

SRINIVASAINSTITUTEOFTECHNOLOGY&SCIENCE

(AUTONOMOUS)

ApprovedbyAICTE,NewDelhi–AffiliatedtoJNTUA,Ananthapuramu

AccreditedbyNAACwith'A'GradeChennai-HyderabadBypassRoad,Ukkayapalli,Kadapa-516002

M.TECH.INARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

COURSESTRUCTURE&SYLLABI

(Applicablefromtheacademicyear2026-27onwards)

SEMESTER–I

S.No.	Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	26MAM101	AdvancedAlgorithms	PC	3	0	0	3
2.	26MAM102	MathematicsforAIandML	PC	3	0	0	3
3.	26MAM103a 26MAM103b 26MAM103c	**ProgramElectiveI** 1. EvolutionaryComputing 2. DeeplearningTransformers 3. KnowledgeGraphs&Reasoning	PE	3	0	0	3
4.	26MAM104a 26MAM104b 26MAM104c	**ProgramElective II** 1. MedicalImagingwithAI 2. DroneTechnologies 3. Autonomous Vehicles	PE	3	0	0	3
5.	26MAM105	AdvancedDataStructures&Algorithmsfor AILab	PC	0	0	4	2
6.	26MAM106	AIand MLLab	PC	0	0	4	2
7.	26MRM101	ResearchMethodology&IPR	**MC**	**2**	**0**	**0**	**2**
8.	26MAM107	MLOps&AIModelDevelopment	SE	0	1	2	2
9.	25MAC101a 25MAC101b 25MAC101c	**AuditCourse– I** 1. EnglishforResearchPaperWriting 2. DisasterManagement 3. EssenceofIndianTraditional Knowledge	AC	2	0	0	0
Total							**20**

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SEMESTER–II

S.No	code	Course Name	Category	Hours per			Credits
				L	T	P	
1.	26MAM201T	AgenticAI	PC	3	0	0	3
2.	26MAM202	ConversationalAI	PC	3	0	0	3
3.	26MAM203a 26MAM202b 26MAM203c	**ProgramElective–III** 1. AIEnhancedData Science 2. DeepReinforcementLearning 3. AdvancedPromptDesignandEngg.	PE	3	0	0	3
4.	26D13204a 26D13204b 26D13204c	**ProgramElective–IV** 1. VisualTransformers 2. AIforSmart Cities 3. AIforEdge Computing	PE	3	0	0	3
5.	26MAM201P	AgenticAILab	PC	0	0	4	2
6.	26D97201P	XAIandResponsibleAILab	PC	0	0	4	2
7.	26MAM205	**QuantumTechnologiesAndApplications**	MC	2	0	0	2
8.	26MAM206	**ComprehensiveViva Voce**	PC	0	0	0	2
9.	26MAC201a 26MAC201b 26MAC201c	**AuditCourse– II** • PedagogyStudies • PersonalityDevelopmentThroughLife Enlightenment Skills • YogaForStressManagement	AC	2	0	0	0
Total							**20**

****StudentshavetoundergoanIndustryInternshipafterIYearIISemesterforadurationof6to8weeks**

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SEMSTER-III

S.No.	Course code	Course Name	Category	Hoursper			Credits
				L	T	P	
1.	26MAM301a 26MAM301b 26MAM301c	**Program Elective–V** 1. Big Data Curation 2. Mining Massive Data Sets 3. AI driven Software Engineering	PE	3	0	0	3
2.	26MAM302	**Open Elective-I** **AI Tools**	OE	3	0	0	3
3.	26MAM303	**Dissertation Phase–I**	PR	0	0	20	10
4.	26MAM304	**Industry Internship**		0	0	0	2
5.	26MAM305	**Co-Curricular Activities**		0	0	0	1
Total							**19**

Open Elective-I

S.No.	Course Code	Course Name	Offered by the Dept.
1	26MCE302a	Green Buildings	Civil
2	26MCE302b	Road Safety Engineering	
3	26MEC302	IoT and its Applications	ECE
4	26MEE302	Photo voltaic Systems	EEE
5	26MME302	Integrated Product Design and Development	ME
6	26MBS302a	Advanced Numerical Methods and Computational Mathematics	Mathematics
7	26MBS302b	Mathematics for Machine Learning and Data Science	
8	26MBS302c	Statistical Learning Theory and Mathematical Foundations of AI	
9	26MBS302d	Chemistry Of Nano materials And Applications In Engineering	Chemistry
10	26MHS302	Photonics For Engineers	Physics

SEMESTER-IV

S.No.	Corse Codes	Course Name	Category	Hoursper			Credits
				L	T	P	
1.	**26MAM401**	**Dissertation Phase–II**	PR	0	0	32	16
Total							**16**

26MAM101	**ADVANCEDALGORITHMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

CourseObjectives(COBJ):

1. Toprovideirigoroustraininginanalyzingthe**time,space,andcomplexitybounds** of advanced algorithms.
2. Tostudy**divide&conquer,dynamicprogramming,greedy,backtracking,andbranch & bound** techniques with proofs of correctness.
3. Toexplore**networkflows,approximation,randomized,andparameterizedalgorithms** in depth.
4. Tounderstandthe**theoreticalfoundationsofNP-Completeness**andexploreemerging topics like **quantum and parallel algorithms**.
5. Toapplyalgorithmdesignparadigmsto **AI,ML,datascience,andoptimization problems**.

CourseOutcomes(COs):

Aftercompletingthiscourse, thestudent willbe able to:

CO1: Analyzeandevaluatethe **asymptotic complexity**ofadvancedalgorithms.

CO2: Apply divide-and-conquer, greedy, and dynamic programming methods to**design efficientalgorithms**.

CO3: Formulateandsolveoptimizationproblemsingraphs,networks,andsequencealignment using **DP and network flow techniques**.

CO4: Develop solutions for **constraint satisfaction and NP-Hard problems** using backtrackingand branch & bound.

CO5: Classify problemsinto**P,NP,NP-Complete,NP-Hard**,andexplore**approximationand randomized algorithms** for intractable problems.

CO6: Demonstrate ability to connect algorithmic paradigms to **AI/ML, bioinformatics, and data-driven applications**.

UnitI:Advanced ComplexityAnalysis

Review of asymptotic notations (Big-O, Ω, Θ, little-o), Amortized analysis: aggregate, accounting, potential methods, Solving recurrences: recursion tree, Master's theorem, Akra–Bazzi method, Average-case analysis (probabilistic methods), Complexity classes: P, NP, co-NP, PSPACE, Polynomial hierarchy and beyond, Lower bounds on algorithmic complexity, Case studies: complexity in large-scale ML training.

