ACADEMIC REGULATIONS

(Choice Based Credit System)

R25

Computer science and Engineering

(Artificial Intelligence & Machine Learning)

M. Tech (Regular-Full time)

(Effective for the students admitted into I year from the Academic Year **2025-26** onwards)

SWARNANDHRA

COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

SEETHARAMAPURAM, NARSAPUR - 534280, W.G.DT., A.P.

Vision and Mission of the Institute

Vision:

"To produce global competent, ethical and dynamic professionals by creating Centre of Excellence in Technical Education for societal empowerment."

Mission:

- To provide quality education with knowledge and skills for rural and urban students.
- To collaborate the industries with academia for empowering the students to meet global standards
- To induce highly ethical entrepreneurship in young minds with good leadership quality for the society.
- To enhance the institution in Research and Development by human intellectual capability.

Vision and Mission of the Department

Vision:

To empower Computer Science Engineers as highly proficient, innovative, self-driven, and socially responsible professionals by offering a multidimensional education.

Mission:

- **M1: Empowerment of Computer Science Engineers:** To empower Computer Science Engineers through comprehensive education, fostering high proficiency.
- **M2: Multidimensional Education Focus:** To provide a diverse education, equipping engineers with skills to navigate the global needs
- **M3: Development of Proficiency and Innovation:** To ensure graduates are well-prepared to address technical issues with creativity and innovation.
- **M4: Social Responsibility and Professional Excellence** To in-still a strong sense of commitment, shaping graduates into socially responsible professionals and self-driven.

Programme Education Objectives (PEOs)

Mapping of Mission statements to PEOs:

Mission Statement	PEO1	PEO2	PEO3	PEO4
MS1	✓	✓	✓	✓
MS2	✓	✓	✓	✓
MS3	✓	✓		✓
MS4		✓	✓	✓
MS5		✓	✓	✓
MS6			✓	✓

PEO1: To impart a strong foundation in mathematics, basic sciences, and engineering principles for solving complex AIML problems with analytical thinking.
PEO 2: To enable graduates to design, develop, and deploy intelligent systems using advanced algorithms and AI/ML techniques for real-world applications.
PEO 3: To promote innovation, research aptitude, and critical thinking through hands-on labs, seminars, and project-based learning in AIML.
PEO4: To nurture professionalism, ethics, teamwork, and communication skills, preparing graduates for success in industry, academia, and society.

Programme Outcomes (POs):

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: Apply principles of mathematics, science, and engineering to analyze and solve complex problems across diverse domains.

PO5: Design effective engineering solutions and systems with consideration for societal, environmental, and safety constraints.

PO6: Identify, formulate, research, and analyze complex problems in Computer Engineering using principles of mathematics, natural sciences, and engineering sciences.

Mapping of Programme Outcomes to PEOs

Programme Outcomes	PEO1	PEO2	PEO3	PEO4
PO1	✓	✓	✓	
PO2			✓	✓
PO3	✓	✓	✓	✓
PO4	✓	✓	✓	
PO5		✓		✓
PO6	✓	✓	✓	

R25

M.Tech

CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Programme Course Structure & Syllabus

ACADEMIC REGULATIONS - R25 FOR M. Tech (REGULAR) DEGREE COURSE

Applicable for the students admitted to M. Tech (Regular) Course from the Academic Year 2025-26 and onwards. The M. Tech Degree of Jawaharlal Nehru Technological University Kakinada shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates

(i) in national level qualifying Entrance Test (GATE),

(ii) AP PGECET conducted by State Government and

(iii) Few Sponsored seats notified by university on the basis of any order of merit as approved by the State Government /University, subject to reservations as laid down by the Government from time to time.

2.0 AWARD OF M. Tech DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech Degree, if he pursues a course of study in not less than two and not more than four academic years. Under any circumstances, permission shall not be given to complete the course work beyond four years.

2.2 The student shall register for all 80 credits and secure all the 80 credits.

2.3 The minimum instruction period in each semester is 16 weeks.

3.0 ATTENDANCE

3.1 Attendance is calculated separately for each course. Attendance in all classes (Lectures/Laboratories) is compulsory. The minimum required attendance in each course is 75%. A student shall not be permitted to appear for the Semester End Examinations (SEE), if his/her attendance is less than 75%.

3.2 Condoning of shortage of attendance (between 65% and 75%) up to a maximum of 10% (*considering the days of attendance in sports, games, NSS activities and medical exigencies*) in each course (Theory/Lab/Seminar) is condoned on production of valid Certificates/documents in the stipulated time mentioned here with:

3.2.1 Students who are admitted as in patients for treatment are only eligible to claim condonation of attendance. Such students under medical exigencies need to Produce (a) Doctor Medical Prescription, (ii) Medical bills duly signed by Doctor/Hospital authorities, (c) Diagnosis reports, if any, (d) Discharge summary issued at the time of discharge and any other supporting documents within two week(s) from the date of discharge to the respective institution.

Note: University at any point of time can inform the institution(s) to submit such list/proofs. *Hence, respective institution shall verify and accord condonation privilege scrupulously*.

3.2.2 Students' participation in Sports/Games and NSS activities shall also be permitted for condonation of attendance. In such cases, they need to produce (a) invitation letter from the organizing institute/agency, (ii) participation certificate and any supporting documents within two week(s) from the date of participation to the respective institution

3.3 A prescribed fee per course shall be payable for condoning shortage of attendance after getting the approval of College Academic Committee for the same. The College Academic Committee shall maintain all the relevant documents along with the request from the students, whose attendance is condoned.

3.4 Shortage of Attendance below 65% in any course shall in no case be condoned.

3.5 A Student, whose shortage of attendance is not condoned in any course(s) (Theory/Lab/Seminar) in any Semester, is considered as '**Detained in that course(s)**, and is not eligible to write Semester End Examination(s) of such Course(s), (in case of Seminar, his/her Seminar Report or Presentation are not eligible for evaluation) in that Semester; and he/she has to seek re-registration for those course(s) in subsequent Semesters, and attend the same as and when offered.

3.6 A student shall put in a minimum required attendance in at least FOUR courses in I semester for promotion to II Semester; and at least FOUR courses in II semester for promotion to III Semester.

Re-admission / re-registration

3.7 A student shall not be permitted to appear for the Semester End Examinations (SEE) in a course unless they meet the prescribed attendance requirements for that course. Such students may take readmission for the course in the subsequent semester when it is offered by paying the prescribed fee, *at least 30 days before the commencement of classwork*. The college must obtain permission from the University by submitting the list of students eligible/applied for readmission before the commencement of classwork

3.8 Students who fail due to **less internal marks (less than 50%)** may register for the course within the maximum permissible duration of the Program.

3.9 In such a case, the candidate must re-register for the course(s) and secure the required minimum attendance. The candidate's attendance in the re-registered course(s) shall be calculated separately to decide upon eligibility for writing the end examination in those course(s).

3.10 In a semester, students are permitted to re-register maximum of THREE courses.

3.11 Upon re-registration, the student's previous performance in the respective course(s) will be nullified. Re-registration must be completed by paying the prescribed fee at least 30 days prior to the commencement of classwork. The college is required to obtain approval from the University by submitting a list of eligible and interested students before the start of commencement of classwork.

4.0 EVALUATION

The performance of the candidate in each semester shall be evaluated course-wise, with a maximum of 100 marks for theory and 100 marks for practical, on the basis of Internal Evaluation and End Semester Examination.

4.1 For the theory courses 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The continuous / internal evaluation shall be made based on the **average** of the marks secured in the two CIE/Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each CIE/midterm examination shall be conducted for a total duration of 120 minutes with 4 questions (without choice) each question for 10 marks. End semester examination is conducted for 60 marks for all FIVE (5) questions (one question from one unit) to be answered (either or).

4.2 For practical courses, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks. The internal evaluation based on the day-to-day work-10 marks, record- 10 marks and the remaining 20 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the examiners, with breakup marks of Procedure-**15,** Experimentation- **25,** Results-10, Viva-voce-10.

4.3 For Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Seminar, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

4.4 A candidate shall be deemed to have secured the minimum academic requirement in a course if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.7 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher or teacher of the respective college and the second examiner shall be appointed by the University from the panel of examiners submitted by the respective college.

5.8 Students shall undergo mandatory summer internship / industrial training (3 credits) for a minimum of **eight weeks duration** at the end of second semester of the Programme/Summer Break. A student will be required to submit a summer

internship/industrial training report to the concerned department and appear for an oral presentation before the committee. The Committee comprises of a HoD / Professor of the department and two faculty. The report and the oral presentation shall carry 40% and 60% weightages respectively. For summer internship / industrial training, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.9 The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering/Specialization in the PG program. Viva will be conducted in 3rd semester. The examination committee will be constituted by the HoD and consist of Professor of the department and two faculty. For comprehensive viva-voce, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

6.0 EVALUATION OF SEMINAR/INTERNSHIP/DISSERTATION WORK

All the students admitted under these regulations have to mandatorily comply the requirements of (i) Seminar-I, (ii) Seminar-II, (iii) Comprehensive Viva, (iv) Dissertation Part-A and (v) Dissertation Part-B. Out of these, (i) to (iv) are evaluated by internally by Project Review Committee (PRC) and (v) External Evaluation.

6.1 A Project Review Committee (PRC) shall be constituted with Head of the Department and Two other senior faculty members in the department.

6.2 Students are required to appear for Seminar-I and Seminar-II in First and Second semester respectively. They shall present before PRC on the topic of their choice/interest preferably on the courses listed in respective semesters. PRC shall advise the students in advance to select topics which strengthen their Dissertation Part-A and Dissertation Part-B.

6.3 Students shall undergo mandatory summer internship / industrial training (*2 credits*) for a minimum of eight weeks duration at the end of second semester of the Programme/Summer Break. A student will be required to submit a summer internship/industrial training report to the concerned department and appear for an oral presentation before PRC. The report and the oral presentation shall carry 40% and 60% weightages respectively. For summer internship / industrial training, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

6.4 The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering/Specialization in the PG program. Viva will be conducted in 3rd semester. For comprehensive viva-voce, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

6.5 Registration of Dissertation/Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses, both theory and practical and duly approved by PRC.

6.6 After satisfying 6.5, student has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval

6.7 If a candidate wishes to change his/her supervisor or topic of the project, he/she can do so with the approval of PRC. However, the PRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.8 Continuous assessment of Dissertation-Part A and Dissertation-Part B during the Semester(s) will be monitored by PRC. *Dissertation-Part A* will be only internal evaluation by PRC for 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

6.9 The candidate shall submit a status report to the PRC in two stages, each accompanied by an oral presentation, with a minimum interval of three months between the two.

6.10 The work on the project shall be initiated at the beginning of the III Sem and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis *(Dissertation – Part A & Part B)* only with the approval of PRC not earlier than 40 weeks from the date of registration of the project work.

6.11 Three copies of the project thesis, printed on both sides of the page and certified by the supervisor, shall be submitted to the College/Institute along with the plagiarism report.

6.10 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.11 If the report of the examiner is not favorable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is not favorable again, the thesis shall be summarily rejected. The candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the University.

6.12 If the report of the examiner is favorable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Head of the Department shall coordinate and make arrangements for the conduct of Viva-Voce examination. The Board shall jointly report the candidate's work for a maximum of 100 marks. Corresponding grade will be awarded by the University.

6.13 If the report of the Viva-Voce is unsatisfactory (i.e., < 50 marks), the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

7.0 Cumulative Grade Point Average (CGPA)

Marks Range (Max – 100)	Letter Grade	Level	Grade Point
≥ 90	S	Outstanding	10
≥80 to <90	A	Excellent	9
≥70 to <80	B	Very Good	8
≥60 to <70	C	Good	7
≥50 to <60	D	Fair	6
<50	F	Fail	3
		Absent	0

Computation of SGPA

- The following procedure is to be adopted to compute the Semester Grade Point Average(SGPA) and Cumulative Grade Point Average(CGPA):
- The **SGPA** is the ratio of 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 and the sum of the number of credits of all the courses undergone by a student, i.e

$$SGPA\ (Si) = \sum (Ci \times Gi) / \sum Ci$$

- Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

Computation of CGPA

- The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a Programme, i.e.

$$CGPA = \sum (Ci \times Si) / \sum Ci$$

- Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- Equivalent Percentage = (CGPA- 0.5) x 10

8.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	
First Division with Distinction	≥ 7.5 (without supplementary History)	From the CGPA secured from 80 credits
First Class	≥ 6.5	
Second Class	≥ 6.0 to < 6.5	

The secured grade, grade points, status and credits obtained will be shown separately in the memorandum of marks.

