.

B. Academic Year: Means the year starting on 1st day of July and ends on the 30th day of June succeeding year.

C. Residence Time: Means time a student spends attending classes in the College/Institution (either Online/Offline) as a full-time student and enrolled in any Academic programme of the Institution.

D. **Semester:** Means 18 weeks (90 Working days) of teaching-learning session of which two weeks shall be set apart for examinations and evaluation.

E. Grade: Means a letter grade assigned to a student in a course for his/her performance at academic sessions as denoted in symbols of: O(Outstanding), A+ (Excellent), A (Very good), B+ (Good), B (Above average), C (Average), P (Pass), F (Fail) and Ab (Absent) with a numeric value of O = 10, A+ = 9, A = 8, B+ = 7, B = 6, C = 5, P = 4, and F = 0, Ab = 0.

F. Grade Point Average (GPA): Means an average of the Grades secured by a student in all courses in a given academic session duly weighted by the number of credits associated to each of the courses.

G. Cumulative GPA (CGPA): Means the weighted average of all courses the student has taken in the entire programme of study.

H. Common Courses: Means the set of courses that all students who are admitted are required to study; these courses include, Languages (English- Modern Indian languages), NEP specific courses viz. Understanding India, Environmental sciences/Education, Health and wellbeing/Yoga, and Digital & Technological solutions.

I. Major Discipline Courses: Means the core subjects mandatory for the Computer Science discipline. These courses are common across all specializations of Computer Science.

J. Minor Discipline Courses: Means allied/elective/specialization specific subjects of Computer Science discipline. Based on the set of Minor Discipline Courses the candidate study, specialization in Computer Science will be awarded. Eg.: B.Sc. (Artificial Intelligence and Machine Learning) with minor discipline courses in Artificial Intelligence and Machine Learning will be awarded B.Sc. Artificial Intelligence and Machine Learning.

K. Credit Requirements: For a Degree/Diploma/Certificate Programme means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be.

L. Exit option: Means the option exercised by the student, to leave the Programme at the end of any given Academic year.

M: Lateral Entry: Means a student being admitted into an ongoing Programme of the University otherwise than in the 1st year of the programme.

N: Vocational Studies/Education: Means set of activities for participation in an approved project or practical or lab, practices of application of scientific theories, studio activities involving students in creative artistic activities, workshop-based activities, field-based shop-floor learning, and Community engagement services, etc. **(These courses are expected to enable students to incorporate the learned skills in daily life and start up entrepreneurship.)**

O: Skill-based Learning/project: Means activities designed to understand the different socio-economic contexts, first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process.

P: Work-based Internship: Means structured internships with Software Companies, Research and Higher Educational Institution Laboratories, Corporate offices, etc. which will further improve employability.

4. AWARD OF UG DEGREE/DIPLOMA/CERTIFICATE

Four years B.Sc. Degree Programme shall have options for earning a Certificate/Diploma/UG Degree/UG Degree with Honors based on the exit option exercised by the candidates.

4.1 Degree and Nomenclature

Candidates who complete Eight semesters and earn a minimum of 160 credits will be awarded either of the following degrees after successful completion of the said requirements.

- B.Sc. Artificial Intelligence and Machine Learning (Honors with Research)*
- B.Sc. Artificial Intelligence and Machine Learning (Honors)**

* for candidates who complete a research project work in the Eighth Semester

** for candidates who complete 3 theory courses (MJD 21, MJD 22, and MJD 23) instead of the research project work in the Eighth Semester

4.2 Exit Options

Candidates can exercise the following exit options and obtain the said certificate or diploma or degree, if the minimum required credits are earned and other conditions are met.

Exit after 2nd Semester: Certificate in Data Visualization will be awarded for candidates who exit the course at the end of 2nd semester and earned a minimum of 40 credits and have completed a Summer Internship of 4 credits for 4 - 6 weeks duration, during the summer vacation post 2nd semester.

Exit after 4th Semester: Diploma in Artificial Intelligence and Machine Learning will be awarded for candidates who exit the course at the end of 4th semester and earned a minimum of 80 credits and have completed a Summer Internship of 4 credits for 4 - 6 weeks duration, during the summer vacation post 4th semester.

Exit after 6th Semester: UG Degree in B.Sc. Artificial Intelligence and Machine Learning will be awarded for candidates who exit the course at the end of 6th semester and earn a minimum of 120 credits and have completed a Summer Internship of 4 credits for 4 - 6 weeks duration, during the summer vacation post 4th semester.

Exit after	Credits and other requirements	Awards
2nd Semester	Min: 40 Credits, Internship 45 days	Certificate in Data Visualization
4th Semester	Min: 80 Credits, Internship 45 days	Diploma in Artificial Intelligence and Machine Learning
6th Semester	Min: 120 Credits, Internship 45 days	B.Sc. Artificial Intelligence and Machine Learning

5. PEDAGOGICAL APPROACHES

COURSE TYPES	APPROACH
a) Lecture Courses	Regular classroom lectures by qualified / experienced Expert Teachers ● These Lectures may also include classroom discussion, demonstrations, case analysis ● Use of Models, Audio-Visual contents, Documentaries, PPTs may supplement.
b) Tutorial Courses	Problem solving Exercise classes, guided discussion, supplementary readings, vocational training, etc.
c) Practical / Lab work	Practical Lab activity with Theoretical support Mini projects, Activity based engagement, Program executions, Data processing and presentation exercise.
d) Seminar Course	A course requiring students to design and participate in discussions, Group Discussions, Elocution and Debate, Oral Communication Paper Presentations, Poster Presentation, Role Play Participation, Quiz Competitions, Business Plan Preparation/Presentation, etc.
e) Internship course	Courses requiring students to *Learn by Doing* in the workplace external to the educational Institutions. Internships involve working in Software Companies, Research and Higher Educational Institution Laboratories, Corporate Offices, etc. All Internships should be properly guided and inducted for focused learning.
f) Research Project	Students need to study and analyze the recent research publications from indexed/peer reviewed journals in their area of specialization. Outcome of the study and analysis need to be presented as a thesis or research report with necessary experimental results.

6. ACADEMIC AUDIT OF COURSES

The Internal Quality Assurance Cell (IQAC) at every Institution is expected to supervise the implementation of National Education Policy (NEP) Regulations in these programmes. Availability of required number of Classrooms, Faculty Rooms, Labs, Library Facilities, Computer Centre and recruitment of Faculty members, Allocation of funds for running the Science Labs/Computer Centre etc., is the responsibility of the College Administration.

7. ADMISSIONS & LATERAL ENTRY

7.1 Admissions Eligibility

The candidates for admission to this programme shall be required to have passed the 10+2 / 10+3 system of examinations or equivalent with mathematics / business mathematics / equivalent as one of the subjects of study.

Students shall be admitted to this programme based on admissions criteria fixed by the University / Government of Puducherry from time to time.

7.2 Lateral Entry

As per NEP, students have a choice of exit and entry into the programme multiple times. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students.