UnitII:AdvancedDivideandConquer&GeometryAlgorithms

Strassen's algorithm & fast matrix multiplication improvements, Closest pair of points problem, Convex hull algorithms (Graham's scan, Divide & Conquer), Voronoi diagrams & Delaunay triangulations, Range searching and segment trees, Parallel divide-and-conquer algorithms, Applications in image processing & computational biology, Case study: fast convolution for deep learning.

UnitIII:Greedy,Dynamic Programming&NetworkOptimization

Matroid theory & greedy-choice property, Graph algorithms: MST (Prim's, Kruskal's), shortest paths (Dijkstra, Bellman-Ford), Maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp, Push-Relabel), Matching algorithms in bipartite graphs (Hungarian algorithm), Dynamic programming in sequence alignment & edit distance, Optimal binary search trees & matrix chain multiplication,

Applications of DP in reinforcement learning. Case study: optimization problems in natural language processing.

UnitIV:AdvancedSearch–Backtracking,Branch&Bound,CSPs

Backtracking: general method and complexity analysis, N-Queens, subset sum, graph coloring revisited, Branch & Bound: TSP, knapsack with bounding techniques, Constraint satisfaction problems (CSP) and heuristics, SAT solving and backtracking-based SAT solvers, Exactexponential algorithms (clique, independent set), Integer programming & cutting-plane methods, Applications in scheduling, robotics, and AI planning.

UnitV:NP-Completeness,Approximation&RandomizedAlgorithms

Cook-Levin theorem & NP-Complete proofs, Reductions between NP-complete problems, Parameterized complexity & fixed-parameter tractability (FPT), Approximation algorithms: vertex cover, set cover, Polynomial-time approximation schemes (PTAS, FPTAS), Primal-dual method for approximations, Randomized algorithms: Monte Carlo, Las Vegas, Emerging topics: quantum algorithms and complexity.

Textbooks(Core):

1. T.H.Cormen,C.E.Leiserson,R.L.Rivest,C.Stein–*IntroductiontoAlgorithms*,MIT Press.
2. E.Horowitz,S. Sahni,S.Rajasekaran– *Fundamentalsof ComputerAlgorithms*, Galgotia.
3. J.Kleinberg,E.Tardos –*AlgorithmDesign*, Pearson.

ReferenceBooks(Advanced&Research-Oriented):

1. V.Vazirani – *Approximation Algorithms*, Springer.
2. S.Dasgupta,C.H.Papadimitriou,U.V.Vazirani–*Algorithms*,McGrawHill.
3. M.Sipser– *Introduction to theTheory of Computation*, Cengage.
4. S.Arora,B.Barak–*ComputationalComplexity:AModernApproach*,Cambridge University Press.
5. T.Roughgarden–*AlgorithmsIlluminated*series(fordeeperinsightsintoalgorithmic paradigms).
6. Selected**researchpapers**fromSTOC,FOCS,andSODAconferences(foremergingtopics like quantum algorithms, streaming algorithms, and AI-related optimizations).

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25MAM103a	**EVOLUTIONARYCOMPUTING (PE-I)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

CourseObjectives(COBJ):

1. Tointroducethe**theoryandbiologicalinspiration**behindevolutionaryalgorithms.
2. Tounderstand**geneticalgorithms,geneticprogramming,andswarmintelligence techniques** in depth.
3. Toapplyevolutionarycomputingfor**single-objectiveandmulti-objectiveoptimization problems**.
4. Toexplore**hybridapproaches** combiningevolutionaryand machinelearning algorithms.
5. Todevelop**evolutionarycomputingsolutions**forAI/MLapplicationssuchas**feature selection, hyperparameter tuning, and neural architecture search**.

CourseOutcomes (COs):

Bythe end ofthis course,studentswill be able to:

- **CO1:**Explaintheworkingprinciplesandbiological basisofevolutionaryalgorithms.
- **CO2:**Applygeneticalgorithmsandgeneticprogrammingtosolveoptimizationandsearch problems.
- **CO3:**ImplementswarmintelligencealgorithmsforAI/MLapplications.
- **CO4:**Analyzeandsolvemulti-objectiveoptimizationproblemsusingPareto-based evolutionary techniques.
- **CO5:**Developevolutionarycomputingsolutionsfor**AI/MLtaskssuchasfeature selection, model optimization, and neural architecture design**.
- **CO6:**Compareandevaluatedifferentevolutionaryandswarm-basedtechniquesfor computational intelligence tasks.

UnitI:Introduction toEvolutionary Computing

Biological inspiration: Darwin's theory, natural selection, survival of the fittest, General evolutionary algorithm framework, Representation schemes: binary, real-valued, permutation encoding, Fitness evaluation functions, Selection methods: roulette wheel, tournament, rank-based, Schema theorem and building block hypothesis, Exploration vs exploitation in evolutionary algorithms, Applications in search, optimization, and learning.

UnitII:GeneticAlgorithms(GA)

Canonical GA: initialization, selection, crossover, mutation, Advanced operators: adaptivemutation, elitism, steady-state GA, Parameter tuning and convergence analysis, Hybrid GA with local search (memetic algorithms), Applications in combinatorial optimization (scheduling,routing),FeatureselectioninmachinelearningusingGA,Casestudy:GAforfunctionoptimiza tion, Case study: GA for ML hyperparameter tuning.

UnitIII:GeneticProgramming(GP)

BasicsofGP andevolutionarycomputationmodels,Tree-based representationofprograms,Genetic operators in GP: crossover, mutation, reproduction, Fitness measures in GP (error-based, complexity-based),Symbolicregressionand classificationusingGP,Automaticprogram generation and symbolic AI, Applications in neural architecture search and reinforcement learning, Case study: GP for automated ML pipeline design.

UnitIV:SwarmIntelligenceTechniques

Particle Swarm Optimization (PSO): velocity update, global/local best, Ant Colony Optimization (ACO): pheromone model, path construction, Artificial Bee Colony (ABC) optimization, Firefly Algorithm and Cuckoo Search, Comparative study of SI techniques with GA/GP, Applications in clustering and routing problems, Neural network training using SI algorithms, Case study: PSO/ACO for AI optimization problems.

UnitV:Multi-Objective&Advanced Applications

Multi-objective optimization: Pareto optimality and dominance, Evolutionary algorithms for multi-objective optimization (NSGA-II, SPEA2), Differential Evolution (DE) and Evolution Strategies (ES), Hybrid evolutionary algorithms with ML/DL, Ensemble methods using evolutionary optimization, Neural architecture search using evolutionary algorithms, Applications in robotics, computer vision, and data mining, Case study: Multi-objective optimization for deep learning hyperparameter tuning.