If a student wants to leave the program / exit after successful completion of first two semesters, he/she will be awarded Post Graduate Diploma in the specialization concerned.

9.0 WITH HOLDING OF RESULTS

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

10.0 GENERAL

10.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

10.2 The academic regulation should be read as a whole for the purpose of any interpretation.

10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

10.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	Both the candidates involved in the malpractice will forefeit their seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.

11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators:

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
   (i) A show cause notice shall be issued to the college.
   (ii) Impose a suitable fine on the college.
   (iii) Shifting the examination center from the college to another college for a specific period of not less than one year.

I - Semester

S. No.	Course Code	Course Title	L	T	P	C	IM	EM	Total
1		**ProgramCore-1** Data Science & Applications	3	1	0	4	40	60	100
2		**ProgramCore-2** Artificial Intelligence	3	1	0	4	40	60	100
3		**ProgramCore-3** Advanced data structures and algorithms	3	1	0	4	40	60	100
4		**Professional Elective–I**	3	0	0	3	40	60	100
5		**Professional Elective–II**	3	0	0	3	30	70	100
6		**Laboratory-1** Artificial Intelligence Lab	0	1	2	2	40	60	100
7		**Laboratory-2** Data Wrangling Lab	0	1	2	2	40	60	100
8		**Seminar-I**	0	0	2	1			
		TOTAL	**15**	**5**	**6**	**23**			

List of Professional Elective Courses in I Semester (Electives– I & II)

S.No.		Course code	Course Title
1	**Professional Elective–I**		Advanced datamining
2			Mining Massive Data Sets
3			High performance computing
4	**Professional Elective–II**		Augmented Reality and Virtual Reality
5			Recommender Systems
6			Time Series Analysis
7			*Swayam 12 week MOOC course Suggested by BOS*

@ Minimum 2 / 3 themes per elective

II - Semester

S. No.	Course Code	Course Title	L	T	P	C	IM	EM	Total
1		**ProgramCore-4** Machine Learning	3	1	0	4	40	60	100
2		**ProgramCore-5** Deep Learning	3	1	0	4	40	60	100
3		**ProgramCore-6** Mathematics for Machine Learning	3	1	0	4	40	60	100
4		**Professional Elective–III**	3	0	0	3	40	60	100
5		**Professional Elective–IV**	3	0	0	3	40	60	100
6		**Laboratory-3** Deep Learning Lab	0	1	2	2	40	60	100
7		**Laboratory-4** Machine Learning Lab	0	1	2	2	40	60	100
8		**Seminar–II**	0	0	2	1			
		TOTAL	**15**	**5**	**6**	**23**			

*During the summer break, students need to pursue Summer Internship / Industrial Training, it will be evaluated in the III Sem.

List of Professional Elective Courses in II Semester (Electives III & IV)

S. No.		Course code	Course Title
1	**Professional Elective–III**		Cloud Computing
2			Reinforcement Learning
3			Generative AI
4	**Professional Elective–IV**		Computer Vision
5			Quantum Computing
6			Soft computing
7			*Swayam 12 week MOOC course Suggested by BOS*

@Minimum 2/ 3 themes per elective

III - Semester

S. No.	Course Code	Course Title	L	T	P	C	IM	EM	Total
1		Research Methodology and IPR / *Swayam 12 week MOOC course– RM&IPR*	3	0	0	3	40	60	100
2		Summer Internship / Industrial Training (8-10 weeks)*	-	-	-	3	100	-	100
3		Comprehensive Viva#	-	-	-	2	100	-	100
4		Dissertation Part–A$	-	-	20	10			
		TOTAL	**3**	**-**	**20**	**18**			

* Student attended during summer / year break and assessment will be done in 3rd Sem.

Comprehensive viva can be conducted courses completed up to second sem.

$ Dissertation–Part-A, internal assessment

IV - Semester

S.No.	Course Code	Course Title	L	T	P	C	IM	EM	Total
1		Dissertation Part– B%	-	-	32	16			
	TOTAL		**-**	**-**	**32**	**16**			

% External Assessment

I Semester	DATA SCIENCE & APPLICATIONS	L	T	P	C
		3	1	0	4

Course Objectives:

The objective of this course is to cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short-term memory cells and convolution neural networks.

- Explain the concepts of modules, packages, and advanced module usage in Python programs
- Evaluate and implement tools and techniques for persistent data storage and Python/C integration.
- Understand the basics of **NumPy arrays** and their applications in fast, element-wise computations.
- Apply data wrangling techniques including cleaning, transforming, merging, and reshaping datasets.
- Understand the basics of **matplotlib** and its API for creating visual representations of data.

Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Explain how data is collected, managed and stored for data science.	K2
CO2	Understand the key concepts in data science, including their real-world Applications and the tool kit used by data scientists.	K2
CO3	Implement data collection and management scripts using Python Pandas	K3
CO4	Ability to efficiently pre process, wrangle, and aggregate data from diverse Sources for effective analysis and transformation.	K3
CO5	Ability to visualize and analyze data using matplot lib and pandas, including Timeseries and financial data applications.	K4

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	L	H	H	L	H
CO3	M	M	H	H	H	H
CO4	H	L	H	H	M	H
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT–1	PYTHON Basics and Programming Concepts: Introducing Python, Types and Operations - Numbers, Strings, Lists, Tuples, Dictionaries, Files, Numeric Types, Dynamic Typing; Statements and Syntax - Assignments, Expressions, Statements, Loops, iterations, comprehensions; Functions - Function Basics, Scopes, Arguments, Advanced Functions; Modules – Module Coding Basics, Module Packages, Advanced Module Topics; Classes and OOP-Class, Operator Overloading, Class Designing; Exceptions and Tools-Exception Basics, Exception Coding Details, Exception Objects, Designing With Exceptions, Parallel System Tools	12
UNIT– 2	GUI Programming: Graphical User Interface - Python gui development options, Adding Widgets, GUI Coding Techniques, Customizing Widgets; Internet Programming - Network Scripting, Client Side scripting, Pymailgui client, server-side scripting, Pymailcgi server; Tools and Techniques-data bases and persistence, data structures, text and language, python/cintegration	12
UNIT– 3	Pandas and NumPy: Numpy Basics - Fast Element wise array functions, Multidimensional Array, Data Processing using arrays, file i/o with arrays; Pandas - Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Handling Missing Data, Hierarchical Indexing	12
UNIT– 4	Data Preprocessing: Data Loading, Storage, and File Formats - Reading and Writing data in text format, binary data formats, interacting with html and web apis, interacting with databases; Data Wrangling: Clean, Transform, Merge, Reshape - Combining and Merging Data Sets, Reshaping and Pivoting, Data Transformation, String Manipulation; Data Aggregation and Group Operations – Group by Mechanics, Data Aggregation, Group by Operations and Transformations, Pivot Tables and Cross-Tabulation	12
UNIT– 5	Data Visualization: A Brief matplotlib API Primer, Plotting Functions in pandas, Time Series, Financial and Economic Data Applications	12
	Total	60

Text Books:

1. " Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter ", (3rd Edition) by Wes McKinney.- **2022**
2. LearningPython,5thEdition, MarkLutz,OReilly,2013.
3. ProgrammingPython,4thEdition, MarkLutz,OReilly,2010.
4. PythonForDataAnalysis,2ndEdition, WesMckinney,OReilly,2017.

Reference Books:

1. Python: The Complete Reference,1stEdition, Martin C.Brown, McGraw Hill Education, 2018.
2. HeadFirstPython,2ndEdition,PaulBarry,O′Reilly,2016.

Web Resources:

1. https://www.youtube.com/watch?v=_Fd2U1wPUSk
2. https://www.geeksforgeeks.org/dbms/data-preprocessing-in-data-mining/
3. https://wesmckinney.com/book/accessing-data

I Semester	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	1	0	4

Course Objectives: From the course the student will learn

- Gain a historical perspective of Artificial Intelligence (AI) and its foundations.
- Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
- Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool. Experiment with a machine learning model for simulation and analysis.
- Explore the current scope, potential, limitations, and implications of intelligent systems.

Course Out comes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level(K)#
CO1	Analyze and formalize the problem as a state space, graph, design heuristics And select amongst different search or game-based techniques to solve them	K2
CO2	Analyze and apply problem reduction techniques and game playing and Adversarial search strategies in AI.	K4
CO3	Develop intelligent algorithms for constraints at is faction problems and also Design intelligent systems for Game Playing.	K3
CO4	Apply probabilistic and evidential reasoning techniques to handle Uncertainty in intelligent systems.	K5
CO5	Understand the fundamental concepts of fuzzy sets and fuzzy logic.	K6

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	-	H	M	-	M
CO2	H	-	H	H	-	H
CO3	H	-	H	H	M	H
CO4	H	-	H	H	-	H
CO5	H	-	H	H	-	H
CO6	-	-	-	-	-	-

UNIT	CONTENTS	Contact Hours
UNIT– 1	**Introduction to artificial intelligence:** Introduction, history, intelligent systems, foundations of AI, applications, tic-tac-tie game playing, development of AI languages, current trends in AI, **Problem solving: state-space search and control strategies:** Introduction, general problem solving, characteristics of problem, exhaustive searches, heuristic search techniques, iterative- deepening a*, constraints at is faction	12
UNIT– 2	**Problem reduction and game playing:** Introduction, problem reduction, game playing, alpha-beta pruning, two-player perfect information games, **Logic concepts:** Introduction, propositional calculus, proportional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate Logic	12
UNIT– 3	**Knowledge representation:** Introduction, approaches to knowledge representation, knowledge representation using semantic network, extended semantic networks for KR, knowledge representation using frames, **advanced knowledge representation techniques:** Introduction, conceptual dependency theory, script structure, Cyc theory, case grammars, Semantic web.	12
UNIT– 4	**Uncertainty measure: probability theory:** Introduction, probability theory, Bayesian belief networks, certainty factor theory, dempster-shafer Theory	12
UNIT– 5	**Fuzzy sets and fuzzy logic:** Introduction, fuzzy sets, fuzzy set operations, types of membership functions, multi valued logic, fuzzy logic, linguistic variables and hedges, fuzzy propositions, inference rules for fuzzy propositions, fuzzy systems.	12
	Total	60

Text Books:

1. Artificial intelligence A modern Approach, 2nded, Stuart Russel, Peter Norvig, Prentice Hall
2. “Artificial Intelligence: A Modern Approach (4th Edition)”, Stuart Russell & Peter Norvig-2020
3. Artificial Intelligence, Saroj Kaushik, 1stEdition, CENGAGE Learning, 2011.