Candidates seeking entry at the second, third and fourth year, should meet the necessary eligibility criteria with respect to the certificate / diploma / degree they possess, with necessary minimum credits banked in the Academic Bank of Credits (ABC). Such students who get admitted in later years, other than first year will be guided by the following clauses:

- that the University shall notify the admission process and number of vacancies open for lateral entry.
- that the Lateral entrants shall be admitted only after such transparent screening process and such procedure that the University may prescribe from time to time. University may prescribe different methods of screening for different programmes depending on the circumstances prevailing in each case.
- Lateral entry shall be permissible only in the beginning of years 2, 3, 4 of the Under Graduate / Honors programme; provided that the students seeking lateral entry shall have obtained the minimum pass marks / grades fixed by the University in their previous academic years.

8. EVALUATION (INTERNAL & END SEMESTER ASSESSMENT) AND GRADES (Upto 6th Semester)

All Credit courses are evaluated for 100 marks. The Internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks for theory courses. In case of practical courses, research project work etc., Internal Assessment component is for 50 marks and the End Semester University exam is for 50 marks.

Internal Test Scheme: Principal of the College schedules the Mid-Semester Exam for all courses during 8/9th week of start of classes. Mid-Semester exams for 90 minutes duration need to be conducted for all these theory courses. The evaluated marks need to be uploaded to the Controller of Examinations of the University. The answer books of Mid-Semester exams need to be preserved until the declaration of results by the University.

8.1 INTERNAL ASSESSMENTS

8.1.1 Internal Assessment Marks for Theory subjects

Total Internal Assessment mark for a theory subject is 25 marks. The breakup is as follows:

Evaluation Component	Marks
A. Mid Semester Exam (one)	20
B. Percentage of Attendance	05
Total	**25**

8.1.2 Internal Assessment marks for Skill Enhancement/Practical/Internships subjects

Faculty member in-charge of Lab practical shall evaluate the practical subjects for 50 marks. The breakup is as follows:

Evaluation Component	Marks
A. Mid-Semester Practical Exam (one) / Viva-voce	20
B. Practical Record / Internship Report	25
C. Percentage of Attendance	05
Total	**50**

8.1.3 Internal Assessment marks for Research Project Work

There shall be a faculty member assigned as a Project Guide for each candidate doing the Research Project. Progress of the candidate can be assessed once in a month in a project review meeting. Three project review meetings shall be conducted for Internal Assessment.

Project review committee may be constituted and the committee shall organize project review meetings and evaluate the progress and to award the Internal Assessment marks. The Internal Assessment component for the Research Project is 50 Marks. The breakup is as follows:

Evaluation Component	Marks
A. Monthly Review (3 Reviews – 10 Marks each)	30
B. Project Report	10
C. Project Presentation and viva-voce	10
Total	**50**

8.1.4 Internal Assessment marks for Theory Subjects with Practical Components

Faculty members in-charge of Theory Subjects with Practical Component shall evaluate the candidates both for their performance in theory and practical. The Internal Assessment marks for Theory Subjects with Practical Components is 25 marks. The break up is as follows:

Evaluation Component	Marks
A. Mid Semester Exam (one)	15
B. Observation Note / Practical Record	05
C. Percentage of Attendance	05
Total	**25**

8.1.5 Marks for Attendance

Marks for attendance is as follows

Attendance %	Marks
Below 75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

8.2 END SEMESTER ASSESSMENT (ESA)

Controller of Examinations (CoE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on the university calendar. For Theory courses with Practical components, End semester exams shall be conducted separately for Theory and Practical.

A detailed Exam Time Table shall be circulated at least 15 days before the start of exams, mostly during 15/16th week of the Semester. Question Papers shall be set externally based on

BoS approved syllabus. All students who have a minimum of 70% attendance are eligible to attend the end-semester exams. Attendance percentage shall be calculated for each course to decide the eligibility of the candidate for writing the end-semester examination.

8.2.1 Breakup of End Semester Marks

(All End Semester Exams shall be conducted by the Pondicherry University)

The question paper shall be set as per the Bloom's Taxonomy. Various levels along with its description and sample questions are as follows:

Knowledge: Recall or remember previously learned information.
Example: List the basic data types in Python

Comprehension: Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas.
Example: Explain how a stack data structure works.

Application: Apply knowledge and concepts to solve problems in new situations. Use learned information in a different context.
Example: Write a Python program to solve the deadlock problem.

Analysis: Break down information into parts and examine the relationships between the parts. Identify motives or causes.
Example: Analyze the efficiency of two sorting algorithms and compare their advantages and disadvantages.

Synthesis: Create a new whole by combining elements in novel ways. Use creativity to produce something original.
Example: Design a web application that can generate a time table of a school.

Distribution of questions at various levels are as indicated.

Course Components	Max. Marks	End-Semester Exam Duration
A. Theory subjects: Sec A: 10 Questions of 2 Marks each (20 Marks) *(Knowledge: 3, Comprehension: 2, Application: 3, Analysis:2)* Sec B: 5 out of 7 Questions of 5 Marks each (25 Marks) *(Knowledge: 1, Comprehension: 2, Application: 1, Analysis:3)* Sec C: 2 Either/OR choice questions of 15 Marks each (30 Marks) *(Application: 1, Analysis:1)* **Questions from all units of Syllabus equally distributed.**	75 Marks	3 Hours
B. Skill Enhancement/Practical/Internship/Project Work subjects: **Skill Enhancement / Practical Subjects:** Based on Practical Exams conducted by CoE of University **Internship / Research Project Work:** Presentation of the work / Report / Viva-voce examinations	50 Marks	3 Hours --
C. Theory Subjects with Practical Components: **i. Theory Component:** Sec A: 5 Questions of 2 Marks each (10 Marks) *(Knowledge: 3, Comprehension: 2, Application: 3, Analysis:2)* Sec B: 5 out of 7 Questions of 4 Marks each (20 Marks) *(Comprehension: 2, Application: 3, Analysis:2)* Sec C: 2 Either or type questions of 10 Marks each (20 Marks) *(Analysis / Synthesis)* **Questions from all units of Syllabus equally distributed.**	50 Marks	3 Hours

ii. Practical Component: Based on Practical Exams / Presentation / Viva-voce with external examiner appointed by the University Controller of Examinations, and schedules exclusively prepared for such practical examinations by the University Examination Section. **The examination shall be conducted for 50 Marks and reduced to 25 Marks.** **Total Marks: 75 (Theory: 50 Marks + Practical: 25 Marks)**	25 Marks	3 Hours

8.3 CONSOLIDATION OF MARKS AND PASSING MINIMUM

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in End-Semester examinations. The total marks will be converted into letter grades. The passing minimum is 40% marks (Internal Assessment + End Semester Assessment put together) and students who secure between 40% and 49% will be awarded 'P' (Pass Grade).

8.3.1 Arrear Exam

A student who secures less than 40% marks in aggregate is declared as ***Fail*** and that student is eligible to take up supplementary examination by registering to the failed course in the following Semester. All other candidates who failed due to shortage of attendance and those who are seeking to improve the grade shall repeat the course.

8.3.2 Letter Grades and Calculation of CGPA

Total Marks Secured by a student in each subject shall be converted into a letter grade. UGC Framework has suggested a Country wide uniform letter grades for all UG courses. The following table shows the seven letter grades and corresponding meaning and the grade points for calculation of CGPA.