Textbooks(Core):

1. DavidE.Goldberg–*GeneticAlgorithmsinSearch,Optimization,andMachineLearning*, Pearson.
2. MelanieMitchell–*AnIntroductiontoGeneticAlgorithms*,MIT Press.
3. A.E.Eiben, J.E. Smith–*Introduction to EvolutionaryComputing*,Springer.

ReferenceBooks (Advanced):

1. KalyanmoyDeb –*Multi-ObjectiveOptimizationUsing EvolutionaryAlgorithms*, Wiley.
2. JamesKennedy,RussellEberhart,Y.Shi–*SwarmIntelligence*,MorganKaufmann.
3. RiccardoPoli,WilliamB.Langdon,NicholasMcPhee –*AFieldGuidetoGenetic Programming*.
4. SimonD.– *EvolutionaryOptimization Algorithms*, Wiley.
5. YaochuJin –*KnowledgeIncorporation inEvolutionaryComputation*, Springer.

25MAM103b	**DEEP LEARNING TRANSFORMERS(PE-I)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

Theobjectives ofthis courseareto:

1. Introducethe fundamentalsofattentionmechanismsandtransformerarchitectures.
2. Understandtheprinciplesofencoder–decodermodelsinsequencelearning.
3. Explorestate-of-the-art modelssuchasBERT,GPT,andVisionTransformers.
4. Studytransfer learningand fine-tuningtechniquesfor transformers.
5. ApplytransformerstoNaturalLanguageProcessing(NLP),ComputerVision(CV),and multimodal AI tasks.

CourseOutcomes (COs)

Bythe end ofthis course,studentswill be able to:

- **CO1:**Explainthe workingof attention mechanismsandtheir significance indeep learning.
- **CO2:**Analyzetransformerarchitecturesandtheir components.
- **CO3:**ImplementBERT,GPT,andVisionTransformersfor real-worldAIproblems.
- **CO4:**Applyfine-tuningand transferlearningstrategiesfordomain-specific applications.
- **CO5:**Evaluatetransformer-basedmodelsinNLP,CV,andmultimodaltasks,considering efficiency, scalability, and interpretability.

UnitI:Introduction&AttentionMechanisms

Sequence modeling challenges in RNNs and LSTMs, Additive vs. multiplicative attention, Self-attention and multi-head attention, Positional encoding and its significance, Applications ofattention in NLP and computer vision, Comparative study: RNN/LSTM vs. Transformers, Practical use cases of attention mechanisms, Limitations and scalability issues in attention-based models.

UnitII:TransformerArchitecture

Encoder–decoder structure and working, Scaled dot-product attention, Multi-head attention mechanism, Feed-forward layers and residual connections, Layer normalization and dropout in transformers, Training transformers: optimization and parallelization, Handling long sequences (efficient transformer variants), Challenges in training large-scale transformer models.

UnitIII:BERTandGPTModels

BERT: bidirectional encoding and masked language modelling, Pre-training and fine-tuning strategies for BERT, GPT family: autoregressive modeling and generative capabilities,Applications: text classification, summarization, translation, and dialogue systems, Comparative study: BERT vs. GPT architectures, Case studies in real-world NLP tasks, Transfer learning with large pre-trained models, Deployment issues and challenges with large models.

UnitIV:VisionTransformers &Multimodal Models

Vision Transformer (ViT) architecture and patch embeddings, Image classification using ViT, Multimodal transformers: CLIP, ALIGN, Flamingo, Applications in image captioning, cross-modal retrieval, and videounderstanding, Transformersin healthcareimagingand robotics,Casestudies in autonomous driving and surveillance, Comparison with CNN-based approaches, Future scope of transformers in multimodal AI.

UnitV: Fine-Tuning&AdvancedTopics

Transfer learning strategies in transformers, Domain adaptation and low-resource fine-tuning, Prompt engineering techniques, Parameter-efficient fine-tuning (LoRA, adapters), Challenges: computational cost, model bias, interpretability, and ethical concerns, Emerging trends: Large Language Models (LLMs) and foundation models, Transformers in scientific discovery and industrial applications, Future research directions in transformer-based AI.

Textbooks

1. Vaswanietal.–*Attention isAllYouNeed*, NeurIPS2017 (OriginalTransformer Paper).
2. LewisTunstall,LeandrovonWerra,ThomasWolf–*NaturalLanguageProcessingwith Transformers*, O'Reilly.
3. HuggingFaceTeam–*TransformersLibraryDocumentation.*

References

1. IanGoodfellow,YoshuaBengio,AaronCourville–*DeepLearning*,MITPress.
2. DenisRothman –*TransformersforNaturalLanguageProcessing*,PacktPublishing.
3. JayAlammar – *TheIllustrated Transformer*(OnlineResource).
4. Dosovitskiyetal.–*AnImageisWorth16x16Words:TransformersforImageRecognition at Scale (ViT)*, ICLR 2021.
5. Devlinetal.–*BERT:Pre-trainingofDeepBidirectionalTransformersforLanguage Understanding*.
6. Radfordetal.–*GPTSeriesPapers (GPT-2,GPT-3)*,OpenAI.
7. Radfordetal.–*LearningTransferableVisualModelsfromNaturalLanguageSupervision (CLIP)*, ICML 2021.

25MAM103c	**KNOWLEDGEGRAPHS&REASONING (PE-1)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. Introducethe fundamentalsofknowledge representationusinggraphs.
2. UnderstandRDF,ontologies,and graphdatabases forsemanticdatamodeling.
3. Studyreasoningtechniques andinference mechanisms.
4. Learnto queryand manipulateknowledge graphsusingSPARQLand Cypher.
5. ApplyknowledgegraphsinAIapplicationslikeNLP,recommendationsystems,and question answering.

CourseOutcomes (COs)

Bythe end ofthis course,studentswill be able to:

- **CO1:**Explaingraph-basedknowledge representationandsemanticmodeling.
- **CO2:**UseRDFand ontologiesforstructuredknowledgerepresentation.
- **CO3:**Applyreasoningtechniques using enginesand description logics.
- **CO4:**Queryknowledge graphs usingSPARQLand graph databases.
- **CO5:** Implementreal-worldAIapplicationsusingknowledgegraphs.

UnitI:IntroductiontoKnowledge Graphs

Basics of knowledge representation and semantic web concepts, Graph structures: nodes, edges, labels, properties, Difference between relational databases and graph databases, Labeled property graphs vs RDF graphs, Applications of knowledge graphs in AI and data integration, Case study: Google Knowledge Graph, Knowledge graph lifecycle: construction and storage, Tools and platforms: Neo4j, GraphDB (overview).