Reference Books:

1. "Fuzzy Logic with Engineering Applications (4th Edition)", Timothy J. Ross, Wiley-2016
2. Artificial intelligence, structures and Strategies for Complex problem solving, 5th Edition, George F Lugar, PEA
3. Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer,2017
4. Artificial Intelligence, A new Synthesis,1stEdition, Nils J Nilsson, Elsevier,1998
5. Artificial Intelligence -3rd Edition, Rich, Kevin Knight, Shiv Shankar B Nair, TMH
6. Introduction To Artificial Intelligence and Expert Systems, 1stEdition, Patterson, Pearson India, 2015

Web Resources:

1. https://www.geeksforgeeks.org/artificial-intelligence/alpha-beta-pruning-in-adversarial-search-algorithms/

2. https://www.youtube.com/watch?v=gzOaucyZDRM

I Semester	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	1	0	4

Course Objectives: From the course the student will learn

- Concepts of Algorithms, Searching and Sorting techniques, Trees, Binary trees,
- representation, traversal.
- Dictionaries, ADT for List, Stack, Queue, Hash table representation, Hash functions,
- Priority queues, Priority queues using heaps, Search trees.
- AVL trees, operations of AVL trees, Red-Black trees, Splay trees, comparison of search trees.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level(K)#
CO1	Understand, design, and analyze algorithms for efficient problem-solving in computing.	K4
CO2	Understand and apply fundamental algorithms and data structures, including searching, sorting, trees, and graphs, to organize and process data efficiently.	K3
CO3	Understand and apply Abstract Data Types (ADTs) and hashing techniques For efficient data storage and retrieval	K2
CO4	Design and implement variety of data structures including linked lists, Binary trees, heaps, graphs and search trees	K6
CO5	Compare various search trees (AVL, Red- Black, Splay, B- Trees) based on Performance and applications.	K4

Mapping of course out comes with program out comes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	-	H	H	-	H
CO2	M	-	H	M	-	H
CO3	M	-	H	M	M	H
CO4	H	-	H	M	H	H
CO5	M	-	H	M	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT–1	The Role of Algorithms in Computing, Algorithms, Algorithms as technology, analyzing algorithms, Designing algorithms,	12

	Growth of Functions, Asymptotic notation, Standard notations and Common functions	
UNIT– 2	Searching-Linear and Binary, Search Methods, Sorting-Bubble Sort, Selection Sort, Insertion sort, Quick Sort, Merge Sort. Trees- Binary trees, Properties, Representation and Traversals (DFT, BFT), Expression Trees (Infix, prefix, postfix). Graphs-Basic Concepts, Storage structures and Traversals.	12
UNIT– 3	Dictionaries, ADT, The List ADT, Stack ADT, Queue ADT, Hash Table Representation, Hash Functions, Collision Resolution- Separate Chaining, Open Addressing-Linear Probing, Double Hashing.	12
UNIT– 4	Priority queues- Definition, ADT, realizing a Priority Queue Using Heaps, Definition, Insertion, Deletion, Search Trees- Binary Search Trees, Definition, ADT, Implementation, Operations Searching, Insertion, Deletion.	12
UNIT– 5	Search Trees- AVL Trees, Definition, Height of AVL Tree, Operations-, Insertion, Deletion and Searching, Introduction to Red-Black and Splay Trees, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees.	12
	Total	60

Text Books:

1. "Introduction to Algorithms and Data Structures", Micahelle Perez, Publisher Cengage Learning -2023
2. "Algorithms, 4th Edition", Robert Sedgewick and Kevin Wayne, **Publisher**: Addison-Wesley-2023
3. IntroductiontoAlgorithms,3rd Edition, Thomas HCormen, Charles E.Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press.
4. Data Structures: A Pseudo Code Approach, 2nd Edition, Richard F.Gilberg, BehrouzA. Forouzon and Cengage

Reference Books:

1. "A Textbook of Data Structures and Algorithms, Volume 3", G. A. Vijayalakshmi Pai, Publisher: Wiley-ISTE -2023

Web Resources:

1. https://www.youtube.com/watch?v=BOKMKWqanPo

I Semester	ADVANCED DATA MINING	L	T	P	C
		3	0	0	3

Course Objectives: From the course the student will learn

- Explain the statistical limits of data mining and the role of predictive analytics.
- Analyze compact representations of frequent item sets to reduce computational complexity.
- Evaluate and compare advanced association mining techniques for accuracy and efficiency.
- Understand the importance and objectives of cluster analysis in data mining.
- Apply data mining methods to create comprehensive, accurate predictive models.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level(K)#
CO1	Understand and compare major datamining methodologies such as CRISP-DM and SEMMA	K2
CO2	Performcovarianceandcorrelationanalysisinthecontextofassociation mining.	K1
CO3	Make use of association rule mining techniques on categorical and Continuous data.	K6
CO4	Identify and apply clustering algorithm (with open-source tools), interpret, Evaluate and report the result.	K3
CO5	Evaluate clustering algorithms based on cluster characteristics, data properties, and cluster quality metrics.	K4

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	H
CO2	M	M	H	M	M	H
CO3	M	-	H	M	L	M
CO4	H	H	H	M	M	H
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	Data Mining Methodologies: CRISP-DM and SEMMA, Comparison of Data Mining Methodologies. Statistical Limits on Data Mining, Introduction to Predictive Analytics, Classification & Prediction: Predictive Modelling; Concepts, General Approach to solving a classification problem, - ZeroR, One R, Decision Tree Induction: Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Bayesian Classification Methods: Bayes Theorem, Naïve Bayes Classification, Model Evaluation and Selection, Visualization techniques And experiments with weka.	12
UNIT–2	Association Analysis: Problem Definition, Frequent Itemset Generation, Rule Generation: Confident Based Pruning, Rule Generation in Apriori Algorithm, Compact Representation of frequent item sets, FP-Growth Algorithm, Generating item sets and rules efficiently, Covariance and Correlation analysis.	12
UNIT– 3	Advanced Concepts on Association Analysis: Handling Categorical and Continuous Attributes, handling a Concept Hierarchy, Sequential Patterns: Preliminaries, Sequential Pattern Discovery, Timing Constraints, Alternative Counting Schemes; Subgraph Patterns: Preliminaries: Frequent Subgraph Mining, Candidate Generation, Candidate Pruning, Support Counting (Tan & Vipin Kumar)	12
UNIT– 4	Clustering: Importance of Cluster Analysis, Clustering techniques, Different Types of Clusters; K-means: The Basic K-means Algorithm, K-means Additional Issues, Agglomerative Hierarchical Clustering: Basic Agglomerative Hierarchical Clustering Algorithm DBSCAN: Traditional Density Center- Based Approach, DBSCAN Algorithm, Strengths and Weaknesses. (Tan & Vipin Kumar)	12
UNIT– 5	Cluster Analysis: Additional Issues and Algorithms: Cluster Evaluation, Characteristics of Data, Clusters, and Clustering Algorithms. (Tan &Vipin Kumar) Mining rich data types: Mining text data, Spatial-temporal data, Graph and networks (Han 4th ed) Mining real data: Preprocessing data from are all medical domain, data Mining techniques to create a comprehensive and accurate model of data.	12
	Total	60

Text Books:

1. Data Mining: Concepts and Techniques (4th Edition) by Jiawei Han, Jian Pei, and Hanghang Tong – *2022*
2. **Data Mining and Predictive Analytics (2nd Edition)** by Daniel T. Larose and Chantal D. Larose, - *2022*
3. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, 2nd edition
4. Data Mining: Concepts and Techniques, J. Han and M. Kamber, Morgan Kaufmann C.J. Date, Database Systems, Pearson, 4th edition

Reference Books:

1. **Data Mining Methods** by Rajan Chattamvelli, *Published: 2016*
2. Fundamentals of Data Warehouses, 2nd edition, Jarke, Lenzerini, Vassiliou, Vassiliadis, Springer.

Web Resources:

- https://www.geeksforgeeks.org/data-analysis/difference-between-classification-and-prediction-methods-in-data-mining/
- https://www.youtube.com/watch?v=s5ZR83dd5-k

Suggested NPTEL Course:

https://nptel.ac.in/courses/106105174/

I Semester	MINING MASSIVE DATA SETS	L	T	P	C
		3	0	0	3

Course Objectives:

Help students learn basic concepts and techniques for handling and analyzing large datasets, including data mining, distributed computing, data stream Tos, frequent patterns, clustering, and dimensionality reduction, to solve practical problems.

- Understand the fundamental concepts and significance of data mining in knowledge discovery.
- Explain the MapReduce programming model and its role in parallel data processing
- Apply MapReduce algorithms to solve large-scale data mining and analytics problems.
- Analyze performance issues and optimizations in MapReduce-based data processing.
- Evaluate modern extensions to MapReduce such as Apache Spark, Hive, and Pig for enhanced scalability.

Course Outcomes:

		Knowledge Level(K)#
CO1	Understand the fundamentals of datamining, statistical modeling, and Feature extraction for analyzing large datasets.	K2
CO2	Apply the Map Reduce frame work and distributed file systems for efficient Processing of massive data.	K3
CO3	Analyze data streams using techniques like sampling, filtering, and counting Distinct elements in real-time scenarios.	K4
CO4	Usefrequentitemsetminingalgorithmstoidentifypatternsinlargedatasets And optimize their computation	K3
CO5	Evaluate clustering techniques and dimensionality reduction methods to Group data and reduce complexity in high-dimensional datasets.	K5

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	H
CO2	H	M	H	H	M	H
CO3	M	L	H	H	L	H
CO4	H	M	H	M	L	H
CO5	H	M	H	M	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	**Data Mining:** Introduction, Statistical Modeling, Machine Learning, Computational Approaches to Modeling, Feature Extraction, Statistical Limits on Data Mining, Hash Functions, Indexes, Natural Logarithms, Power Laws.	12
UNIT–2	**Map Reduce and the New Software Stack:** Distributed File Systems, Map Reduce, Algorithms Using Map Reduce, Extensions to MapReduce, Complexity Theory for MapReduce	12
UNIT– 3	**Mining Data Streams:** The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Counting Ones in a Window, Decaying Windows.	12
UNIT– 4	**Frequent Item sets:** The Market-Basket Model, Market Baskets and the A-Priori Algorithm, Handling Larger Data sets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream.	12
UNIT– 5	**Clustering:** Introduction to Clustering Techniques, Hierarchical Clustering, K-means Algorithms, The CURE Algorithm, Clustering in Non-Euclidean Spaces, and Clustering for Streams and Parallelism. Dimensionality Reduction: Eigen values and Eigenvectors of Symmetric Matrices, Principal-Component, Analysis, Singular-Value, Decomposition, CURD decomposition.	12
	Total	60

Text Books:

1. "Data Mining: Concepts and Techniques (4th Edition)", Jiawei Han, Jian Pei, Hanghang Tong, Publisher: Elsevier-2022
2. "Mining of Massive Datasets (3rd Edition)", Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Publisher: Cambridge University Press-2022
3. Mining of Massive Datasets-Jure Leskovec, Anand Rajaraman, Jeffrey D.Ullman.

Reference Books:

1. "Data Mining Methods by Rajan Chattamvelli", *Published: 2016*
2. Fundamentals of Data Warehouses, 2nd edition, Jarke, Lenzerini, Vassiliou, Vassiliadis, Springer.

Web Resources:

1. https://www.youtube.com/watch?v=ZUJ0UT9j2lQ
2. https://www.youtube.com/watch?v=43CMKRHdH30
3. https://www.geeksforgeeks.org/c-sharp/map-reduce-in-hadoop/

I Semester	HIGH PERFORMANCE COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:

The main objectives of the course are to study parallel computing hardware and programming models, performance analysis and modeling of parallel programs.

- Identify and understand various sources of overhead in parallel programs.
- Apply performance metrics to evaluate the scalability and efficiency of parallel systems.
- Analyze the impact of granularity and cost models on overall program performance.
- Implement analytical models for achieving optimal execution time in parallel systems.
- Apply dense matrix algorithms such as matrix-vector and matrix-matrix multiplication in parallel environments.