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
O	Outstanding	10
A+	Excellent	9
A	Very Good	8
B+	Good	7
B	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

In order to work out the above letter grades, the marks secured by a student (Total of Internal Assessment and End Semester Assessment) would be categorized for relative grading.

The range of marks for each grade would be worked as follows:

- Highest marks in the given subject: X
- Cut of marks for grading purpose: 50 marks
- Passing minimum: 40
- Number of grades (except P - Pass) (O, A+, A, B+, B, C): G = 6
- Range of marks: K = (X - 50) / G

(i) If K ≥ 5, then the grades shall be awarded as given in the following table.

If K ≥ 5		
Range of Marks in %	**Letter Grade Points for**	**Grade Points for**
X to (X-K) + 1	O	10

(X-K) to (X-2K) + 1	A+	9
(X-2K) to (X-3K) + 1	A	8
(X-3K) to (X-4K) + 1	B+	7
(X-4K) to (X-5K) + 1	B	6
(X-5K) to 50	C	5
40 – 49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If K< 5, then the grades shall be awarded as given in the following table.

If K < 5		
Range of Marks in %	**Letter Grade Points for**	**Grade Points for**
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below 40	F	0
Absent (lack of attendance)	Ab	0

8.3.3 Calculation of SGPA and CGPA

Semester Grade Point Average (SGPA) is calculated by taking a weighted average of all grade points secured by a candidate from all subjects registered by him/her in the given Semester. The weights being the number of credits that each subject carries.

Cumulative Grade Point Average (CGPA) shall be calculated as the weighted average of credits that course carries and the value of Grade points averaged for all subjects.

8.3.4 Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):
The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student to the sum of the number of credits of all the courses undergone by a student, i.e. $SGPA\ (S_i) = \Sigma(C_i \times G_i) / \Sigma C_i$

where C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course.

(i) Example for Computation of SGPA where candidate has not failed in any course

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	B	6	4 X 6 = 24
		20			139
				SGPA	**139/20=6.95**

(ii) Example for Computation of SGPA where candidate has failed in one course

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			115
				SGPA	**115/20=5.75**

(iii) Example for Computation of SGPA where candidate has failed in two courses

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	F	0	3 X 0 = 00
I	Course 4	3	B	6	3 X 6 = 18
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			85
				SGPA	**85/20=4.25**

The CGPA shall also be calculated in a similar way as shown in examples (i), (ii) and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails

more than once in the same subject, then while calculating CGPA, the credit and grade point related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

8.3.5 Declaration of Results

The Controller of Examinations (CoE) of the University shall declare the results of a given UG programme following the CGPA secured by students by the end of 6th Semester and 8th Semester.

8.3.6 Classification of Divisions

Range of CGPA	Result
9.0 – 10	First Class with distinction*
6.0 - 8.99	First Class
5.0 - 5.99	Second Class
4.0 - 4.99	Pass Class

* Distinction will be awarded only to those candidates who have cleared ALL the subjects in the first attempt.

8.4 INTERNAL ASSESSMENT/END SEMESTER ASSESSMENT/PASSING MINIMUM/GRADES (7TH AND 8TH SEMESTERS)

Regulations to be notified in the next revision after the confirmation from the University NEP Committee.

B.Sc. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

CURRICULUM & COURSE COMPONENTS

9. MINIMUM CREDITS REQUIREMENT - BREAK-UP OF THE COURSES

S.No.	Components	3-year UG			4-year UG (Honors / Honors With research)		
		Credits	Courses	Cr/Course	Credits	Courses	Cr/Course
1	Major Disciplinary/ Interdisciplinary Courses	56	14	4	76	19	4
2	Minor Disciplinary/ Interdisciplinary Courses	24	6	4	32	8	4
3	Multi-Disciplinary Courses	9	3	3	9	3	3
4	Ability Enhancement Courses	8	4	2	8	4	2
5	Skill Enhancement Courses	9	3	3	9	3	3
6	Value-added courses	8	4	2	8	4	2
7	Summer Internship (MJD 11)	4	1	4	4	1	4
8	Community Engagement and Service	2	1	2	2	1	2
9	Research Project/Dissertation	--	--	--	12	Project or 3 Courses##	
Total		**120**			**160**		

##Note: Honors students not undertaking research will do 3 courses for 12 credits in lieu of a research project/Dissertation.

- MJD: Major Disciplinary (Compulsory – Hardcore Subjects)
- MID: Minor Disciplinary (Specialization Specific – Softcore Subjects)
- MLD: Multi-Disciplinary
- AEC: Ability Enhancement Courses

- SEC: Skill Enhancement Courses
- VAC: Value Added Courses
- SG: Specialization Group
- Course Code: AM1MJ01(E) (AM-B.Sc. Artificial Intelligence and Machine Learning), 1-Semester, MJ-Component, 01-Course Number in the respective component, E-Elective)

B.Sc. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

10. CURRICULUM

FIRST SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 1	AM1MJ01	Digital Logic Fundamentals	H	4	3		2
2	MID 1	AM1MI01	Data Visualization	S	4	3		2
3	MLD 1		One course from the MLD streams 1 to 10	H	3	4		
4	AEC 1	AM1AE01	English I	H	2	2		2
5	SEC 1		S.No. 1 or 2 from Table 7	S	3	2		2
6	VAC 1	AM1VA01	Understanding India	H	2	4		0
7	VAC 2	AM1VA02	Environmental Sciences/Education /Higher Order Thinking	H	2	4		0
				Total	20	30 Hours		

SECOND SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 2	AM2MJ02	Problem Solving & Programming Fundamentals	H	4	3		2
2	MID 2	AM2MI02	Introduction to Artificial Intelligence	S	4	3		2
3	MLD 2		One course from the MLD streams 1 to 10 except the stream chosen in MLD1	H	3	4		
4	AEC 2	AM2AE03	Indian Language I	H	2	2		2
5	SEC 2		S.No. 3 or 4 from Table 7	S	3	2		2

6	VAC 3	AM2VA03	Health & Wellness/Yoga Education/ Universal Human Values	H	2			4
7	VAC 4	AM2VA04	Digital Technologies	H	2	3		
				Total	20	29 Hours		

THIRD SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 3	AM3MJ03	Mathematical Foundations of CS	H	4	4	1	
2	MJD 4	AM3MJ04	Data Structures	H	4	3		2
3	MID 3	AM3MI03	AI and Ethics	S	4	3		2
4	MLD 3		One course from the MLD streams 1 to 10 except the streams chosen in MLD1 and MLD2	H	3	4		
5	AEC 3	AM3AE05	English II	H	2	2		2
6	SEC 3		S.No. 5 or 6 from Table 7	S	3	2		2
				Total	20	27 Hours		

FOURTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 5	AM4MJ05	Computer System Architecture	H	4	3		2
2	MJD 6	AM4MJ06	Design and Analysis of Algorithms	H	4	3		2
3	MJD 7	AM4MJ07	Object Oriented Programming	H	4	3		2
4	MID 4	AM4MI04	Mathematical Foundations of Machine Learning	S	4	3		2
5	AEC 4	AM4AE06	Indian Language II	H	2	2		2