UnitII:RDFandSemanticData Modeling

RDFbasics: triples, subjects, predicates,objects, RDFSchema (RDFS):definingvocabularies, Web Ontology Language (OWL) – introduction, Ontology design principles,Linked Data principles, Schemaalignment and integration, Exampledatasets: DBpedia, Wikidata,Tools forRDFmodeling: Protégé, RDFLib.

UnitIII:Ontologies and Reasoning

Ontologyconceptsandexamples,BuildingontologiesusingProtégé, Typesofreasoning:deductive, inductive, abductive (overview), Description logics – basics, Reasoning tasks: classification, consistency checking, Reasoning engines: Pellet, HermiT (introductory use), Rule-based reasoning: SWRL, Case study: ontology-driven applications in healthcare.

UnitIV:QueryingKnowledge Graphs

SPARQL basics: triple patterns and graph matching, SPARQL queries with filters and optional patterns, SPARQL updates, Querying linked datasets (e.g., DBpedia), Introduction to Cypher query language (Neo4j), Path queries and shortest path problems, Query optimization basics, Hands-on exercise: small KG query using SPARQL and Neo4j.

UnitV:ApplicationsofKnowledgeGraphs

Knowledge graphs in search engines, Knowledge graphs in recommendation systems, Question answeringwithknowledgegraphs,IntegrationwithNLP:entitylinking,Relationextractionfor

knowledgegraphconstruction, Explainable AI using knowledgegraphs,Industrialcase studies:e-commerce, social networks, Research challenges and open problems in KG.

Textbooks

1. DeanAllemang&JamesHendler–*SemanticWebfortheWorkingOntologist*,Morgan Kaufmann.
2. IanRobinson,JimWebber,EmilEifrem–*Graph Databases*,O'Reilly.
3. TomHeath&ChristianBizer–*LinkedData:EvolvingtheWebintoaGlobalDataSpace*, Morgan & Claypool.

References

1. FranzBaaderetal.–*TheDescriptionLogicHandbook:Theory,Implementationand Applications.*
2. PascalHitzleretal. –*Foundationsof Semantic Web Technologies.*
3. Neo4jDocumentation (online).
4. Protégétutorials (Stanford).
5. RDFLibPythonlibrarydocumentation.

25MAM104a	**MEDICALIMAGINGWITHAI(PE-II)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

Theobjectives ofthis courseareto:

1. IntroducethefundamentalsofmedicalimagingmodalitiessuchasMRI,CT,Ultrasound,X-ray, and PET.
2. Understandpreprocessing,enhancement,andfeatureextractiontechniquesinmedical imaging.
3. Applysegmentationand detection algorithms,includingAI-basedapproaches.
4. Implementdeeplearningmodelsforclassification,detection,andanalysisofmedical images.
5. Exploreethical, legal, and regulatoryissues in AI-driven healthcare applications.

CourseOutcomes (COs)

Bythe end of this course,students will be able to:

- **CO1:**Explain medicalimagingmodalitiesand theirfundamental characteristics.
- **CO2:**Applypreprocessingandfeatureextractiontechniques tomedical images.
- **CO3:**Implementdeeplearningarchitecturesforclassification,segmentation,andanomaly detection.
- **CO4:**EvaluateAImethodsformedicalimagingtaskssuchascancerdetection,brain analysis, and organ segmentation.
- **CO5:**Analyzeethical, privacy, and regulatorychallenges in deployingAIfor healthcare.

UnitI:IntroductiontoMedicalImaging

Overview of imaging modalities: MRI, CT, X-ray, Ultrasound, PET, Basic principles of image acquisition and reconstruction, Characteristics of medical images: resolution, contrast, artifacts, and noise, Clinical importance of imaging in diagnosis and treatment, File formats in medical imaging (DICOM, NIfTI), Limitations and challenges in medical image analysis, Role of AI in clinical decision support and imaging workflows.

UnitII:PreprocessingandFeature Extraction

Image enhancement: filtering, denoising, histogram equalization, Noise reduction techniques: Gaussian, median, and non-local means filtering, Normalization and standardization of medical image datasets, Feature extraction: shape, texture, intensity, and edge-based features,Dimensionality reduction: PCA, LDA, t-SNE (overview), Data augmentation strategies for medical imaging datasets, Introduction to medical imaging datasets: BraTS, CheXpert, LIDC-IDRI, ISLES, Hands-on: preprocessing pipeline for MRI/CT images.

UnitIII:Segmentation andDetection

Traditional segmentation methods: thresholding, region growing, clustering, Watershed algorithm and morphological segmentation, AI-based segmentation: U-Net, Mask R-CNN, DeepLab, Tumor and lesion detection techniques in MRI/CT images, Object detection in medical images using Faster R-CNN, YOLO, Evaluation metrics: Dice coefficient, Jaccard index, sensitivity/specificity, Case study: brain tumor segmentation (BraTS challenge), Hands-on: segmentation workflow for lung X-rays or MRI scans.

UnitIV:DeepLearning in MedicalImaging

CNN architectures for classification: VGG, ResNet, DenseNet, Transfer learning and fine-tuning on medical datasets, Multi-modal deep learning: combining imaging with clinical data, Generative models (GANs, VAEs) for synthetic medical image generation, Applications: cancer detection, organ segmentation, COVID-19 diagnosis, Explainability in deep learning models for medical imaging, Deployment of AI models in clinical settings, Case study: deep learning for chest X-ray anomaly detection

UnitV:Ethics,Regulations&AdvancedTopics

Ethical issues in AI for healthcare: bias, transparency, and fairness, Data privacy and patient confidentiality challenges, Regulatory frameworks: HIPAA, GDPR, and FDA guidelines, Explainable AI and interpretability in medical decision-making, Federated learning for privacy-preserving medical AI, Emerging trends: digital twins, precision medicine, personalized AI diagnosis, Role of AI in treatment planning and prognosis prediction, Research challenges and future directions in AI for healthcare imaging.

Textbooks

1. S.KevinZhou,HayitGreenspan,DinggangShen –*DeepLearningforMedicalImage Analysis*, Academic Press.
2. AymanEl-Baz,JasjitS.Suri– *BigData inMultimodalMedical Imaging*,CRC Press.
3. KlausD. Toennies – *Guideto Medical ImageAnalysis*, Springer.