Course Outcomes:

		Knowledge Level(K)#
CO1	Understand the need for parallelism and the scope of parallel computing. Explain various parallel programming platforms, architectures, and their limitations.	K2
CO2	Developanefficientparallelalgorithmtosolvegivenproblemanalyzeand Measure performance of modern parallel computing system	K3
CO3	Understand fundamental communication operations in parallel computing and their performance implications. Explain the basics of shared address Space programming using threads, synchronization, and Open MP.	K2
CO4	Evaluate performance metrics, overheads, and scalability factors in parallel Systems using analytical models	K5
CO5	Build the logic to parallelize the programming task Develop parallel algorithms for sorting, graph problems, and CUDA-based GPU Programming to address computational challenges in modern systems.	K6

Mapping of course out comes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	M	H	L	M
CO2	H	M	H	H	M	H
CO3	M	L	M	M	L	M
CO4	M	L	M	M	L	M
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT–1	Introduction: Motivating Parallelism, Scope of ParallelComputing, Parallel Programming Platforms: Implicit Parallelism, Trends in Microprocessor and Architectures, Limitations of Memory, System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Scalable design principles, Architectures: N-wide superscalar architectures, multi-core architecture.	12
UNIT– 2	**Parallel Programming:** Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, The Age of Parallel Processing, the Rise of GPU Computing, A Brief History of GPUs, Early GPU.	12
UNIT– 3	**Basic Communication:** Operations- One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix- Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations. Programming shared address space platforms: threads-basics, synchronization, Open MP programming.	12
UNIT– 4	**Analytical Models:** Sources of overhead in Parallel Programs, Performance Metrics for Parallel Systems, and the effect of Granularity on Performance, Scalability of Parallel Systems, Minimum execution time and minimum cost, optimal execution time. Dense Matrix Algorithms: Matrix Vector Multiplication, Matrix-Matrix Multiplication.	12
UNIT– 5	**Parallel Algorithms:** Sorting and Graph: Issues in Sorting on Parallel Computers, Bubble Sort and its Variants, Parallelizing Quick sort, All-Pairs Shortest Paths, Algorithm for sparse graph, Parallel Depth-First Search, Parallel Best First Search. CUDA Architecture: CUDA Architecture, Using the CUDA Architecture, Applications of CUDA Introduction to CUDA C-Write and launch CUDA C kernels, Manage GPU memory, Manage communication and synchronization, Parallel Programming in CUDA- C.	12
	Total	60

Text Books:

1. "Introduction to Parallel Computing", S. Kumar, Publisher: Cambridge University Press-2023
2. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, " Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2.
3. Jasonsanders, Edward Kandrot, "CUDA by Example", Addison-Wesley, ISBN-13: 978-0-13-138768-3.

Reference Books:

1. "Programming in Parallel with CUDA: A Practical Guide", Richard E. Ansorge,**Publisher**: Cambridge University Press-2022
2. KaiHwang, " ScalableParallelComputing", McGrawHill 1998, ISBN:0070317984.
3. Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufmann Publishers Inc. San Francisco, CA, USA2013 ISBN: 9780124159884.
4. David Culler Jaswinder Pal Singh," Parallel Computer Architecture: A Hardware/ Software Approach", Morgan Kaufmann,1999, ISBN 978-1-55860-343-1.
5. RodStephens,"EssentialAlgorithms",Wiley,ISBN:ISBN:978-1-118-61210-1.

Web Resources:

1. https://www.geeksforgeeks.org/mobile-computing/parallel-algorithm-models-in-parallel-computing/

2. https://www.youtube.com/watch?v=m1b74x18kZk&list=PLhbrpS8rYbc0RD5cCF-IDtwzuRhBGEHl0

I Semester	AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3

Course Objectives: To acquire the knowledge on augmented reality.

- To demonstrate the augmented reality devices.
- To acquire the knowledge on virtual reality.
- To illustrate the VR devices.
- To explain how to apply VR/AR for various applications.
- Evaluate the impact of AR applications on learning, visualization, and productivity.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level(K)#
CO1	Explain the origin and fundamental concepts of Augmented Reality. Explain the working of Augmented Reality and identify its key ingredients	K1
CO2	Understand the relationship between Augmented Reality and other related technologies	K2
CO3	Understand the fundamental concepts, historical development, and key components of virtual reality systems and input interfaces.	K2
CO4	Apply knowledge of VR output devices and human factors to analyze user interaction, performance, and safety in virtual environments.	K3
CO5	Apply augmented and virtual reality concepts to identify, design, and Evaluate applications in domains like manufacturing and robotics.	K3

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	L	M	M	L	L	M
CO2	M	L	M	M	M	M
CO3	L	M	M	L	L	M
CO4	M	L	H	M	M	M
CO5	M	M	H	H	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	Augmented Reality, origin of Augmented Reality, The Relationship Between Augmented Reality and Other Technologies, Augmented Reality	12

	Concepts, working of Augmented Reality, Ingredients of an Augmented Reality Experience.	
UNIT– 2	Augmented Reality Hardware, Major Hardware Components for Augmented Reality Systems, Augmented Reality Software, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.	12
UNIT– 3	**Virtual Reality:** The Three I's of Virtual Reality, A Short History of Early Virtual Reality, Early Commercial VR Technology, VR Becomes an Industry, The Five Classic Components of a VR System. Input Devices: Trackers, Navigation, and Gesture Interfaces: Three-Dimensional Position Trackers, Navigation and Manipulation Interfaces.	12
UNIT– 4	**Output Devices:** Graphics, Three-Dimensional Sound, and Haptic Displays: Graphics Displays, Sound Displays, Haptic Feedback. Human Factors in VR: Methodology and Terminology, User Performance Studies, VR Health and Safety Issues, VR and Society.	12
UNIT– 5	Augmented Reality Applications, characteristics of a Good Augmented Reality Application, Application Areas, Magic Books, Magic Windows and Doors, Applying Augmented Reality to a Problem, Evaluating Augmented Reality Applications, VR Applications in Manufacturing, Applications of VR in Robotics.	12
	Total	60

Text Books:

1. "Handbook of Augmented and Virtual Reality", Sumit Badotra, Sarvesh Tanwar, Ajay Rana, Nidhi Sindhwani, Ramani Kannan, **Publisher**: De Gruyter,-2023
2. "Everyday Virtual and Augmented Reality", Giuseppe Riva, Brenda K. Wiederhold, Pietro Cipresso, **Publisher**: Springer-2023
3. AlanB.Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
4. Burdea,G.C.and P.Coffet. Virtual Reality Technology, Second Edition.Wiley-IEEE Press, 2003/2006.

Reference Books:

1. "Virtual Reality", Steven M. LaValle, **Publisher**: Cambridge University Press-2023
2. LaValle, "VirtualReality", CambridgeUniversityPress,2016.
3. Alan B Craig,William R Shermanand Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
4. JohnVince, "VirtualRealitySystems", PearsonEducationAsia,2007.
5. Anand R.,"Augmented and VirtualReality",Khanna Publishing House,Delhi.

Web Resources:

1. https://www.geeksforgeeks.org/blogs/basics-augmented-reality/
2. https://www.interaction-design.org/literature/topics/augmented reality?srsltid=AfmBOopSV7ApIAvRlB8xVVTHIbYYEbdQn_LdV5m6hT1JC9JHUAHgrbjY
3. https://www.geeksforgeeks.org/computer-graphics/architecture-of-augmented-reality-and-its-components/
4. https://www.youtube.com/watch?v=04AMaTsXFJU

I Semester	RECOMMENDER SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

This course covers the basic concepts of recommender systems, including personalization algorithms, evaluation tools, and user experiences.

- To identify **applications and challenges** associated with building and deploying recommender systems.
- To implement **nearest neighbor** techniques for user-item similarity measurement
- To analyze **case-based recommenders** and evaluate their effectiveness in domains requiring contextual knowledge.
- To evaluate the **advantages and limitations** of different hybrid recommender system designs.
- To understand the **importance and methods** of evaluating recommender systems.

Course Outcomes:

		Knowledge Level(K)#
CO1	Understand the fundamentals, mathematical notations, and applications of Recommender systems along with associated challenges.	K2
CO2	Evaluate different collaborative filtering approaches and assess the impact Of attacks on recommender systems to improve their robust ness and performance.	K5
CO3	Develop content-based and knowledge-based recommendation models Using it profiles, feature extraction, and classification algorithms.	K3
CO4	Design and implement hybrid recommender systems by exploring various Hybridization strategies.	K6
CO5	Evaluate recommender systems, and explore the integration of social tagging, trust, and community- driven recommendations for personalized Web search.	K5

Mapping of course out comes with program out comes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	L	M	M	L	L	M
CO2	M	M	H	M	M	M
CO3	H	M	H	H	M	H
CO4	H	M	H	H	H	H
CO5	H	H	H	M	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.	12
UNIT–2	Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing-based approaches, Attacks on collaborative recommender systems.	12
UNIT– 3	Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms. Knowledge based recommendation: Knowledge representation and reasoning, Constraint Based recommenders, Case based recommenders.	12
UNIT– 4	Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.	12
UNIT– 5	Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics. Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, social tagging Recommender systems, Trust and recommendations.	12
	Total	60

Text Books:

1. "Recommender Systems: The Textbook", Charu C. Aggarwal, **Publisher**: Springer-2016
2. Jannach D.,Zanker M.and FelFeringA.,Recommender Systems :An Introduction, Cambridge University Press (2011), 1st ed.
3. RicciF., Rokach L.,Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2011), 1st ed.

Reference Books:

1. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer (2013), 1st ed.
2. "Recommender Systems: An Introduction", Dietmar Jannach, Markus Zanker, Alexander Felfernig, Gerhard Friedrich, **Publisher**: Cambridge University Press-2010

Web Resources:

1. https://www.geeksforgeeks.org/machine-learning/user-based-collaborative-filtering/
2. https://www.geeksforgeeks.org/machine-learning/what-are-recommender-systems/
3. https://www.youtube.com/watch?v=t4oDiPFyuK4

I Semester	TIME SERIES ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

The main objective of the course is to introduce a variety of statistical models for time series and cover the main methods for analyzing these models.

- Understand the fundamental concepts of time series and forecasting
- Explain the general approach to developing and validating time series forecasting models.
- Understand the concept of linear regression and its application in time series forecasting.
- Analyze time series data for stationarity and apply transformations to achieve stationary conditions.
- Analyze multivariate stationary processes and assess their stability and dependencies.

Course Outcomes:

		Knowledge Level(K)#
CO1	Develop and design forecasting models using time series data by analyzing its structure, auto correlation patterns, and applying appropriate techniques For accurate predictions.	K6
CO2	Use statistical software to estimate the models from real data, and draw Conclusions and develop solutions from the estimated models.	K6
CO3	Evaluate and apply advanced regression techniques and time series models To analyze data, make predictions, and assess model adequacy.	K5
CO4	Communicate the statistical analyses of substantial data sets through explanatory text, tables and graphs. Apply ARIMA and Seasonal ARIMA models to analyze time series data, assess stationarity.	K3
CO5	Combine and adapt different statistical models to analyze large random re Complex data.	K6

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	M	H	H	M	H
CO3	H	L	M	M	L	M
CO4	M	H	M	L	L	M
CO5	H	M	H	H	M	H

UNIT	CONTENTS	Contact Hours
UNIT–1	**Introduction of Timeseries Analysis:** Introduction to Time Series and Forecasting, Different types of data, Internal structures of timeseries. Models for time series analysis, Autocorrelation and Partial Auto correlation. Examples of Time series Nature and uses of forecasting, Forecasting Process, Data for forecasting, Resources for forecasting	12
UNIT–2	**Statistics Background for Forecasting**: Graphical Displays, Time Series Plots, Plotting Smoothed Data, Numerical Description of Time Series Data, Use of Data Transformations and Adjustments, General Approach to Time Series Modeling and Forecasting, Evaluating and Monitoring Forecasting Model Performance.	12
UNIT– 3	**Time Series Regression Model:** Introduction Least Squares Estimation in Linear Regression Models, Statistical Inference in Linear Regression, Prediction of New Observations, Model Adequacy Checking, Variable Selection Methods in Regression, Generalized and Weighted Least Squares, Regression Models for General Time Series Data, Exponential Smoothing, First order and Second order	12
UNIT–4	**Autoregressive Integrated Moving Average (ARIMA)Models:** Auto regressive Moving Average (ARMA)Models, Stationarity and Invertibility of ARMA Models,Checking for Stationarity using Variogram, Detecting Non stationarity, Autoregressive Integrated Moving Average (ARIMA) Models, Forecasting using ARIMA, Seasonal Data, Seasonal ARIMA Models Fore casting using Seasonal ARIMA Models Introduction, Finding the “BEST” Model. **Example:** Internet Users Data Model Selection Criteria, Impulse Response Function to Study the Differences in Models Comparing Impulse Response Functions for Competing Models.	12
UNIT– 5	**Multivariate Time Series Models and Forecasting**: Multivariate Time Series Models and Forecasting, Multivariate Stationary Process, Vector ARIMA Models, Vector AR(VAR)Models, Neural Networks and Forecasting Spectral Analysis, Bayesian Methods in Forecasting.	12
	Total	60

Text Books:

1. *"Forecasting: Principles and Practice* (3rd Edition)", Rob J Hyndman & George Athanasopoulos, **Publisher**: OTexts-2023
2. IntroductionToTimeSeriesAnalysisandForecasting,2nd Edition, Wiley Series in Probability and Statistics, By Douglas C. Montgomery, Cheryl L. Jen (2015).
3. Master Time Series Data Processing, Visualization, And Modeling Using Python Dr. Avishek Pallor. Pks Prakash (2017)

Reference Books:

1. "Modern Time Series Forecasting with Python", Manu Joseph, **Publisher**: Packt Publishing - 2022

2. "Applied Time Series Modelling and Forecasting", Richard Harris & Robert Sollis, **Publisher**: John Wiley & Sons-2003

Web Resources:

1. https://www.geeksforgeeks.org/machine-learning/time-series-analysis-and-forecasting/

2. https://otexts.com/fpp2/graphics.html

3. https://www.youtube.com/shorts/i5zu-O1_5sw

4. https://www.youtube.com/watch?v=ZoJ2OctrFLA&list=PLvcbYUQ5t0UHOLnBzl46_Q6QKtFgfMGc3

I Semester	ARTIFICIAL INTELLIGENCE LAB	L	T	P	C
		0	1	2	2

Course Objective:

The objective of this lab is to equip students with hands-on experience in implementing fundamental and advanced artificial intelligence algorithms using Python. Students will learn to solve real-world problems using search strategies, heuristic techniques, game-playing algorithms, optimization methods, and expert systems, fostering their ability to design intelligent systems for various applications**.**

- To understand the fundamental concepts, functions, and applications of recommender systems along with the mathematical foundations such as linear algebra and covariance matrices.
- To learn various recommendation techniques including collaborative filtering, content-based filtering, and knowledge-based approaches, and understand their advantages and limitations.
- To explore different hybrid recommendation strategies that combine multiple methods to improve accuracy and overcome individual system weaknesses.
- To develop the ability to analyze and evaluate recommender systems using appropriate evaluation metrics, datasets, and user-centered approaches.
- To examine the role of recommender systems in social and community contexts, emphasizing trust, collaboration, and personalization in modern web applications.

Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Implement and analyze classic AI search techniques, such as DFS and BFS, for solving structured problems using Python.	K3
CO2	Apply heuristic-based approaches, including TSP and simulated annealing, to optimize complex problem - solving scenarios.	K3
CO3	Develop and implement advanced AI algorithms like A*, AO*, and hill-Climbing to address puzzles and decision-making tasks effectively.	K4
CO4	Design game-playing strategies using Min-Max algorithms and evaluate Their performance in adversarial settings.	K4
CO5	Build and test expert systems utilizing forward and back ward chaining Methods to automate reasoning processes in Python.	K3

#BasedonsuggestedRevisedBTL

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M
CO6	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

Experiment No.	List of Experiments
1	Implementation of DFS for water jug problem using PYTHON.
2	Implementation of BFS for water jug problem using PYTHON.
3	Implementation of BFS for tic-tac-toe problem using PYTHON.
4	Implementation of TSP using heuristic approach using PYTHON.
5	Implementation of Hill-climbing to solve 8-Puzzle Problem using PYTHON.
6	Implementation of Monkey Banana Problem using PYTHON.
7	Implementation of A* Algorithm using PYTHON.
8	Implementation of AO* Algorithm using PYTHON.
9	Implementation of Min-Max Game playing algorithm using PYTHON.
10	Implementation Expert System with forward chaining using PYTHON.
11	Implementation Expert System with back ward chaining using PYTHON.

Text Books:

1. *"Artificial Intelligence: Foundations of Computational Agents* (3rd Edition)", David L. Poole & Alan K. Mackworth, **Publisher**: Cambridge University Press-2023
2. Artificial intelligence, A modern Approach, 2nded, Stuart Russel, Peter Norvig, Prentice Hall
3. Artificial Intelligence, Saroj Kaushik,1stEdition, CENGAGE Learning,2011.

Reference Books:

1. "Artificial Intelligence: A Modern Approach (4th Edition)", Stuart Russell & Peter Norvig, **Publisher**: Pearson-2020
2. Artificial intelligence, structuresandStrategiesforComplexproblemsolving,5th Edition, George F Lugar, PEA.
3. Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer,2017.
4. Artificial Intelligence, AnewSynthesis,1stEdition, Nils J Nilsson, Elsevier, 1998.
5. ArtificialIntelligence-3rdEdition, Rich, Kevin Knight, Shiv Shankar B Nair, TMH.
6. IntroductionToArtificialIntelligenceandExpertSystems,1stEdition, Patterson, Pearson India, 2015.

Web Resources:

1. https://www.youtube.com/watch?v=tHFH2NkYI8Y
2. https://www.geeksforgeeks.org/artificial-intelligence/water-jug-problem-in-ai/
3. https://www.youtube.com/watch?v=9bjsOhSlwVM

I Semester	DATA WRANGLING LAB	L	T	P	C
		0	1	2	2

Course Objectives:

To equip students with practical skills in data handling, analysis, and visualization using Python, including file operations, data cleaning, and advanced techniques like web scraping and database integration.

- Understand and process various data formats (CSV, JSON, XML, Excel, PDF) using Python libraries.
- Perform data cleaning and wrangling operations using Pandas.
- Store and retrieve structured data using SQLite databases in Python.
- Analyze and visualize data using Agate, Matplotlib, and Pygal.
- Apply end-to-end data processing techniques to real-world datasets like child labour and child marriage data.

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level(K)#
CO1	Perform Read and write operations on CSV, JSON and XML files.	K3
CO2	Process the Excel file using Pandas.	K3
CO3	Parse and Extract the Tables using Python library.	K3
CO4	Apply the basis of Data cleanup operation on the given dataset.	K3
CO5	Explore the web scraping in Python.	K3

#BasedonsuggestedRevisedBTL

Mapping of course out comes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L,M,H)

Experiment No	List of Experiments
1	Write a Python script to read each row from a given csv file and print a list of strings.
2	Write a Python program to read a given CSV file as a dictionary.
3	Write a Python program to convert Python dictionary object (sort by key) to JSON data. Print the object members with indent level 4.
4	Write the python script to Read the XML file.
5	Write a Pandas program to import excel data (child labour and child marriage data.xlsx) into a Pandas data frame and process the following.
6	Get the data types of the given excel data.
7	Display the last ten rows.
8	Insert a column in the sixth position of the said excel sheet and fill it with NaN values.
9	Develop the python script to parse the pdf files using pdf miner.
10	Extract the Table from the child labour and child marriage data.xlsx using Pdf ables library.
11	Write a Python data wrangling scripts to insert the data into SQLite database.
12	Develop the Python Shell Script to do the basic data clean upon child labour And child marriage data.xlsx.
13	Check duplicates and missing data.
14	Eliminate Mismatches.
15	Cleans line breaks, spaces, and special characters.
16	Import the data into `agate` then explores the table using a gate methods and Perform statistical correlations.
17	Draw the chart between perceived corruption scores compared to the child Labour percentages using matplotlib.
18	Write the python script to Map the Child Labour Worldwide using pygal.

Text Books:

1. "Python Data Science 2024: Explore Data, Build Skills, and Drive Insights", Stephen Wilson, **Publisher**: Independently published -2024
2. Jacqueline Kazil & Katharine Jarmul,"Data Wrangling with Python", O'Reilly Media, Inc,2016.
3. Dr.Tirtha jyoti Sarkar,Shubha deep,"Data Wrangling with Python: Creating actionable data from raw sources", Packt Publishing Ltd,2019.

Reference Books:

1. "Mastering Python for Data Science (2nd Edition)", Samir Madhavan, Publisher: Packt Publishing-2025

2. "Python Data Analytics: Data Analysis and Science Using Pandas, Matplotlib, and the Python Programming Language (3rd Edition)", Fabio Nelli, Publisher: Apress-2015

Web Resources:

1. https://www.geeksforgeeks.org/python/load-csv-data-into-list-and-dictionary-using-python/
2. https://www.geeksforgeeks.org/python/python-sqlite-insert-data/
3. https://www.youtube.com/watch?v=i49yJxB3J38

II Semester	MACHINE LEARNING	L	T	P	C
		3	1	0	4

Course Objectives: Machine Learning course will

- Understand the concept of intelligent machines and well-posed problems.
- Evaluate model performance using regression and classification metrics
- Apply descriptive statistical techniques to learning models.
- Apply perceptron and Widrow-Hoff (delta) rule for cognitive machine learning.
- Analyze the strengths and limitations of decision tree-based learning approaches.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level(K)#
CO1	Domain Knowledge for Productive use of Machine Learning and Diversity of Data.	K4
CO2	Demonstrate on Supervised and Computational Learning.	K2
CO3	Analyze on Statistics in learning techniques and Logistic Regression	K4
CO4	Illustrate on Support Vector Machines and Perceptron Algorithm.	K2
CO5	Design a Multilayer Perceptron Networks and classification of decision tree.	K6

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	M	H	H	M	H
CO3	H	L	H	H	L	H
CO4	M	L	H	H	L	H
CO5	H	M	H	H	L	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	**Introduction:** Towards Intelligent Machines, well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured/ Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques.	12

UNIT–2	**Supervised Learning:** Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Overfitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metris for assessing classification.	12
UNIT– 3	**Statistical Learning:** Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, Bayesian Reasoning: A probabilistic approach to inference, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.	12
UNIT– 4	**Support Vector Machines (SVM):** Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly separable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, Regression by Support vector Machines. **Learning with Neural Networks:** Towards Cognitive Machine, Neuron Models, Network Architectures, Perceptron, Linear neuron and the Widrow- Hoff Learning Rule, The error correction delta rule.	12
UNIT– 5	**Multilayer Perceptron** Networks and error back propagation algorithm, Radial Basis Functions Networks. Decision Tree Learning: Introduction, Example of classification decision tree, measures of impurity for evaluating splits in decision trees, ID3, C4.5, and CART decision trees, Pruning the tree, strengths and weak ness of decision tree approach.	12
	Total	60

Text Books:

1. " Probability and Statistics for Machine Learning: A Textbook ",Charu C. Aggarwal, Publications: Springer-2024
2. Applied Machine Learning, M.Gopal,McGrawHillEducation,2019.
3. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press,2012.
4. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis (CRC) 1st Edition-2014.

Reference Books:

1. "Fundamentals of Supervised Machine Learning: With Applications in Python, R, and Stata", Giovanni Cerulli, , Publications: Springer-2023
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009. (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer,2007.
4. Machine Learning Methods in the Environmental Sciences, Neural Networks, William WHsieh, Cambridge Univ Press. *1* edition (August 31,2009).
5. Richardo. Duda,Peter E.Hart and DavidG.Stork,pattern classification, JohnWiley & SonsInc., 2nd Edition-2001.

Web Resources:

1. https://www.geeksforgeeks.org/machine-learning/statistics-for-machine-learning/

2. https://www.youtube.com/watch?v=E0Hmnixke2g

II Semester	DEEP LEARNING	L	T	P	C
		3	1	0	4

Course Objectives:

The objective of this course is to cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short-term memory cells and convolution neural networks.

- Understand the structure and functioning of biological and computational neurons.
- Apply empirical risk minimization and regularization techniques.
- Understand second-order methods for efficient neural network training.
- Understand recurrent neural networks and backpropagation through time.
- Analyze state-of-the-art deep learning trends in AI research.

Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Understand the structure of biological and computational neurons, perceptron models, and the fundamentals of perceptron learning and linear separability.	K2
CO2	Understand and explore feed forward networks Gain a mathematical Understanding of deep learning approaches, algorithms, and paradigms.	K2
CO3	Apply deep learning techniques, including neural networks and advanced models, to real-world applications in various domains like computer vision, Natural language processing, and speech recognition.	K3
CO4	Apply concepts of RNNs, LSTMs, CNNs, and generative models like RBMs to design and analyze deep learning architectures for sequential and Image data.	K3
CO5	Analyze and implement advanced deep learning models such as recurrent neural networks, convolutional neural networks, and generative models for Complex data processing.	K4

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	L	H	H	L	H
CO3	M	M	H	H	H	H
CO4	H	L	H	H	M	H
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT–1	Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts Unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm.	12
UNIT– 2	Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, auto encoders. Deep Neural Networks: Difficulty of training deep neural networks, Greedy layer wise training.	12
UNIT– 3	Better Training of Neural Networks: Newer optimization methods for neural networks (Ada grad, ada delta, rms prop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methos (dropout, drop connect, batch normalization).	12
UNIT– 4	Recurrent Neural Networks: Back propagation through time, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs. Convolutional Neural Networks: LeNet, AlexNet. Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.	12
UNIT–5	Recent trends: Variational Autoencoders, Transformers, GPT Applications: Vision, NLP, Speech.	12
	Total	60

Text Books:

1. "Deep Learning: Foundations and Concepts", by Christopher M. Bishop - 2024.
2. Deep Learning, Ian Good fellow and Yoshua Bengio and Aaron Courville, MITPress, 2016.

Reference Books:

1. Neural Networks: A Systematic Introduction, RaúlRojas,1996.
2. Pattern Recognition and Machine Learning, Christopher Bishop,2007.
3. Deep Learning with Python, François Chollet, Manning Publications,2017.

Web Resources

1. https://www.geeksforgeeks.org/nlp/feedforward-neural-network/
2. https://www.geeksforgeeks.org/nlp/feedforward-neural-network/
3. https://www.youtube.com/watch?v=tUoUdOdTkRw

II- Semester	MATHEMATICS FOR MACHINE LEARNING	L	T	P	C
		3	1	0	4

Course Objectives: From the course the student will learn

- Develop a Strong Foundation in Linear Algebra and Analytic Geometry.
- Apply Analytical and Geometric Concepts to Solve Real- World Problems.
- Master Techniques for Solving Systems of Linear Equations and Matrix Computations.
- Understand the Fundamentals of Vector Calculus and Their Applications.
- Explore Probability Theory and Optimization for Applied Mathematical Modeling.

Course Out comes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level
CO1	Understand and apply linear mappings and transformations	K2
CO2	Apply orthogonal projections and understand projection operators	K3
CO3	Compute the determinant and trace of any square matrix and Decomposition	K3
CO4	Differentiate univariate functions and compute higher-order derivatives	K3
CO5	Apply Baye's theorem to update posterior probabilities in discrete or Continuous domains.	K3

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	M	H	L	H
CO2	M	L	M	H	L	H
CO3	H	L	M	H	L	H
CO4	M	L	M	H	L	M
CO5	H	M	H	H	M	H
CO6						

UNIT	CONTENTS	Contact Hours
UNIT– 1	**Linear Algebra**: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces	12
UNIT–2	**Analytic Geometry**: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Ortho normal Basis, Orthogonal Complement,	12

	Inner Product of Functions, Orthogonal Projections, Rotations	
UNIT– 3	**Matrix Decompositions:** Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky, Decomposition, Eigende composition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny	12
UNIT– 4	**Vector Calculus:** Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Back propagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series	12
UNIT– 5	**Probability and Distributions:** Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Gaussian Distribution, Conjugacy and the Exponential Family, Change of Variables/Inverse Transform Continuous Optimization: Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers, Convex Optimization	12
	Total	60

Text Books:

1. "Mathematics for Machine Learning", Marc Peter Deisenroth, A.Aldo Faisal and Cheng Soon Ong, Cambridge University Press -2020
2. "Engineering Mathematics I: Matrices and Calculus", Dr. A. Singaravelu, Meenakshi Agency, -2020
3. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd Edition, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer- 2017.

Reference Books:

2. "Essential Math for AI", Hala Nelson, O'Reilly Media -2023
3. Machine Learning: An Applied Mathematics Introduction, Paul Wilmott, Panda Ohana Publishing- 2019.

Web Resources:

1. https://www.geeksforgeeks.org/maths/linear-algebra/
2. https://www.youtube.com/watch?v=1XlT3Y2oyAU&list=PLU6SqdYcYsfI7Ebw_j-Vy8YKHdbHKP9am

II Semester	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

Course Objective:

- To implement Virtualization.
- To implement Task Scheduling algorithms.
- Apply Map – Reduce concept to applications.
- To build Private Cloud.
- Broadlyeducatetoknowtheimpactofengineeringonlegalandsocietalissues involved.

Course Out comes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Understand the fundamentals of network-centric computing, cloud models, Ethical concerns, and challenges in distributed systems.	K2
CO2	Analyze cloud infra structure, platforms, applications, and paradigms to Identify opportunities and challenges in various domains.	K4
CO3	Apply virtualization techniques and cloud scheduling policies to manage And allocate cloud resources effectively.	K3
CO4	Evaluate cloud storage systems and assess cloud security risks, privacy concerns, and protective mechanisms.	K5
CO5	Evaluate own organizations' needs for capacity building and training in cloud computing-related IT areas.	K5

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	M	H
CO2	H	M	H	M	H	M
CO3	H	M	H	H	M	H
CO4	M	M	H	M	H	H
CO5	M	H	M	L	H	M

UNIT	CONTENTS	**Contact Hours**
UNIT–1	**Introduction**: Network centric computing, Network centric content, peer-to –peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing. Parallel and Distributed Systems: Introduction, architecture, distributed	12

	systems, communication protocols, logical clocks, message delivery rules, concurrency, model concurrency with Petri Nets.	
UNIT–2	**Cloud Infrastructure**: At Amazon, The Google Perspective, Microsoft Windows Azure, Open Source Software Platforms, Cloud storage diversity, Inter cloud, energy use and ecological impact, responsibility sharing, user experience, Software licensing. Cloud Computing: Applications and Paradigms: Challenges for cloud, existing cloud applications and new opportunities, architectural styles, workflows, The Zookeeper, The Map Reduce Program model, HP Concloud, biological research.	12
UNIT–3	**Cloud Resource virtualization**: Virtualization, layering and virtualization, virtual machine monitors, virtual machines, virtualization-full and para, performance and security isolation, hardware support for virtualization, Case Study: Xen, Blades. Cloud Resource Management and Scheduling: Policies and Mechanisms, Applications of control theory to task scheduling, Stability of a two-level resource allocation architecture, feedback control based on dynamic thresholds, coordination, resource bundling, scheduling algorithms, fair queuing, start time fair queuing, cloud scheduling subject to deadlines, Scheduling Map Reduce applications, Resource management and dynamic application scaling.	12
UNIT–4	**Storage Systems**: of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system. Apache Hadoop, Big Table, Megastore (text book 1), Amazon Simple Storage Service(S3) (Text book 2).Cloud Security: Cloud security risks, security–a top concern for cloud users, privacy and privacy impact assessment, trust, OS security, Virtual machine security, Security risks.	12
UNIT–5	**Cloud Application Development**: Amazon Web Services: EC2 – instances, connecting clients, security rules, launching, usage of S3 in Java, Installing Simple Notification Service on Ubuntu 10.04, Installing Hadoop on Eclipse, Cloud based simulation of a Distributed trust algorithm, Cloud service for adaptive data streaming (Text Book 1). Google: Google App Engine, Google Web Toolkit(TextBook2). Microsoft: Azure Services Platform, Window slive, Exchange Online, Share Point Services, Microsoft Dynamics CRM (Text Book 2).	12
	Total	60

Text Books:

1. "Cloud Computing: Concepts, Technology, and Architecture", Thomas Erl, Ricardo Puttini, Zaigham Mahmood , 2nd Edition - 2023
2. Cloud Computing, Theory and Practice, Dan CMarinescu, M K Elsevier.
3. Cloud Computing, A Practical Approach, Anthony T Velte, Toby JVelte, Robert Elsenpeter, TMH.

Reference Books:

1. Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi, TMH

Web Resources:

1. https://www.youtube.com/watch?v=UBVVq-xz5i0
2. https://aws.amazon.com/what-is/cloud-infrastructure/
3. https://www.geeksforgeeks.org/software-engineering/cloud-computing-infrastructure/
4. https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/Instances.html

II Semester	REINFORCEMENT LEARNING	L	T	P	C
		3	0	0	3

Course Objective:

To provide students with comprehensive knowledge of reinforcement learning fundamentals, from basic exploration-exploitation problems to advanced deep RL algorithms, enabling them to design, implement, and evaluate intelligent agents for sequential decision-making tasks.

- Understand the fundamental concepts, elements, and limitations of reinforcement learning.
- Evaluate Partially Observable MDPs (POMDPs) using belief states and basic formulations.
- Understand Monte Carlo methods for prediction and control in model-free RL
- Understand function approximation techniques in RL for large and continuous state spaces.
- Analyze imitation learning methods including behavior cloning, IRL, and GAIL.

Course Out comes: At the end of the course, student will be able to:

CO	Course Outcome	Knowledge Level(K)#
CO1	Understand the fundamentals of reinforcement learning, exploration-exploitation trade-offs, and solve multi-armed bandit problems using various action selection strategies.	K2
CO2	Formulate sequential decision-making problems as Markov Decision Processes and apply dynamic programming techniques to find optimal policies in known environments.	K3
CO3	Implement model-free reinforcement learning algorithms including Monte Carlo methods, temporal-difference learning (SARSA, Q-learning), and eligibility traces for learning optimal behavior through interaction.	K3
CO4	Design and develop deep reinforcement learning systems using function approximation, deep Q-networks, policy gradient methods, and actor-critic architectures for complex, high-dimensional problems.	K4
CO5	Evaluate and apply advanced RL techniques including model-based methods, multi-agent systems, hierarchical reinforcement learning, and imitation learning to solve real-world problems.	K5

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	L	M
CO2	H	M	H	H	L	H
CO3	M	L	H	M	L	H
CO4	H	M	H	H	M	H
CO5	M	H	M	L	M	M

UNIT	CONTENTS	**Contact Hours**
UNIT–1	**Reinforcement Learning** , Elements of Reinforcement Learning, Limitations and Scope, Types of Tasks, The Exploration-Exploitation Dilemma **Multi-Armed Bandit Problems :** The k-Armed Bandit Problem- Action Selection Methods - Greedy and ε-greedy methods - Optimistic initialization - Bound action selection - Upper Confidence Bound (UCB) - Thompson Sampling - Regret analysis - Associative Search(Contextual bandits), Non-stationary bandits	12
UNIT–2	**Markov Decision Processes:** Components of MDP - The Markov Property Types of MDP - Policies and Value Functions - Optimal Value Functions - Optimality and Approximation **Dynamic Programming (Planning with a Known Model):** Policy Evaluation - Policy Improvement - Policy Iteration - Value Iteration - Asynchronous DP **Partially Observable MDPs (POMDPs):** Basic concepts and formulation Belief states	12
UNIT–3	**Model-Free Reinforcement Learning** **Monte Carlo Methods:** Concepts and Characteristics - Monte Carlo prediction (estimating $V\pi$) - First-visit and every-visit MC - Estimation of action values - Monte Carlo control - ε-soft/ε-greedy policies - Off-policy Monte Carlo via importance sampling **Temporal-Difference Learning:** TD prediction: TD(0) - Comparison: TD vs Monte Carlo vs Dynamic Programming - On-policy TD control: SARSA - Off-policy TD control: Q-learning - Expected SARSA **Eligibility Traces and n-Step Returns:** Forward vs backward view - n-step TD learning - TD(λ) and eligibility traces - Sarsa(λ), Q(λ)	12
UNIT–4	**Deep Reinforcement Learning** **Function Approximation in RL:** Large/continuous state spaces - Linear function approximation and feature design - Non-linear approximation (neural networks) - Batch vs online learning - Convergence and stability issues - Architectures in RL: CNNs (vision), RNNs/LSTMs (memory) **Deep Q-Networks (DQN):** Neural function approximation for Q-values - Experience replay - Target networks - Double DQN - Dueling DQN - Prioritized Experience Replay **Policy Gradient Methods:** Policy parameterization - Policy Gradient Theorem - REINFORCE (Vanilla Policy Gradient) - Variance reduction:	12

	Baselines and advantage functions **Actor-Critic Methods:** Structure and intuition - Advantage Actor-Critic (A2C) - Asynchronous Advantage Actor-Critic (A3C) - Proximal Policy Optimization (PPO) - Deep Deterministic Policy Gradient (DDPG) - Soft Actor-Critic (SAC)	
UNIT–5	**Model-Based Reinforcement Learning:** Dyna-Q architecture - Model learning and planning - Model predictive control in RL **Multi-Agent Reinforcement Learning:** Types of agent interactions - Learning paradigms: Independent learning, joint-action learning - Centralized Training with Decentralized Execution (CTDE) - Key challenges: Non-stationarity, coordination, scalability - Value-Based and Policy-Based MARL **Hierarchical Reinforcement Learning:** Semi-Markov Decision Processes (SMDPs) - Options framework - MAXQ value function decomposition - Feudal Networks (FuNs) - Hierarchical DQN (h-DQN) - Hierarchical Actor-Critic (HAC) **Imitation Learning:** Behavior Cloning - Inverse Reinforcement Learning (IRL) - Generative Adversarial Imitation Learning (GAIL) **Emerging Topics (Overview):** Offline RL: Conservative Q-Learning (CQL) - Meta-Reinforcement Learning: Key concepts	**12**
	Total	60

Text Books:

1. "Deep Reinforcement Learning Hands-On", (Third Edition) by Maxim Lapan-2024
2. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning-An Introduction",2nd Edition, The MIT Press, 2018.
3. Marco Wiering, Martijn van Otterlo Reinforcement Learning: State-of-the-Art (Adaptation, Learning, and Optimization (12)) 2012th Edition.