6	Project	AM4CS01	Community Engagement and Service	H	2			6
				Total	20	30 Hours		

FIFTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 8	AM5MJ08	Operating Systems	H	4	3		2
2	MJD 9	AM5MJ09	Database Management Systems	H	4	3		2
3	MJD 10	AM5MJ10	Management Strategies & Concepts	H	4	4		
4	MID 5	AM5MI05	Artificial Neural Networks	S	4	3	2	
5	MJD 11	AM5MJ11	Summer Internship	H	4			6
				Total	20	25 Hours		

SIXTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 12	AM6MJ12	Computer Networks	H	4	3		2
2	MJD 13	AM6MJ13	Software Engineering Theory and Practice	H	4	3		2
3	MJD 14	AM6MJ14	System Modelling & Simulation	H	4	3		2
4	MJD 15	AM6MJ15	Web Engineering	H	4	3	2	
5	MID 6		Any one course from Table 1	S	4	3		2
				Total	20	25 Hours		

SEVENTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 16	AM7MJ16	Software Testing and Quality Assurance	H	4	3		2
2	MJD 17	AM7MJ17	Distributed Systems	H	4	3		2
3	MJD 18	AM7MJ18	Wireless Communication Networks (5G)	H	4	3		2
4	MID 7		Any one course from Table 2	S	4	3		2
5	MID 8		Any one course from Table 3	S	4	3		2
				Total	20	25 Hours		

EIGHTH SEMESTER - B.Sc. AI & ML (Honors)								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 19		Any one course from Table 4	H	4	3		2
2	MJD 20		Any one course from Table 5	H	4	3		2
3	MJD 21	AM8MJ21	Large Language Models	H	4	3		2
4	MJD 22	AM8MJ22	Prompt Engineering	H	4	3		2
5	MJD 23	AM8MJ23	Time Series Analysis	H	4	3		2
				Total	20	25 Hours		

EIGHTH SEMESTER - B.Sc. AI & ML (Honors with Research)								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 19		Any one course from Table 4	H	4	3		2
2	MJD 20		Any one course from Table 5	H	4	3		2

3	MJD 21	AM8MJ24	Research Project	H	4			5
4	MJD 22	AM8MJ25	Project Report	H	4			5
5	MJD 23	AM8MJ26	Project Viva-voce	H	4			5
				Total	20	25 Hours		

Table 1: MID 6 – SIXTH SEMESTER

S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MID 6	AM6MI06E1	Machine Learning in IoT	S	4	3		2
2	MID 6	AM6MI06E2	Big Data Analytics	S	4	3		2

Table 2: MID 7 – SEVENTH SEMESTER

S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MID 7	AM7MI07E1	Reinforcement Learning	S	4	3		2
2	MID 7	AM7MI07E2	Natural Language Processing	S	4	3		2

Table 3: MID 8 – SEVENTH SEMESTER

S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MID 8	AM7MI08E1	Deep Learning and Image Analytics	S	4	3		2
2	MID 8	AM7MI08E2	Robotics	S	4	3		2

Table 4: MJD 19 – EIGHTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 19	AM8MJ19E1	Sequence Models	S	4	3		2
2	MJD 19	AM8MJ19E2	AI and Cybersecurity	S	4	3		2

Table 5: MJD 20 – EIGHTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 20	AM8MJ20E1	Generative AI	S	4	3		2
2	MJD 20	AM8MJ20E2	Explainable AI	S	4	3		2

Table 6: MJD 21 / MJD 22 / MJD 23 – EIGHTH SEMESTER								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	MJD 21	AM8MJ21	Large Language Models	H	4	3		2
2	MJD 22	AM8MJ22	Prompt Engineering	H	4	3		2
3	MJD 23	AM8MJ23	Time Series Analysis	H	4	3		2

Table 7: SEC 1 / SEC 2 / SEC 3 – I / II / III SEMESTERs								
S.No.	Component	Course Code	Title of the Course	H/S	Credits	Hours/Week		
						L	T	P
1	SEC 1	AM1SE01E1	Python Programming	S	3	3		2
2	SEC 1	AM1SE01E2	Building Interactive Dashboards	S	3	3		2
3	SEC 2	AM2SE02E1	Data Wrangling with R	S	3	3		2
4	SEC 2	AM2SE02E2	Logic Programming	S	3	3		2
5	SEC 3	AM3SE03E1	Machine Learning Frameworks	S	3	3		2
6	SEC 3	AM3SE03E2	Data Mining & Tools	S	3	3		2

Table 8: List of Major Disciplinary Courses				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**MJD 1**	**AM1MJ01**	Digital Logic Fundamentals	**H**
2.	**MJD 2**	**AM2MJ02**	Problem Solving & Programming Fundamentals	**H**
3.	**MJD 3**	**AM3MJ03**	Mathematical Foundations of Computer Science	**H**
4.	**MJD 4**	**AM3MJ04**	Data Structures	**H**
5.	**MJD 5**	**AM4MJ05**	Computer System Architecture	**H**
6.	**MJD 6**	**AM4MJ06**	Design and Analysis of Algorithms	**H**
7.	**MJD 7**	**AM4MJ07**	Object Oriented Programming	**H**
8.	**MJD 8**	**AM5MJ08**	Operating Systems	**H**
9.	**MJD 9**	**AM5MJ09**	Database Management Systems	**H**
10.	**MJD 10**	**AM5MJ10**	Management Strategies & Concepts	**H**
11.	**MJD 11**	**AM5MJ11**	Summer Internship	**H**
12.	**MJD 12**	**AM6MJ12**	Computer Networks	**H**
13.	**MJD 13**	**AM6MJ13**	Software Engineering - Theory and Practice	**H**
14.	**MJD 14**	**AM6MJ14**	System Modelling & Simulation	**H**
15.	**MJD 15**	**AM6MI15**	Web Engineering	**H**
16.	**MJD 16**	**AM7MJ16**	Software Testing and Quality Assurance	**H**
17.	**MJD 17**	**AM7MJ17**	Distributed Systems	**H**
18.	**MJD 18**	**AM7MJ18**	Wireless Communication Networks (5G)	**H**
19.	**MJD 19**		Sequence Models / AI and Cybersecurity	**S**
20.	**MJD 20**		Generative AI / Explainable AI	**S**

Table 9: List of Minor Disciplinary Courses				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**MID 1**	**AM1MI01**	Data Visualization	**S**
2.	**MID 2**	**AM2MI02**	Introduction to Artificial Intelligence	**S**
3.	**MID 3**	**AM3MI03**	AI and Ethics	**S**
4.	**MID 4**	**AM4MI04**	Mathematical Foundations of Machine Learning	**S**
5.	**MID 5**	**AM5MI05**	Artificial Neural Networks	**S**
6.	**MID 6**	**AM6MI06**	Machine Learning in IoT / Big Data Analytics	**S**
7.	**MID 7**		Reinforcement Learning / Natural Language Processing	**S**
8.	**MID 8**		Deep Learning and Image Analytics / Robotics	**S**