References

1. GeertLitjensetal.–*ASurveyonDeepLearning inMedicalImageAnalysis,MedicalImage Analysis*, 2017.
2. Ronnebergeretal. –*U-Net:ConvolutionalNetworksforBiomedicalImageSegmentation*.
3. Estevaet al.– *AGuide toDeepLearning inHealthcare*, *Nature Medicine*.
4. Kaggledatasetsandgrandchallenges: BraTS,ISLES, CheXpert.
5. Onlineresources:Medical Imaging withDeep Learning(MIDL)conferencepapers.

		L	T	P	C
25MAM104b	**DRONETECHNOLOGIES–PE-II**	**3**	**0**	**0**	**3**

Course Objectives

Thecourseaims to:

1. Introducethefundamentalsofdronedesign,aerodynamics, andsystemintegration.
2. Explorenavigationtechniques,positioningsystems,andautonomousflightmechanisms.
3. Understandthe roleofsensors,communicationprotocols,andpayloadsindrones.
4. ApplyAIandmachinelearningtechniquesfordronecontrol,perception,anddecision-making.
5. Studyswarmdroneconceptsandtheirapplicationsindefense,agriculture,logistics,and disaster management.
6. Analyzeregulatory,ethical,andsafetyconsiderationsindrone deployment.

CourseOutcomes (COs)

Bythe end ofthis course,studentswill be ableto:

- **CO1**:Explaindronedesignprinciples,aerodynamics,andsystemarchitecture.
- **CO2**:Applynavigation,guidance,andcontroltechniquesfor UAVs.
- **CO3**:Evaluateandintegratesensors,payloads,andcommunicationsystemsindrones.
- **CO4**:ImplementAIandmachinelearningalgorithmsfordroneautonomyanddecision-making.
- **CO5**:Analyzeswarmdronecoordinationstrategiesandreal-worldapplications.
- **CO6**:Assessregulatory, safety,and ethicalissuesindronetechnologies.

UnitI:Fundamentalsof Drone Design

Introduction to UAVs and types of drones (fixed-wing, rotary-wing, hybrid), Drone aerodynamics and flight principles, Structural design and material selection, Propulsion systems: motors, propellers, batteries, fuel cells, Flight dynamics and stability considerations, Drone system architecture: hardware and software components, Case studies: consumer drones vs. industrial drones

UnitII:Navigation, Guidance,and Control

BasicsofUAVnavigationandguidancesystems,GPS,GNSS,andalternativelocalizationmethods, Inertial Navigation Systems (INS) and sensor fusion, Path planningalgorithms (Dijkstra, A*, RRT), Control strategies: PID, LQR, MPC for UAVs, Autonomous flight modes and autopilot systems (PX4, Ardupilot), Obstacle avoidance and collision detection methods

UnitIII:Sensors, Payloads,and Communication

Onboard sensors: IMU, gyroscope, accelerometer, magnetometer, Vision-based sensors: RGB, thermal, LiDAR, depth cameras, Environmental sensing (gas, weather, multispectral sensors), Payload integration: cameras, delivery mechanisms, agricultural sprayers, Communication systems: RF, Wi-Fi, 4G/5G, LoRaWAN, Drone-to-drone and drone-to-ground communication protocols, Power management and endurance enhancement techniques

UnitIV:AIandAutonomousDrone Control

RoleofAIin UAVautonomyand perception, Computervision fordrones (object detection, SLAM, mapping), Deep learning for aerial image classification and tracking, Reinforcement Learning (RL) for UAV path optimization, Swarm intelligence and AI-based coordination, Edge computing and onboard AIprocessing, Applications: surveillance, precision agriculture, disaster response, delivery services

UnitV:SwarmDrones,Regulations,andFutureTrends

Swarm drone architectures and coordination mechanisms, Multi-agent systems and communication in swarms, Applications of swarm drones (defense, search & rescue, smart cities), Cybersecurity threats and countermeasures in UAV networks, Regulatory frameworks: FAA, DGCA, EASA guidelines, Ethical and legal challenges in drone deployment, Future trends: drone taxis, autonomous cargo, military UAVs, AI-powered UAV swarms

Textbooks

1. RandalW.Beard&TimothyW.McLain –*Small UnmannedAircraft:TheoryandPractice*, Princeton University Press.
2. KimonP.Valavanis&GeorgeJ.Vachtsevanos–*HandbookofUnmannedAerialVehicles*, Springer.
3. B.L.Stevens&F.L.Lewis–*AircraftControlandSimulation*, Wiley.

References

1. PaulG. Fahlstrom& ThomasJ. Gleason–*Introduction to UAVSystems*, Wiley.
2. MichaelS.Lewis–*AutonomousFlyingRobots:UnmannedAerialVehiclesandMicro Aerial Vehicles*, Springer.
3. HusseinA.Abbassetal. –*FoundationsofTrustedAutonomy*,Springer(forAIandswarm aspects).
4. ResearchpapersfromIEEE*TransactionsonRobotics*,*JournalofFieldRobotics*,and *Unmanned Systems*.
5. Onlineresources:PX4andArdupilotdocumentation,DronecodeConsortium,FAA& DGCA guidelines.

25MAM104c	**AUTONOMOUSVEHICLES–PE-II**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

Thecourseaims to:

1. Introducethe fundamentalsofautonomousdrivingsystemsandtheirarchitecture.
2. Studyperceptionmethodsusingsensorsandcomputervisionforenvironment understanding.
3. Explorelocalization,mapping,andstateestimationtechniques.
4. Applypath planningandcontrol algorithms forautonomous navigation.
5. Integratedeepreinforcement learningfordecision-makingandvehiclecontrol.
6. Analyzesafety,ethical,and regulatoryissues inautonomousvehicledeployment.

CourseOutcomes(COs)

Bythe end ofthis course,studentswill be able to:

- **CO1**:Explainthesystemarchitectureandcomponentsofautonomousvehicles.
- **CO2**:Applyperception techniquesusingLiDAR,radar, andvision-based systems.
- **CO3**:Implementlocalizationandmappingalgorithmsforautonomousnavigation.
- **CO4**:Developpath planningand motioncontrolstrategies.
- **CO5**: Applydeep reinforcement learningtechniques forautonomous driving tasks.
- **CO6**:Analyzesafety,ethical,and regulatoryissuesin autonomousvehiclesystems.