Reference Books:

1. "Multi-Agent Reinforcement Learning: Foundations and Modern Approaches", by Stefano V. Albrecht, Filippos Christianos & Lukas Schäfer -2024
2. Vincent François-Lavet, Peter Henderson, Riashat Islam, An Introduction to Deep Reinforcement Learning (Foundations and Trends(r) in Machine Learning), 2019.

Web Resources

1. https://www.youtube.com/watch?v=lfHX2hHRMVQ
2. https://www.youtube.com/watch?v=NFo9v_yKQXA&list=PLzvYlJMoZ02Dxtwe-MmH4nOB5jYlMGBjr
3. https://www.geeksforgeeks.org/deep-learning/deep-q-learning/
4. https://medium.com/@shruti.dhumne/deep-q-network-dqn-90e1a8799871

II Semester	GENERATIVE AI	L	T	P	C
		3	0	0	3

Course Objectives:

- Understand the principles and concepts underlying Generative AI.
- Explore various types of generative models and their applications.
- Developpracticalskillsinimplementingandtraininggenerativemodels.
- Evaluate the performance and limitations of different generative AI techniques.
- AnalyseethicalconsiderationsandemergingtrendsinGenerativeAI.

Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Understand the basics of generative AI, its applications, and the role of Probability in data generation and style transformation.	K2
CO2	Apply the building blocks of deep neural networks, including CNNs and RNNs, to handle vision and sequence- based data	K3
CO3	Evaluate and implement generative adversarial networks (GANs) for image Generation using various advanced GAN architectures.	K5
CO4	Apply generative models such as GANs and auto encoders to create Deep fakes and understand their operational work flows and features.	K3
CO5	Understand generative models used in music composition, including LSTMs and Muse GAN, and explore emerging applications in generative AI.	K2

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	M	L	M
CO2	H	M	H	H	L	H
CO3	M	M	H	M	M	H
CO4	H	M	H	H	M	H
CO5	M	H	M	L	H	M

UNIT	CONTENTS	**Contact Hours**
UNIT–1	Introduction to Generative Al: “Drawing" Data from Models Applications Of AI, the rules of probability, why use generative models, Style transfer And image transformation.	12

UNIT– 2	Building Blocks of Deep Neural Networks Perceptron's — a brain in a function, multi-layer perceptron's and backpropagation, Varieties of networks: Convolution and recursive, Networks for seeing: Convolutional architectures, Networks for sequence data RNNs and LSTMs	12
UNIT– 3	Image Generation with GANs, The taxonomy of generative models Generative adversarial networks, Vanilla GAN, Improved GANs, Progressive GAN	12
UNIT– 4	Deep fakes with GANs, Deep fakes overview, Modes of operation, Key feature set, High-level work flow, Replacement using auto encoders, Re-enactmentusingpix2pix	12
UNIT– 5	Composing Music with Generative Models Getting started with music generation, Music generation using LSTMs, Music generation using GANs,Muse GAN—poly phonic music generation, Emerging applications In generative AI	12
	Total	60

Text Books:

1. "Generative Deep Learning (2nd Edition)", by David Foster Publicatios: Oreilly media, 2023
2. Generative AI with Python and Tensor Flow 2, Joseph Babcock, Raghav Bali.
3. Hands-On Generative Adversarial Networks with Keras, Rafael Valle, PacktPublishing.

Reference Books:

1. GANs in Action: Deep Learning with Generative Adversarial Networks by Jakub Langr & Vladimir Bok-2019

Web Resources:

1. https://www.youtube.com/watch?v=RAa55G-oEuk
2. https://www.youtube.com/watch?v=MZmNxvLDdV0
3. https://www.tutorialspoint.com/artificial_neural_network/artificial_neural_network_building_blocks.htm
4. https://ishwaryasriraman.medium.com/neural-networks-the-building-blocks-of-deep-learning-bce361c995b9
5. https://www.geeksforgeeks.org/machine-learning/neural-networks-a-beginners-guide/

II Semester	COMPUTER VISION	L	T	P	C
		3	0	0	3

Course Objectives:

- Understand the principles of pinhole cameras and image formation.
- Analyze local and global shading models for photometric applications.
- Understand image segmentation techniques using clustering and graph-theoretic methods.
- Learn model fitting techniques such as the Hough Transform for lines and curves.
- Apply affine camera models and photogrammetry for 3D reconstruction.

Course Out comes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Recall and understand the fundamental principles of radiometry, shading, And color in image formation using pinhole camera models.	K1
CO2	Apply concepts of lighting, shading, and color perception to analyze how Light interacts with surfaces in computer vision applications.	K3
CO3	Apply stereo vision and clustering techniques for image segmentation and multi-view geometry in computer vision.	K3
CO4	Apply probabilistic models such as the Hough Transform, EM algorithm, And Kalman filtering for segmentation, fitting, and tracking in dynamic scenes.	K3
CO5	Apply geometric camera models and calibration techniques, including model-based vision methods, for applications like mobile robotics and Medical image registration.	K3

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	M	L	H	M	L	H
CO3	M	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	M	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	Pinhole Cameras Radiometry – Measuring Light: Light in Space, Light on Surfaces, Important Special Cases Sources, Shadows, and Shading: Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo Interreflections: Global Shading Models	12
UNIT–2	**COLOR AND IMAGE REPRESENTATION** Color: The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color	12
UNIT– 3	**GEOMETRY OF MULTIPLE VIEWS** The Geometry of Multiple Views: Two Views Stereopsis: Reconstruction, Human Stereopsis, Binocular Fusion, Using More Cameras	12
UNIT– 4	**SEGMENTATION AND CLUSTERING** Segmentation by Clustering: What Is Segmentation? Human Vision: Grouping and Gestalt, Applications: Shot Boundary Detection, Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering Segmentation by Fitting a Model: The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness	12
UNIT– 5	**MODEL-BASED VISION AND CAMERA CALIBRATION** Segmentation and Fitting Using Probabilistic Methods: Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice Tracking with Linear Dynamic Models: Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications and Examples **Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations **Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, Case Study: Mobile Robot Localization **Model-Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by Pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Case Study: Registration in Medical Imaging Systems, Curved Surfaces and Alignment	12
	Total	60

Text Books:

1. Computer Vision: Algorithms and Applications by Richard Szeliski — 2nd Edition, 2022.
2. Handbook of Image Processing and Computer Vision: Volume 1 – From Energy to Image by Arcangelo Distante & Cosimo Distante — 1st Edition, 2020.
3. David A.Forsyth and Jean Ponce: Computer Vision–A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

1. E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.
2. R. C. Gonzalez and R. E. Woods "Digital Image Processing" Addison Wesley 2008. 3. Richard Szeliski "Computer Vision: Algorithms and Applications" Springer-Verlag London Limited 2011.

Web Resources

1. https://www.youtube.com/watch?v=oALeFTm7-ZI&list=PLTBdjV_4f-EKTxkbejHedLAM62thMLZ9_
2. https://bowenbz.github.io/posts/SLAM-CV-MVG/

II Semester	QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:

This course covers the basic concept so quantum computing and problem-solving approach using finite dimensional mathematics.

- Understand basic algebra, matrix operations, vectors, and vector spaces relevant to quantum computing.
- Understand quantum states, superposition, and entanglement.
- Learn the construction and functioning of quantum circuits.
- Understand Shor's algorithm for factoring and its implications.
- Analyze the impact of quantum computing on classical cryptographic techniques.

Course Out comes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Understand the foundational concepts of linear algebra, complex numbers, And set theory relevant to quantum computing.	K2
CO2	Understand basic principles of quantum physics, quantum theory, and Entanglement essential for quantum computation.	K2
CO3	Understand the architecture and hard ware components of quantum computers, including qubits, gates, and decoherence challenges.	K2
CO4	Understand the structure and logic behind key quantum algorithms such as Deutsch-Jozsa, Shor's, and Grover's algorithms.	K2
CO5	Understandtheimplicationsofquantumcomputingonclassicalasymmetric cryptographic algorithms and their security.	K2

Mapping of course outcomes with program out comes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	M
CO2	L	L	H	M	L	M
CO3	M	L	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	M	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	Introduction to Essential Linear Algebra: Some Basic Algebra, Matrix Math, Vectors and Vector Spaces, Set Theory. Complex Numbers: Definition of Complex Numbers, Algebra of Complex Numbers, Complex Numbers Graphically, Vector Representations of Complex Numbers, Pauli Matrice, Transcendental Numbers.	12
UNIT–2	Basic Physics for Quantum Computing: The Journey to Quantum, Quantum Physics Essentials, Basic Atomic Structure, Hilbert Spaces, Uncertainty, Quantum States, Entanglement. Basic Quantum Theory: Further with Quantum Mechanics, Quantum Decoherence, Quantum Electrodynamics, Quantum Chromodynamics, Feynman Diagram Quantum Entanglement and QKD, Quantum Entanglement, Interpretation, QKE.	12
UNIT– 3	Quantum Architecture: Further with Qubits, Quantum Gates, More with Gates, Quantum Circuits, The D-Wave Quantum Architecture. Quantum Hardware: Qubits, number of Qubits Needed, Addressing Decoherence, Topological Quantum Computing, Quantum Essentials.	12
UNIT– 4	Quantum Algorithms: Algorithm, Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Algorithm, Grover's Algorithm.	12
UNIT– 5	Current Asymmetric Algorithms: RSA, Diffie-Hellman, Elliptic Curve. The Impact of Quantum Computing on Cryptography: A symmetric Cryptography, Specific Algorithms, Specific Applications.	12
	Total	60

Text Books:

1. **"**Quantum Computing: An Applied Approach **",** Jack D. Hidary 2nd Edition – 2021
2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
3. Dr.Chuck Easttom, Quantum Computing Fundamentals, Pearson.

Reference Books:

1. Quantum Computing for Computer Scientists, Noson S.Yanofsky and MircoA. Mannucci.
2. Principles of Quantum Computation and Information, BenentiG., Casati G.andStriniG.,
3. An Introduction to Quantum Computing Algorithms, PittengerA.O.,

Web Resources

1. youtube.com/watch?v=tsbCSkvHhMo&pp=ygURUXVhbnR1bSBjb21wdXRpbmc%3D
2. https://www.youtube.com/watch?v=hyctIDPRSqY
3. https://www.spinquanta.com/news-detail/how-to-learn-quantum-physics-a-beginners-guide20250116105706

II Semester	SOFT COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:

To introduce the concepts in Soft Computing such as Artificial Neural Networks, Fuzzy logic-based systems, genetic algorithm-based systems and their hybrids.

- Understand different activation functions and their roles in network behavior.
- Apply training algorithms to improve neural network performance.
- Study lambda-cuts, value assignments, and rank ordering in fuzzy systems.
- Understand fuzzy propositions and truth tables in fuzzy logic.
- Understand the fundamentals of genetic algorithms and their applications.