Table 10: List of Multi-disciplinary Courses				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**MLD 1**	**AM1ML01**	Natural Sciences	**H**
2.	**MLD 2**	**AM2ML02**	Physical Sciences	**H**
3.	**MLD 3**	**AM3ML03**	Humanities & Social Sciences	**H**

Table 11: List of Ability Enhancement Courses				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**AEC 1**	**AM1AE01**	English I	**H**
2.	**AEC 2**	**AM2AE02**	Indian Language I	**H**
3.	**AEC 3**	**AM3AE03**	English II	**H**
4.	**AEC 4**	**AM4AE04**	Indian Language II	**H**

Table 12: List of Skill Enhancement Courses				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**SEC 1**	**AM1SE01E1**	Python Programming	**S**
2.	**SEC 1**	**AM1SE01E2**	Building Interactive Dashboards	**S**
3.	**SEC 2**	**AM2SE02E1**	Data Wrangling with R	**S**
4.	**SEC 2**	**AM2SE02E2**	Logic Programming	**S**
5.	**SEC 3**	**AM3SE03E1**	Machine Learning Frameworks	**S**
6.	**SEC 3**	**AM3SE03E2**	Data Mining and Tools	**S**

Table 13: List of Value-Added Courses				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**VAC 1**	**AM1VA01**	Understanding India	**H**
2.	**VAC 2**	**AM1VA02**	Environmental Sciences / Education / Higher Order Thinking	**H**
3.	**VAC 3**	**AM2VA03**	Health & Wellness / Yoga Education / Universal Human Values	**H**
4.	**VAC 4**	**AM2VA04**	Digital Technologies	**H**

Table 14: Project (WP/ Internship)				
S.No.	**Component**	**Course Code**	**Title of the Course**	**H/S**
1.	**Project**	**AM4CS01**	Community Engagement and Service	**H**

*Table 15: MLD 1 / MLD 2 / MLD 3 in Sem 1 / Sem 2 / Sem 3				
S.No.	**Streams**	**Course Code**	**Title of the Course**	**H/S**
1.	Natural Science		Biology	H
2.			Botany	H
3.			Zoology	H
			Biotechnology	H
			Biochemistry	H
5.	Physical Sciences		Chemistry	H
6.			Physics	H
			Biophysics	H
7.			Astronomy	H
			Astrophysics	H
8.			Earth and Environmental Sciences	H
9.	Mathematics & Statistics		STATA	H
10.			SPSS	H
11.			Tally	H
12.				H
13.	Computer Science & Applications	AM1SE01E1	Python Programming	H
14.		AM1SE01E2	Building Interactive Dashboards	H
15.		AM2SE02E1	Data Wrangling with R	H
16.				
17.	Data Analysis			H
18.				H
19.				H
20.				H
21.	Social Sciences		Political Sciences	H
22.			History	H

23.			**Social work**	**H**
24.			**Sociology**	**H**
25.	**Humanities**		**Anthropology**	**H**
26.			**Psychology**	**H**
27.			**Economics**	**H**
28.				**H**
29.	**Commerce & Management**		**Business Management**	**H**
30.			**Accountancy**	**H**
31.			**Finance**	**H**
32.			**Financial Institutions**	**H**
33.	**Media Sciences**		**Journalism**	**H**
34.			**Mass Media**	**H**
35.			**Communication**	**H**

*Courses will be announced after the approval of the respective boards.

SYLLABUS
FIRST SEMESTER

Year	I	**Course Code: AM1MJ01**	**Credits**	4
Sem.	I	**Course Title: DIGITAL LOGIC FUNDAMENTALS**	**Hours**	75
Course Prerequisites, if any	NIL			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		
Course Outcomes	● Understanding the postulates of Boolean algebra and to minimize combinational functions. ● Design and analyze combinational and sequential circuits. ● Evaluate the techniques for the design of digital circuits			
Unit No.	**Course Content**		**Hours**	
Theory Component				
Unit I	**Digital Systems and Binary Numbers** Digital Systems - Binary Numbers - Number-Base Conversions - Octal and Hexadecimal Numbers - Complements of Numbers - Signed Binary Numbers - Binary Codes - Binary Storage and Registers - Binary Logic - Axiomatic Definition of Boolean Algebra - Basic Theorems and Properties of Boolean Algebra - Boolean Functions Canonical and Standard Forms - Other Logic Operations - Digital Logic Gates - Integrated Circuits		9	
Unit II	**Gate-Level Minimization** Introduction - The Map Method - Four-Variable K-Map - Product-of-Sums Simplification - Don't-Care Conditions - NAND and NOR Implementation - Other		9	

	Two-Level Implementations - Exclusive-OR Function - Hardware Description Language	
Unit III	**Combinational Logic** Introduction - Combinational Circuits - Analysis Procedure - Design Procedure - Binary Adder– Subtractor - Decimal Adder - Binary Multiplier - Magnitude Comparator – Decoders – Encoders – Multiplexers - HDL Models of Combinational Circuits.	9
Unit IV	**Synchronous Sequential Logic** Introduction - Sequential Circuits - Storage Elements: Latches - Storage Elements: Flip-Flops - Analysis of Clocked Sequential Circuits - Synthesizable HDL Models of Sequential Circuits - State Reduction and Assignment - Design Procedure	9
Unit V	**Registers and Counters** Registers - Shift Registers - Ripple Counters - Synchronous Counters - Other Counters - HDL for Registers and Counters	9
Practical Component		
Programming Digital Logic in Python	1. Binary to Decimal and vice-versa in Python 2. Decimal to Hexadecimal and Vice-Versa in Python 3. Digital Logic Gates in Python 4. Simplification of Boolean Functions in Python 5. Combinational Logic Circuits in Python i. Code Converters ii. Arithmetic (Adders, Subtractors, Multipliers, Comparators) iii. Data Handling (Multiplexers, Demultiplexers, Encoders & Decoders) 6. Combinational Logic Circuit Design in Python 7. Binary Adder-Subtractor Simulation in Python 8. Decimal Adder Simulation in Python 9. Binary Multiplier Simulation in Python	30

	10. Sequential Circuit Storage Elements: Flip-Flop Simulation in Python (Many more programs can be included related to programming the Digital logic in Python)	
Recommended Learning Resources		
Print Resources	1. M. Morris Mano , Michael D. Ciletti, Digital design With an Introduction to the Verilog HDL, Pearson, Fifth Edition, 2013, ISBN-13: 978-0-13-277420-8, ISBN-10: 0-13-277420-8. 2. M. Rafiquzzaman, Fundamentals of Digital Logic and Microcomputer Design, John Wiley & Sons, Inc., Fifth Edition, 2005.	