UnitI:FundamentalsofAutonomousVehicles

Introduction to autonomous driving: Levels of autonomy (SAE L0–L5), System architecture: perception, planning, control, and actuation layers, Vehicle dynamics and motion models (bicycle, kinematic, dynamic models), Drive-by-wire systems and electronic control units (ECUs), Autonomous driving platforms (Apollo, Autoware, CARLA simulator), Real-world applications: self-driving taxis, delivery vehicles, smart mobility, Challenges in autonomous driving (weather, infrastructure, safety)

UnitII:PerceptionSystems

Sensors for AVs: LiDAR, radar, ultrasonic, cameras, Sensor calibration, synchronization, andfusion techniques, Environment perception: object detection and tracking, Semantic segmentation for road and lane detection, SLAM (Simultaneous Localization and Mapping) basics, Computer vision applications: traffic sign recognition, pedestrian detection, Datasets for AV perception (KITTI, Waymo, nuScenes)

UnitIII:Localization and Mapping

Global Navigation Satellite Systems (GNSS) and limitations, Inertial Measurement Units (IMUs) andodometry,KalmanfiltersandExtendedKalmanFilter(EKF)forstateestimation,Particlefilters and Monte Carlo Localization (MCL), Visual SLAM and LiDAR-based SLAM methods, High-definition (HD) maps and map-based localization, Sensor fusion for robust localization under challenging conditions

UnitIV:PathPlanningand Control

Motion planning problem formulation in AVs, Graph-based planning: Dijkstra, A*, RRT, PRM, Optimalcontrolmethodsfortrajectorygeneration,Localvs.globalplanningapproaches,Control

algorithms: PID, LQR, MPC for vehicle control, Obstacle avoidance strategies in dynamic environments, Simulation platforms for testing planning and control (CARLA, SUMO, Gazebo)

UnitV:DeepReinforcementLearning,Safety&Ethics

Introduction to Reinforcement Learning (RL) in autonomous driving, Deep RL architectures for control (DQN, DDPG, PPO, SAC), Imitation learning and behavior cloning for driving policy learning,SafeRL forcollision-freenavigation,Ethicalchallenges:decision-makinginsafety-critical scenarios, Legal and regulatory issues in autonomous vehicle deployment, Future trends: V2X communication, cooperative AVs, AI-powered traffic systems

Textbooks

1. RajeshRajamani–*Vehicle DynamicsandControl*, Springer.
2. ShaoshanLiu,LiyunLi,JieTang–*DeepLearningforAutonomousVehicleControl*, Springer.
3. UmitOzguner,TankutAcarman,KeithRedmill–*AutonomousGroundVehicles*,Artech House.

References

1. StevenWaslanderetal.–*AutonomousDriving:Technical,LegalandSocialAspects*, Springer.
2. SebastianThrunetal.–*ProbabilisticRobotics*,MITPress.
3. Recentpapersfrom*IEEETransactionsonIntelligentTransportationSystems*and*IEEE Robotics and Automation Letters*.
4. Datasets&openplatforms:KITTI,Waymo,nuScenes,Apollo,Autoware,CARLA simulator.

25MAM105	**ADVANCEDDATASTRUCTURES& ALGORITHMS FOR AI LAB (PC)**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives

Thelabaims to:

1. Providehands-onexperiencewith advanceddatastructuresandalgorithms.
2. Implementgraphalgorithms,trees,heaps, andhashingtechniques.
3. ExploreAI-baseddatastructuresandtheirapplications.
4. Developproblem-solvingand optimization skillsforAIand MLapplications.
5. Enhanceprogrammingproficiencyinimplementingefficientalgorithms.

CourseOutcomes (COs)

Bythe end of this lab, students will beable to:

- **CO1**:Implementand analyzeadvanceddatastructures(heaps,B-trees,hashing).
- **CO2**:Applygraphalgorithmstosolvereal-world AI-relatedproblems.
- **CO3**:DesignandimplementAI-baseddatastructures(Trie,KD-Tree,R-Tree).
- **CO4**:Evaluateperformanceandcomplexityof implemented algorithms.
- **CO5**:Usemoderntools andlibrariesto implementandvisualizealgorithms.

ListofExperiments(12)

1. **Implementationof MinHeapandMaxHeap**–insertion,deletion,heapify.
2. **PriorityQueueusingHeaps** –scheduling applications.
3. **B-TreesandB+Trees**–insertionandsearchoperations.
4. **HashTables**–linearprobing,quadraticprobing,chaining.
5. **DisjointSet(Union-Find)**– applicationsinnetworkconnectivity.
6. **GraphTraversals** –BFS,DFS,applicationsinAIsearch.
7. **ShortestPathAlgorithms**–Dijkstra, Bellman-Ford,A*.
8. **MinimumSpanningTrees** –Kruskal'sandPrim's algorithms.
9. **Tries(PrefixTrees)**– autocompleteandspell-check applications.
10. **KD-TreesforNearestNeighborSearch**– AIand MLusecases.
11. **R-TreesforSpatialDataIndexing**–GISandcomputervisionapplications.
12. **AI-basedExperiment**–ImplementGraphNeuralNetwork(GNN)basicsorReinforcement Learning search using advanced data structures.

Tools and Platforms

- **ProgrammingLanguages**:Python,C++,Java(primary:PythonforAIintegration).
- **Libraries/ Packages**:
  - networkx (graphalgorithms&visualization)
  - heapq/priorityqueue(heapstructures)
  - scipy.spatial(KD-Tree)
  - rtree(spatialindexing)
  - matplotlib/seaborn(visualization)
  - PyTorch/TensorFlow(forAI-basedexperimentlike GNN)
- **DevelopmentTools**:Jupyter Notebook,GoogleColab,VSCode.
- **VisualizationTools**:Gephi(graphvisualization),Graphviz.

Textbooks

1. ThomasH.Cormenetal.–*IntroductiontoAlgorithms*,MIT Press.
2. SartajSahni – *DataStructures,Algorithms andApplicationsin C++*,Universities Press.
3. NarasimhaKarumanchi – *DataStructuresand AlgorithmsMadeEasy*.

References

1. StevenSkiena–*TheAlgorithmDesign Manual*, Springer.
2. Goodrich&Tamassia–*AlgorithmDesignand Applications*.
3. ResearchpapersonAI-baseddatastructures(Trie,KD-Tree,GNN).
4. Onlineresources:GeeksforGeeks,LeetCode,Kaggle(forAIapplications).

25MAM106	**AIANDMLLAB (PC)**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives

Thelabaims to:

1. Providehands-on experiencewithmachine learninganddeep learningtechniques.
2. Implementsupervisedandunsupervisedlearningalgorithmsonreal-worlddatasets.
3. Exploredeeplearningframeworks (TensorFlow,PyTorch)forAIapplications.
4. ApplyAI/MLmethodstonaturallanguageprocessing(NLP)andcomputervision(CV) tasks.
5. Developproblem-solvingand model evaluation skillsusingmodern AItools.