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level(K)#
CO1	Understand the fundamentals of soft computing, artificial neural networks, neuron models, and basic learning mechanisms.	K2
CO2	Analyze and compare different perceptron architectures and training algorithms including Adaptive Linear Neuron and Backpropagation Network.	K4
CO3	Recall basic concepts of fuzzy logic including fuzzy sets, relations, membership functions, and fuzzification methods.	K1
CO4	Understand fuzzy inference systems, rule formation, and hybrid neuro-fuzzy systems such as Mamdani and Sugeno models.	K2
CO5	Apply genetic algorithms and hybrid systems to optimization problems, including genetic-neuro and genetic-fuzzy rule-based systems.	K3

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	L	M
CO2	H	L	H	H	L	H
CO3	M	L	M	M	L	M
CO4	H	L	H	M	M	H
CO5	H	M	H	H	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT– 1	Introduction to Soft Computing, Artificial neural networks, biological neurons, Basic models of artificial neural networks, Connections, Learning, Activation Functions, McCulloch and Pitts Neuron, Hebb network	12
UNIT– 2	Perceptron networks, Learning rule, Training and testing algorithm, Adaptive Linear Neuron, Back propagation Network, Architecture, Training algorithm.	12
UNIT– 3	Fuzzy logic, fuzzy sets, properties, operations on fuzzy sets, fuzzy relations, operations on fuzzy relations, Fuzzy membership functions, fuzzification, Methods of membership, value assignments, intuition, inference, rank ordering, Lambda–cuts for fuzzy sets, Defu zzification methods.	12
UNIT– 4	Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules, Decomposition of rules, Aggregation ofrules, Fuzzy Inference Systems, Mamdani and Suge notypes, Neuro-fuzzy hybrid systems, characteristics, classification.	12
UNIT– 5	Introduction to genetic algorithm, operators in genetic algorithm, coding, selection, cross over, mutation, stopping condition for genetic algorithm flow, Genetic-neuro hybrid systems, Genetic Fuzzy rule-based system.	12
	Total	60

Text Books:

1. Artificial Neural Networks and Type-2 Fuzzy Set: Elements of Soft Computing and Its Applications, Snehashish Chakraverty, Arup K. Sahoo, Dhabaleswar Mohapatra-2024
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing–JohnWiley&Sons,2007.
3. Timothy J.Ross, Fuzzy Logic with engineering applications, JohnWiley&Sons,2016.

Reference Books:

1. N.K.Sinhaand M.M.Gupta, Soft Computing & Intelligent Systems: Theory& Applications-Academic Press /Elsevier. 2009.
2. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc.1998.
3. R.Eberhart and Y.Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/Elsevier, 2007.

4. Driankov D., Hellendoorn H. and Reinfrank M.,An Introduction to Fuzzy Control Narosa Pub., 2001.
5. Bart Kosko, Neural Network and Fuzzy Systems-Prentice HallInc., Engle wood Cliffs, 1992.
6. Goldberg D.E., Genetic Algorithms in Search, Optimization, and Machine Learning Addison Wesley, 1989.

Web Resources

1. https://pravin-hub-rgb.github.io/BCA/resources/sem5/sc/unit1/index.html
2. https://www.geeksforgeeks.org/software-engineering/need-for-soft-computing/
3. https://onlinecourses.nptel.ac.in/noc22_cs54/preview
4. https://www.youtube.com/watch?v=BgsCP0a0RXg&list=PL4gu8xQu0_5Ix4FzEQkMzi46sPu-8-7tM
5. https://www.youtube.com/watch?v=K7S3TgfqnX0&list=PLFW6lRTa1g81F7CJ-CdlsyWKKAa43T62j

II Semester	DEEP LEARNING LAB	L	T	P	C
		0	1	2	2

Course Objective:

To enable students to design, implement, and evaluate deep learning models for diverse real-world applications using state-of-the-art techniques and tools.

- Implement MLP and CNN models for image classification (MNIST, Dogs vs Cats).
- Design neural networks for binary (IMDB) and multi-class (Reuters) text classification.
- Apply neural networks for regression tasks like Boston Housing price prediction.
- Utilize pre-trained CNNs (VGG16) and transfer learning for image classification.
- Implement NLP techniques including one-hot encoding, word embeddings, and RNNs for sequence modeling

Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Implement deep neural networks to solve real world problems	K3
CO2	Utilizepre-trainedmodelslikeVGG16forefficientimagerecognition	K3
CO3	Apply embedding techniques to represent textual data for natural Language processing tasks	K4
CO4	Interpret the results of two different deep learning models	K4
CO5	Choose appropriate pre-trained model to solve real time problem	K4

#BasedonsuggestedRevisedBTL

Mapping of course out comes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	H	M
CO2	M	M	H	H	M	L
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L,M,H)

Software Packages required:

- Keras
- TensorFlow
- PyTorch

S.No	List of Experiments
1	Implement multilayer perceptron algorithm for MNIST Hand written Digit Classification.
2	Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
3	Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset.
4	Design a neural network for predicting house prices using Boston Housing Price dataset.
5	Build a Convolution Neural Network for MNIST Hand written Digit Classification.
6	Build a Convolution Neural Network for simple image (dogs and Cats) Classification.
7	Useapre-trained convolution neural network (VGG16) for image classification.
8	Implement one hot encoding of words or characters.
9	Implement word embeddings for IMDB dataset.
10	Implement a Recurrent Neural Network for IMDB movie review classification problem.

Text Books:

1. Deep Learning with Python, Third Edition by François Chollet-2024
2. Neural Networks and Deep Learning: A Textbook by Charu C. Aggarwal-2023
3. Reza Zadeh and Bharath Ramsundar, “Tensor flow for Deep Learning”, O’Reilly publishers, 2018.References:

Web Resources

1. https://www.kaggle.com/code/santosh1974/reuters-newswires-nn-multi-classification
2. https://colab.research.google.com/github/alzayats/Google_Colab/blob/master/3_6_classifying_newswires.ipynb
3. https://www.kaggle.com/code/okmldl/classifying-newswires-multiclass-classification
4. https://www.youtube.com/watch?v=S4Rll57ItP8
5. https://github.com/fchollet/deep-learning-with-python-notebooks

II Semester	MACHINE LEARNING LAB	L	T	P	C
		0	1	2	2

Course Objective:

To equip students with practice al knowledge of machine learning techniques for data preprocessing, classification, clustering, and visualization using Python.

- Implement dimensionality reduction techniques like PCA and SVD using NumPy.
- Apply concept learning algorithms including FIND-S and Candidate-Elimination on CSV training data.
- Build and test supervised learning models such as Decision Trees, Backpropagation Neural Networks, and Naïve Bayes classifiers.
- Implement Bayesian networks, EM clustering, k-Means, k-NN, and Locally Weighted Regression for prediction and data analysis.
- Perform data visualization using Matplotlib, Pandas, and Seaborn for scatter plots, line charts, and histograms.

Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level(K)#
CO1	Implement dimensionality reduction techniques like PCA and SVD to Preprocess and analyses data.	K3
CO2	Apply FIND-S and Candidate-Elimination algorithms to derive specific And consistent hypotheses from training data in .CSV files	K4
CO3	Build classification models using decision trees (ID3), k-NN, and Bayesian classifiers, and evaluate their performance on various data sets.	K3
CO4	Explore clustering techniques, including k-Means and the EM algorithm, To analyse data quality and patterns.	K4
CO5	Visualize and interpret data insights using regression models, scatter plots, line charts, and histograms with Python libraries like Matplotlib, Seaborn, and Pandas.	K4

#BasedonsuggestedRevisedBTL

Mapping of course out comes with program out comes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	H	M
CO2	H	M	H	H	H	M
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz.,L,M,H)

S.No	List of Experiments
1	Implement Principal Component Analysis (PCA)and Singular Value Decomposition (SVD) using NumPy.
2	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
3	For a given set of training data examples store dina.CSV file, implement and Demonstrate the Candidate-Elimination algorithm to output a description of the set of All hypotheses consistent with the training examples.
4	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Useanappropriatedatasetforbuildingthedecisiontreeandapplythisknowledgeto Classify an example.
5	BuildanArtificialNeuralNetworkbyimplementingtheBackpropagationalgorithm And test the same using appropriate datasets.
6	Write a program to implement the naïve Bayesian classifier for a sample training data set store data. CSV file. Compute the accuracy of the classifier, considering few test datasets.
7	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
8	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
9	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
10	Writeaprogramtoimplementk-NearestNeighbouralgorithmtoclassifytheirisdata set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
11	Implement the non-parametric Locally Weighted Regression algorithm in order to fit datapoints. Select appropriate data set for your experiment and draw graphs.
12	Create the following plots using Matplotlib, Pandas Visualization, Sea born on iris dataset, wine reviews datasets. a. Scatter Plot b. Line chart c. Histogram

Text Books:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition) by Aurélien Géron- 2022
2. Deep Learning and Machine Learning – Python Data Structures and Mathematics Fundamental: From Theory to Practice by Silin Chen et al.-2024
3. Applied Machine Learning, M.Gopal,McGrawHillEducation,2019.
4. Kevin Murphy, Machine Learning: A Probabilistic Perspective,MITPress,2012.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman. The Elements of Statistical Learning, Springer 2009. (freely available online)
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer,2007

Web Resources

1. https://www.geeksforgeeks.org/machine-learning/naive-bayes-classifiers/
2. https://vtupulse.com/machine-learning/naive-bayesian-classifier-in-python/
3. https://vtupulse.com/machine-learning/k-nearest-neighbour-algorithm-in-python/
4. https://stackoverflow.com/questions/1730600/principal-component-analysis-in-python

III Semester	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

Course Objectives:

- Understand the meaning, sources, and scope of a research problem.
- Learn effective approaches for literature studies and critical analysis.
- Understand international cooperation and frameworks in IPR
- Learn procedures for licensing and technology transfer.
- Understand the administration and management of the patent system

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level(K)#
CO1	Identify and formulate research problems, design investigative approaches, and apply appropriate data collection and analysis methods.	K2
CO2	Conduct effective literature reviews, maintain research ethics, and Prepare structured technical reports and research proposals.	K3
CO3	Explain the nature and types of Intellectual Property Rights and Processes for patenting innovations nationally and internationally.	K2
CO4	Analyze patent rights, licensing processes, technology transfer, and the Use of patent databases.	K4
CO5	Evaluate recent developments in IPR, including biological systems, software, and traditional knowledge through case studies.	K5

#BasedonsuggestedRevisedBTL

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H		M			
CO2		H				
CO3			M			M
CO4			M			M
CO5			M			M
CO6						

(Please fill the above with Levels of Correlation, viz ., L, M,H)

UNIT	CONTENTS	Contact Hours
UNIT– 1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting are search problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	12
UNIT– 2	Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and Assessment by are view committee.	12
UNIT– 3	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT	12
UNIT–4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	12
UNIT– 5	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs	12
	Total	60

Text Books:

1. Research Methodology: Best Practices for Rigorous, Credible, and Impactful Research by Herman Aguinis – **2024**.
2. Intellectual Property, Patents, Trademarks, and Copyright in a Nutshell by Arthur R. Miller, Michael H. Davis & Dana Neacsu – 7th edition, - **2023**.

REFERENCES BOOKS:

(1) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
(2) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
(3) Ranjit Kumar,2nd Edition, "Research Methodology: A Step by Step Guide for beginners".
(4) Halbert, "Resisting Intellectual Property", Taylor & FrancisLtd,2007.
(5) Mayall, "Industrial Design", Mc Graw Hill,1992.

(6) Niebel, “Product Design”,Mc GrawHill,1974.
(7) Asimov, “Introduction to Design”, Prentice Hall,1962.
(8) Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age,2016.T.Ramappa,“Intellectual Property Rights Under WTO”, S.Chand,2008.

Web Resources

1. https://researcher.life/blog/article/what-is-a-research-problem-types-and-examples/
2. https://www.youtube.com/watch?v=ImVYrrwXU_s
3. https://thelegalschool.in/blog/scope-of-patent-law-in-india