Year	I	**Course Code: AM1MI01**	**Credits**	4
Sem.	I	**Course Title :DATA VISUALIZATION**	**Hours**	75
Course Prerequisites , if any	Basic understanding of Computers			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory) : 03 Hrs Duration of ESA (Practical) : 03 Hrs		
Course Outcomes	● Understand the concepts of Data visualization. ● Understand the process of building effective visualization ● Apply the Python Libraries to build Visualization ● Analyze various visualization options to build optimal visualization. ● Create effective visualization.			
Unit No.	**Course Content**		**Hours**	
Theory Component				
Unit I	**Introduction** Introduction to Data Visualization – Definition – Use of Data Visualization – Elements of Data Visualization – Importance of Data Visualization.		9	
Unit II	**Visualization Basics** The power of visual storytelling – Good Examples of Data visualization – Benefits. - Different types of charts and graphs used in Data visualization – Selecting right data visualization elements – Grouping – Software tools and libraries for Data visualization.		9	
Unit III	**Matplotlib** Introduction to Matplotlib – Plotting functions – subplot functions – coloring – Building line plots – Bar plots – Scatter plots – Histogram – Pie charts.		9	
Unit IV	**Pandas based plotting**		9	

	Pandas for plotting – Various plots with pandas data – A case study with pandas based plotting.	
Unit V	**Seaborn** Seaborn for visualization – Features – Benefits – Plotting with seaborn – Categorical data plotting with seaborn – Case studies using seaborn.	9
Practical Component		
List of Exercises	1. Build a line plot using Matplotlib. 2. Build a Pie chart using MatplotLib. 3. Build histogram using Matplotlib. 4. Customize the charts built in the above exercises with various options. 5. Build a visualization with source data handling using Pandas. 6. Build any 3 types of charts using seaborn. 7. Perform Categorical data plotting with seaborn. 8. Case Study: Population growth plotting 9. Case Study: Happiness Index across various countries - an analysis. 10. Develop a visualization with multiple subplots.	30
Recommended Learning Resources		
Print Resources	**TEXT BOOK:** 1. Kalilur Rahmman, Python Data Visualization Essentials Guide, BPB publications, First Edition (2021), ISBN : 978-93-91030070. **REFERENCE BOOK:** 1. Cole Nussbaumer Knaflic, Storytelling With Data: A Data Visualization Guide For Business Professionals, Wiley publications , (2015), ISBN: 978-1119002253	

Year	I	**Course Code: AM1SE01E1**	**Credits**	3
Sem.	I	**Course Title : PYTHON PROGRAMMING**	**Hours**	60
Course Prerequisites, if any	Basic Knowledge in Programming Concepts			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Theory) : 03 hrs. Duration of ESA (Practical) : 03 hrs.		
Course Outcomes	• Understand the basics of writing Python code • Implement programs using lists, tuples and dictionaries • Understand the use of control structures • Implement programs using packages • Understand the file manipulation			
Unit No.	**Course Content**		**Hours**	
Theory Component				
Unit I	**Introduction, Data types** Introduction to Python – Advantages of using Python – Executing Python Programs – Python's Core data types – Numeric Types – String Fundamentals.		6	
Unit II	**Lists, Tuples, Dictionaries** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension.		6	
Unit III	**Control Flow, Functions, Modules** Python Statements: Assignments – Expressions – If condition – While and For Loops. Functions: Definition, Calls – Scopes – Arguments – Recursive Functions– Functional Programming tools. Classes and Object Oriented programming with Python - Modules and Packages: Purpose, using packages– Exception Handling with Python.		6	

Unit IV	**Packages** Packages: NumPy, Pandas, Scikit learn - Machine learning with Python – Cleaning up, Wrangling, Analysis, Visualization - Matplotlib package – Plotting Graphs.	6
Unit V	**File Handling** Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions	6
Practical Component		
List of Exercises	1. Exchange the values of two variables 2. Finding minimum among n variables 3. Perform Simple sorting 4. Generate Students marks statement 5. Find square root, GCD, exponentiation 6. Sum the array of numbers 7. Perform linear search, binary search 8. Perform Matrix operations using NumPy 9. Perform Dataframe operations using Pandas 10. Use Matplotlib on dataset and visualise 11. Perform Word count, copy file operations	30
Recommended Learning Resources		
Print Resources	**TEXT BOOKS:** 1. Mark Lutz, “Learning Python”, Fifth Edition, O’Reilly, 2013. 2. Daniel Liang, “Introduction to programming using Python”, Pearson, First edition, 2021. 3. Wes Mc Kinney, “Python for Data Analysis”, O’Reilly Media, 2012. **REFERENCE BOOKS:** 1. Tim Hall and J-P Stacey, “Python 3 for Absolute Beginners”, Apress, First Edition, 2009. 2. Magnus Lie Hetland, “Beginning Python: From Novice to Professional”, Apress, Second Edition, 2005.	

Year	I	**Course Code: AM1SE01E2**	**Credits**	3
Sem.	I	**Course Title : BUILDING INTERACTIVE DASHBOARDS**	**Hours**	60
Course Prerequisites, if any	Basic Knowledge in spreadsheets			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Theory) : 03 hrs. Duration of ESA (Practical) : 03 hrs.		
Course Outcomes	• Understand the basics of dashboards • Implement visualisation using Excel • Understand the use of Tableau in creating dashboards • Visualise using PowerBI • Understand the visualisation features in Looker studio			

Unit No.	**Course Content**	**Hours**
	Theory Component	
Unit I	**Introduction** Introduction to Dashboard - Design principles - Types - Data discovery and exploration - Data requirements for visualisation - Big data lake - Pitfalls of data visualisation	6
Unit II	**Building Interactive dashboards using Excel** Understanding spreadsheets - visualize data using Excel's powerful charting functions - Introduction to Pivot Tables - Using shapes to create infographics - organising data for dashboards - creation of dashboards	6
Unit III	**Tableau** Getting started with Tableau- Creating basic charts - Creating common visualisations - Creating dashboard layouts - Using dashboard filters - Creating calculated fields and measures - Using Quick table calculations	6
Unit IV	**PowerBI** Introduction - Uploading data - Reports - Visual Interactions - Decorating, Saving, Pinning, Filtering a report	6
Unit V	**Looker Studio** Features - Benefits - Tables and charts - report generation - Dashboard generation	6

Practical Component		
List of Exercises	1. Perform simple data visualisation of the given data using any visualisation tool 2. Visualising KPIs using various charts in Excel and create dashboard 3. Create marketing dashboard using Excel 4. Create sales dashboard using Tableau 5. Create Executive dashboard using Tableau 6. Perform finance data visualisation and create a dashboard using PowerBI 7. Create Social media dashboard using PowerBI 8. Create interactive dashboard using Looker studio	30

Recommended Learning Resources	
Print Resources	**TEXT BOOKS:** 1. Cole Nussbaumer Knaflic, "Storytelling With Data: A Data Visualization Guide For Business Professionals", Wiley, 2015. 2. Sireesha Pulipati**,** "Data Storytelling with Google Looker Studio: A Hands-On Guide to Using Data Studio for Building Compelling and Effective Dashboards", Packt Publishing Limited,2022. 3. Dick Kusleika, "Data Visualization with Excel Dashboards and Reports", Wiley, 2021. 4. Alberto Ferrari & Marco Russo, "lntroducing Microsoft PowerBI", Microsoft, 2016. 5. Alexander Loth ,"Visual Analytics with Tableau", Wiley, 2019.