CourseOutcomes (COs)

Bythe end of this lab, students will beable to:

- **CO1**:ImplementclassicalMLalgorithmsforregression,classification,andclustering.
- **CO2**:Applyneural networks and deep learningmodels using TensorFlow/PyTorch.
- **CO3**:SolveNLPtasksusingtextprocessinganddeeplearningapproaches.
- **CO4**:Applycomputervision modelsforimageclassificationanddetection tasks.
- **CO5**:EvaluateAI/MLmodelswith appropriatemetrics andoptimizeperformance.

ListofExperiments(12)

1. **LinearRegression& PolynomialRegression**–predictingcontinuousvalues.
2. **LogisticRegression&SVM**–binary/multi-classclassification.
3. **DecisionTreesandRandomForests** –classificationonreal-worlddatasets.
4. **K-MeansandHierarchicalClustering**–unsupervisedlearningapplications.
5. **PrincipalComponentAnalysis(PCA)** –dimensionalityreduction&visualization.
6. **ArtificialNeuralNetworks(ANNs)** –basicfeedforward andbackpropagation.
7. **ConvolutionalNeuralNetworks(CNNs)**–imageclassification(MNIST/CIFAR-10).
8. **TransferLearningwithPretrainedModels**–ResNet,VGG,or MobileNet.
9. **RecurrentNeuralNetworks(RNNs)&LSTMs**–textsequence modeling.
10. **NLPExperiment**–textclassification/sentimentanalysisusingembeddings(Word2Vec, BERT).
11. **ComputerVisionExperiment**–objectdetectionusingYOLO/FasterR-CNN.
12. **CapstoneAIExperiment**–integrateML/DLforareal-worlddataset(healthcare,finance, or social media analytics).

Tools and Platforms

- **ProgrammingLanguage**:Python (primary).
- **ML/DLFrameworks**:TensorFlow,PyTorch,Scikit-learn,Keras.
- **Libraries**:
  - numpy,pandas(datahandling)
  - matplotlib,seaborn (visualization)
  - nltk,spacy,transformers(NLP)
  - opencv, PIL(computer vision)
- **DevelopmentTools**:JupyterNotebook,GoogleColab,VSCode.
- **Datasets**:MNIST,CIFAR-10,IMDBReviews,COCO,Kaggle datasets.

Textbooks

1. AurélienGéron–*Hands-OnMachineLearningwithScikit-Learn,Keras,andTensorFlow*, O'Reilly.
2. IanGoodfellow,Yoshua Bengio,Aaron Courville–*DeepLearning*,MITPress.
3. SebastianRaschka,VahidMirjalili –*Python MachineLearning*,Packt.

References

1. FrançoisChollet –*DeepLearningwithPython*, Manning.
2. TrevorHastie,RobertTibshirani,JeromeFriedman –*TheElementsofStatisticalLearning*, Springer.
3. Jurafsky&Martin–*Speech and LanguageProcessing*, Pearson (for NLP).
4. Researchpapersfrom *NeurIPS,ICML,CVPR,ACL*.
5. Onlineresources:Kaggle,HuggingFace,TensorFlowHub,PyTorchtutorials.

25MAM107	**MLOPS&AIMODELDEVELOPMENT (SKILL ORIENTED COURSE)**	**L**	**T**	**P**	**C**
		0	**1**	**2**	**2**

Objectives

- Toprovide hands-onexposureto buildingand deployingAI/MLmodels.
- TointroduceMLOpspractices forscalable and reproducibleAIsystems.
- Tointegratedata pipelines,CI/CD,andmonitoringforMLworkflows.
- Todevelop industry-readyskills forAIapplication deployment.

Course Outcome

CO1: ExplainMLOpsconceptsandlifecycleforML/AImodel development.
CO2: Applypipelineautomationfortraining,validation,deployment,andmonitoring.
CO3: UsecontainerizationandorchestrationforscalableAIservices.
CO4: EvaluateMLmodelsinproductionwithmonitoringanddrift detection.
CO5: Analyzechallengesingovernance,reproducibility,andethicaldeploymentofAIsystems.

UnitI:Fundamentalsof MLOps&Workflow Automation

Introduction to MLOps: Need & Benefits, ML Lifecycle: Data → Model → Deployment → Monitoring, Experiment tracking (MLflow, Weights & Biases), Data versioning (DVC, DeltaLake), Workflow orchestration basics (Airflow, Kubeflow), Reproducibility & automation challenges, Case study: End-to-end ML workflow, Hands-on: Setting up ML pipeline with MLflow

UnitII:Data Engineering forAI Pipelines

Data ingestion & preprocessing pipelines, Handling structured & unstructured data, Batch vs. real-time data processing, Streaming data in ML (Kafka, Spark Streaming), Feature engineering & feature stores, Data qualitymonitoring, Scalable storage systems forML, Hands-on: Buildinga data pipeline with Kafka/Spark

UnitIII:ModelDevelopment & Deployment

Model training best practices, Hyperparameter tuning & AutoML, Model compression & optimization, Containerization with Docker, Deployment strategies: REST APIs, microservices, Model serving frameworks (TensorFlow Serving, TorchServe, FastAPI), CI/CD for ML models (GitHub Actions, Jenkins), Hands-on: Deploying a model as REST API using Docker + FastAPI

UnitIV:Monitoring,Maintenance&ResponsibleAI

Model monitoring: drift detection, performance tracking, Logging & error handling, Continuous monitoring frameworks (Prometheus, Grafana, EvidentlyAI), Retraining pipelines for adaptive learning, A/B testing & shadow deployment in ML, Bias, fairness, and explainability in AI models, Ethical AI practices in deployment, Hands-on: Monitoring drift in deployed model

UnitV:IndustrialApplications&CaseStudies

MLOps in healthcare (diagnosis, patient monitoring), MLOps in finance (fraud detection, risk analytics), AI in manufacturing (predictive maintenance, anomaly detection), Cloud platforms for MLOps (AWS Sagemaker, Azure ML, GCP AI Platform), Blockchain integration for AI model security, Scaling MLOps in large enterprises, Case study: End-to-end MLOps pipeline in industry, Hands-on Mini Project: Deploy & monitor an AI model with MLOps tools.

Textbooks

1. MarkTreveil,AlokShukla–*IntroducingMLOps:HowtoScaleMachineLearninginthe Enterprise*. O'Reilly.
2. EmmanuelRaj–*EngineeringMLOps:Rapidlybuild,test,andmanageproduction-ready machine learning life cycles*. Packt.

ReferenceBooks

1. HannesHapke,CatherineNelson–*MachineLearninginProduction:Developingand Operating AI Models*. O'Reilly.
2. Munn,Deep–*PracticalMLOps*.Manning.