SECOND SEMESTER

Year	I	Course Code: AM2MJ02	Credits	4
Sem.	II	Course Title: PROBLEM SOLVING & PROGRAMMING FUNDAMENTALS	Hours	75
Course Prerequisites, if any	NIL			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		
Course Outcomes	• Understand the basic concepts of programming languages, including syntax and semantics. • Apply programming constructs like loops, conditionals, and functions in practical scenarios. • Analyze code to identify and fix errors using debugging techniques. • Create modular programs using functions and procedures, emphasizing good programming practices.			
Unit No.	**Course Content**		**Hours**	
Theory Component				
Unit I	**Introduction to Computer Problem-Solving** The Problem-solving Aspect - Top-down Design - Implementation of Algorithms - Program Verification - The Efficiency of Algorithms - The Analysis of Algorithms		9	
Unit II	**Basic programming constructs** Basic Data types (Numerical, String) – Variables – Expressions – statements - I/O statements for keyboard handling, Editing, compiling/interpreting/running programs - Syntax errors and runtime errors - Comparison of language model with von Neumann architecture.		9	
Unit III	**Decision Making – Branching & Looping** Decision making within a program – Conditions - Relational Operators - Logical Connectives - if statement, if-else statement. Loops: while loop - do while - for loop - Nested loops - Infinite loops - Switch statements.		9	
Unit IV	**Array Techniques** One dimensional array: Array Manipulation - Different operations on one dimensional arrays - two dimensional array - operations on two dimensional arrays - multi-dimensional array - dynamic arrays - Character Arrays and Strings.		9	
Unit V	**Modular solutions** Introduction to functions - Importance of design of functions - Rewriting earlier solutions using functions - Arguments –		9	

	Parameters - return values – signature - local and global scope - Modular code - Recursion	
Practical Component		
Exercises	1. Program to array counting, array order reversal & find the maximum number in a set. 2. Program for removal of duplicates from an ordered array & to partition an array. 3. Program to find the k^{th} smallest element. 4. Program to exchange the values of two variables without using a third variable. 5. Program that takes a list of numbers as input and counts the total number of elements in the list. 6. Program to calculate the sum of a set of numbers entered by the user. 7. Program to compute the factorial of a given integer. 8. Program to compute the sine of an angle (in degrees) using a series expansion. 9. Program to generate the Fibonacci sequence up to a specified limit. 10. Program that takes an integer as input and reverses its digits. 11. Program that converts a number from one base to another (e.g., binary to decimal, decimal to binary).	30
Recommended Learning Resources		
Print Resources	1. R. G. Dromey, "How to solve it by Computer", Pearson Education, 2007. 2. E. Balaguruswamy, "Programming In ANSI C", 4th edition, TMH Publications, 2007. 3. Yashwant Kanetkar, "Let Us C", 13th Edition, PHP, 2013. 4. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.	

Year	I	**Course Code: AM2MI02**	**Credits**	4
Sem.	II	**Course Title : INTRODUCTION TO ARTIFICIAL INTELLIGENCE**	**Hours**	75
Course Prerequisites, if any	Exposure to Algorithms, Data structure and Mathematical Logic.			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory) : 03 hrs. Duration of ESA (Practical) : 03 hrs.		
Course Outcomes	• Explore basic concepts of AI and understand the importance of agents. • Understand various search strategies. • Analyze knowledge representation and reasoning approaches. • Understand the importance of planning in real world scenarios. • Evaluate the architecture of expert systems.			

Unit No.	**Course Content**	**Hours**
	Theory Component	
Unit I	**Introduction** AI – Foundations of AI, Intelligent Agents – Agents and Environments – Good Behavior –Nature of Environments – Structure of Agents.	6
Unit II	**Problem solving** Problem Solving Agents – Searching for solutions- Uninformed Search Strategies – Informed Search Strategies, Heuristic functions - Adversarial search - Local search algorithms and optimization problems – Searching with nondeterministic actions, Constraint satisfaction problems.	12
Unit III	**Knowledge and reasoning** Logical Agents: Wumpus world - Propositional logic - First order logic: Inference, forward and backward chaining, Resolution	9
Unit IV	**Planning** Classical planning – Algorithms – Approaches - Planning and acting in real world – Hierarchical planning – Multiagent planning	9

Unit V	**Expert systems** Expert systems – Introduction – Difference between expert system and conventional programs– Expert system organization – Architecture of Expert system – Knowledge representation techniques- Knowledge acquisition techniques - Inference Engine- Explanation systems.	9
Practical Component		
Exercises	1. Solve the Water Jug Problem using DFS, BFS blind search algorithms 2. Implement Mini-max adversarial search algorithm. 3. Find the optimal path between two cities using best first search and A* heuristic algorithms 4. Implement the Missionaries and cannibals problem using constraint satisfaction method. 5. Represent knowledge using Propositional Logic and perform inference. 6. Represent knowledge using Predicate Logic and perform inference. 7. Case study: Autonomous Vehicles 8. Case Study: Travelling Salesman Problem. 9. Case Study: Planning Delivery of packages 10. Develop an Expert System.	30
Recommended Learning Resources		
Print Resources	**TEXT BOOKS:** 1. Stuart J Russell and Peter Norvig, Artificial Intelligence – A Modern Approach, PHI Learning, Third Edition, 2015. 2. Patterson W D, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, First Edition, 1995. **REFERENCE BOOKS:** Elaine Rich and Kelvin Knight, Artificial Intelligence, TMH, Third Edition, 2009.	

Year	I	**Course Code: AM2SE02E1**	**Credits**	3
Sem.	II	**Course Title : DATA WRANGLING WITH R**	**Hours**	60
Course Prerequisites, if any	Basic computer programming skill			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Theory) : 03 hrs. Duration of ESA (Practical) : 03 hrs.		
Course Outcomes	• Understand the basics of R and data wrangling • Implement programs using data structures in R • Implement data importing, scraping and exporting • Understand basic data objects in R for writing functions, applying loops, and web scraping • Understand the R packages used for data shaping and transforming			

Unit No.	**Course Content**	**Hours**
	Theory Component	
Unit I	**Basics of R and Data Wrangling** Role of data wrangling-Introduction to R-Basics of R programming-Numbers-Character Strings-Regular Expressions-Factors-Dates	6
Unit II	**Managing data structures in R** Data structure basics-Vectors-Lists-Matrices-Data frames-Dealing with missing values	6
Unit III	**Importing, Scraping and Exporting Data with R** Importing data-Scraping data-Exporting data-Web scraping	6
Unit IV	**Creating Efficient code in R** Functions-Built-in-functions-Function definition-Loop control statements-Simplifying code with %>%	6
Unit V	**Shaping and transforming data with R** Summarising data- Reshaping data with tidyr-Transforming data with dplyr	6

Practical Component		
Exercises	1. Perform arithmetic operations 2. Implement various string and date operations 3. Implement string processing with regular expressions 4. Create a vector and find the numbers divisible by 2 5. Create a matrix and find the number of entries in each row which are greater than 4 6. Perform various operations on List 7. Create a data frame from a dataset and handle the missing values 8. Import data into R from different file formats and perform scraping 9. Perform web scraping 10. Perform operations using %>% 11. Write functions to find sum and difference of the arguments passed 12. Write a function which takes a matrix and return a matrix which is the same as the function argument but every odd number is doubled 13. Perform Exploratory data analysis and perform data cleaning	30
Recommended Learning Resources		
Print Resources	**TEXT BOOKS:** 1. Bradley C. Boehmke, " Data wrangling with R", Springer Cham, 2016. 2. Tilman M.Davies, "The Book of R: A First Course in Programming and Statistics", No Starch press, 2016. 3. Andrea de Vries, Joris Meys, "R programming for Dummies", 2nd edition, Wiley, 2016.	

Year	I	**Course Code: AM2SE02E2**	**Credits**	3
Sem.	II	**Course Title : LOGIC PROGRAMMING**	**Hours**	60
Course Prerequisites , if any	Basic Knowledge in Programming Concepts			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Theory) : 03 hrs. Duration of ESA (Practical) : 03 hrs.		
Course Outcomes	• Understand the basics of writing Prolog code • Understand and explain principles of declarative specification, and its relation to file operations • Implement well-crafted Prolog programs of moderate size and sophistication using loops • Implement manipulation of databases using logic programming • Understand and explain the string processing foundations of logic programming			
Unit No.	**Course Content**		**Hours**	
	Theory Component			
Unit I	**Introduction, Clauses and Predicates** Introduction to Prolog – Clauses- Predicates - Loading clauses - Variables - Unification - Evaluating goals - Backtracking - Removing common variables		6	
Unit II	**Operators, Input and Output** Operators: Arithmetic, Equality, Logical. Input and Output: Outputting Terms - Inputting Terms - Input and Output Using Characters - Outputting Characters - Inputting Characters - Using Characters - Input and Output Using Files - File Output: Changing the Current Output Stream - File Input: Changing the Current Input Stream		6	
Unit III	**Loops** Looping a Fixed Number of Times - Looping Until a Condition Is Satisfied: Recursion - Using the 'repeat' Predicate - Backtracking with Failure: Searching the Prolog Database - Finding Multiple Solutions		6	

Unit IV	**Database and List processing** Changing the Database: Adding and Deleting Clauses - Adding Clauses - Deleting Clauses - Changing the Database: Example - Maintaining a Database of Facts Representing Data as Lists - Notation for Lists - Decomposing a List - Built-in Predicates: member - length - reverse - append - List Processing - Using findall/3 to Create a List	6
Unit V	**String Processing** Converting Strings of Characters To and From Lists - Joining Two Strings - Trimming a String - Inputting a String of Characters - Searching a String - Dividing a String into Its Component Parts	6
Practical Component		
Exercises	1. Execute simple programs in Prolog by representing facts and predicates. 2. Apply Unification on a set of facts 3. Execute simple programs in Prolog to read and write input. 4. Implement programs using various operators. 5. Execute simple programs in Prolog using loops 6. Implement programs using recursion 7. Execute simple programs in Prolog to perform list processing 8. Implement database operations 9. Execute simple programs in Prolog to perform string processing 10. Execute simple programs to perform searching	30
Recommended Learning Resources		
Print Resources	**TEXT BOOKS:** 1. Max Bramer, "Logic Programming with Prolog", Springer, 2005 2. J.M. Spivey, "An Introduction to Logic Programming Through Prolog", Prentice Hall, 1996. **REFERENCE BOOKS:** 1. J.W.Lloyd, "Foundations of Logic Programming", Springer Berlin Heidelberg, 2012.	

Year	I	Course Code: AM2VA04	Credits	2
Sem.	II	Course Title: Digital Technologies	Hours	45
Course Prerequisites, if any	-NIL-			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory) : 03 hrs. Duration of ESA (Practical) : 03 hrs.		
Course Outcomes	• Understand the importance of digital technology, digital financial tools, e-commerce. • Analyse the concepts of communication and networks. • Understand the e-governance and Digital India initiatives. • Understand the use & applications of digital technology. • Explore the applications of machine learning and big data.			
Unit No.	**Course Content**		**Hours**	
Theory Component				
Unit I	Introduction & Evolution of Digital Systems. Role & Significance of Digital Technology. Information & Communication Technology & Tools. Computer System & its working, Software and its types. Operating Systems: Types and Functions. Problem Solving: Algorithms and Flowcharts.		7	
Unit II	Communication Systems: Principles, Model & Transmission Media. Computer Networks & Internet: Concepts & Applications, WWW, Web Browsers, Search Engines, Messaging, Email, Social Networking. Computer Based Information System: Significance & Types. E-commerce & Digital Marketing: Basic Concepts, Benefits & Challenges.		7	
Unit III	Digital India & e-Governance: Initiatives, Infrastructure, Services and Empowerment. Digital Financial Tools: Unified Payment Interface, Aadhar Enabled Payment System, USSD, Credit / Debit Cards, e-Wallets, Internet Banking, NEFT/RTGS and IMPS, Online Bill Payments and PoS. Cyber Security: Threats, Significance, Challenges, Precautions, Safety Measures, & Tools, legal and ethical perspectives.		7	
Unit IV	Emerging Technologies & their applications: Overview of Cloud Computing, Big Data, Internet of Things, Virtual Reality,		7	

Unit V	Emerging Technologies & their applications: Blockchain & Cryptocurrency, Robotics, Machine Learning & Artificial Intelligence, 3-D Printing. Digital Signatures.	7
Practical Component		
Exercises	1. Operating System Installation and configuration 2. Application Software Installation and configuration 3. Hardware understanding and minor troubleshooting 4. Networking, cabling, configuration	10
Recommended Learning Resources		
Print Resources	1. Pramod Kumar, Anuradha Tomar, R. Sharmila, "Emerging Technologies in Computing - Theory, Practice, and Advances", Chapman and Hall / CRC, 1st Edition, 2021, eBook ISBN: 9781003121466. https://doi.org/10.1201/9781003121466. 2. V. Rajaraman, "Introduction to Information Technology", PHI, 3rd Edition, 2018, ISBN-10: 9387472299, ISBN-13: 978-9387472297. 3. E. Balagurusamy, "Fundamentals of Computers", Tata Mc GrawHill, 2nd Edition, 2011, ISBN: 9780071077880. 4. Behrouz A. Forouzan, "Data Communications and Networking", McGraw Hill, 4th Edition, 2007, ISBN 978-0-07-296775-3. 5. Rajkumar Buvya, James Broberg, and Andrzej Gosciniski, "Cloud Computing-Principals and Paradigms", Wiley, 2011, ISBN: 978-0-470-88799-8. 6. Stuart Russel and Peter Norvig, "Artificial Intelligence - A Modern Approach", Pearson Education, 3rd Edition, 2010, ISBN- 13: 978-0-13 -604259-4. 7. Samuel Greengard, "Internet of Things", The MIT Press, 2015, ISBN: 9780262328937, https://doi.org/10.7551/mitpress/10277.001.0001. 8. C.S.V. Murthy, "E- Commerce – Concept, Models &Strategies", Himalaya Publishing House, 2015, ISBN: 8178662760. 9. Hurwith, Nugent Halper, Kaufman, "Big Data for Dummies", Wiley & Sons, 1st Edition, 2013, ISBN-13: 978-1118504222.	