25MAM201T	**AGENTICAI(PC)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3S**

Course Objectives

1. Tointroducethe principlesandarchitectureofintelligentautonomous agents.
2. Tounderstandagent-basedmodelingandsimulation frameworks.
3. Toexplorereasoning,planning, and decision-makingin agenticsystems.
4. Tostudycoordination, communication, and cooperation in multi-agent systems.
5. ToapplyagenticAIconceptsinreal-worlddomainssuchasrobotics,finance,andsmart environments.

CourseOutcomes (COs)

Attheendofthiscourse,students willbeable to:

- **CO1:**Explaintheconcept,characteristics,andarchitectureofintelligentagents.
- **CO2:**Implementreasoningandplanningalgorithmsforgoal-driven autonomousagents.
- **CO3:**Designcollaborativeandcompetitivemulti-agentsystems.
- **CO4:**Applyreinforcementandadaptivelearningtechniquesfor agenticintelligence.
- **CO5:**DevelopdomainspecificagenticAIapplications andevaluatetheirperformance.

UnitI–IntroductiontoAgenticAI

Introduction to intelligent agents – definition, characteristics, Types of agents, PEAS representation of agents, Properties of agent environments, Architectures of intelligent agents – reactive, deliberative, and hybrid models., Rationality, autonomy, and bounded rationality in agent design, Agent lifecycle and perception–action loop. Applications of reactive vs. deliberative agents in real-world systems.

UnitII–KnowledgeRepresentation andReasoning

Role of knowledge representation (KR) in agent-based systems, Logical reasoning, Rule-based reasoning systems and production rules, Belief-Desire-Intention (BDI) architecture – components and formalization, Epistemic logic and reasoning, Ontologies and semantic models for agent knowledge bases, Probabilistic reasoning and uncertainty handling in agents.

UnitIII–PlanningandDecision-Making

Goal formulation and problem-space definition, Search-based planning, Classical planning algorithms – STRIPS, GraphPlan, and partial-order planning, Temporal and hierarchical task planning, **Markov Decision Processes (MDPs)**, Reinforcement learning concepts, Game-theoretic approaches to agent decision-making, Integration of planning and learning in dynamicenvironments.

UnitIV–Multi-AgentSystems(MAS)

Introduction to multi-agent systems, Communication protocols – KQML, FIPA-ACL, message structures, Coordination and cooperation strategies among agents, Negotiation, auction, and contract-net protocols, Coalition formation and teamwork in multi-agent environments, Distributed problem solving and consensus algorithms, Emergent behavior and self-organization in MAS, Simulation of MAS using frameworks like **JADE** and **AnyLogic**.

UnitV–Applicationsof AgenticAI

Agentic AI in **robotics,** Intelligent digital assistants and conversational agents, Financial trading agents and decision-support systems, Smart cities and energy grid optimization using agent models, Reinforcement-basedadaptivelearningindynamicenvironments,Simulationframeworksforagent-based modeling (JADE, AnyLogic, NetLogo), Ethical, legal, and safety issues in deploying autonomous agents.

Textbooks

1. MichaelWooldridge–*An IntroductiontoMultiAgentSystems*, Wiley.
2. StuartRussell&PeterNorvig–*Artificial Intelligence:A ModernApproach*, Pearson.
3. GerhardWeiss(Ed.)–*MultiagentSystems:AModernApproachtoDistributedArtificial Intelligence*, MIT Press.

References

1. YoavShoham&KevinLeyton-Brown–*MultiagentSystems:Algorithmic,Game-Theoretic, and Logical Foundations*, Cambridge University Press.
2. JacquesFerber–*Multi-AgentSystems:AnIntroductiontoDistributedArtificialIntelligence*, Addison-Wesley.
3. FIPA(Foundationfor IntelligentPhysicalAgents)Standards–https://www.fipa.org

25MAM202	**CONVERSATIONALAI (PC)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. Tointroducethefoundationsandarchitecturesofdialoguesystemsandconversational design.
2. ToexploreNLP pipelinesforintentdetection, slotfilling, andentityrecognition.
3. Tostudyand applygenerativetransformer-basedmodelssuchasGPT,BERT,andT5for dialogue generation.
4. Todesigncontext-aware, multimodal,andpersonalizedconversationalagents.
5. Toevaluateethicalconsiderations,safety,andperformancemetricsinconversational AI systems.

CourseOutcomes (COs)

Attheend ofthe course,studentswill beable to:

- **CO1:**Understandthestructure,components,andworkingofconversational agents.
- **CO2:**ImplementNLP-basedintentrecognition,sentimentanalysis, anddialogue flow.
- **CO3:**Designandfine-tunetransformer-based generativedialogue models.
- **CO4:**Integratecontextualunderstandinganduserpersonalizationintochatsystems.
- **CO5:**Evaluate conversationalsystemsforperformance,safety,andethicalcompliance.

UnitI–IntroductiontoConversationalAI

Introduction to dialogue systems and chatbots, Types of conversational AI, Components of conversational systems, Conversationdesignprinciples,Historyandevolutionofconversational AI, Frameworks and platforms, Multimodal and voice-based conversational agents.

Unit II– NLPfor Conversation

Text preprocessing, Word embeddings, Intent detection using classification models, Entity recognition (NER) and slot filling for dialogue systems, Sentiment analysis and emotion detectionin conversations, Context modeling in dialogue – dialogue state tracking and context windows, Multilingual and cross-lingual NLP for global conversational systems.

UnitIII – GenerativeModels forConversation

Sequence-to-sequence (Seq2Seq) models, Attention mechanisms and context vector modelling, Transformer, Large Language Models (LLMs), Fine-tuning and prompt engineering, Transfer learning and few-shot learning in conversational AI, Dialogue data curation and preprocessing.

UnitIV–DialogueManagementandContextModeling

Dialoguemanagement,Reinforcementlearning,Contextualdialoguemanagementwithmemory networks and transformers, Hybrid models: retrieval-based and generative dialogue systems, Personalization and adaptive user profiling in conversation, Handling interruptions, context switching, and multi-turn conversations, Integration with external APIs and databases for task completion.

UnitV–Evaluation,Safety,andEthicsinConversational AI

Evaluation metrics for conversational AI – BLEU, ROUGE, METEOR, perplexity, Human evaluation: coherence, engagement, empathy, and naturalness, Bias, fairness, and safety in generative dialogue systems, Ethical considerations, Explainability and transparency in conversational models, Human-AI collaboration and co-creation in dialogue systems.

Textbooks

1. AlanNichol & GregNichols– *Conversational AIwith Rasa*, O'ReillyMedia.
2. PalashGoyal,SumitPandey,KaranJain –*DeepLearningforNaturalLanguageProcessing*, Springer.
3. TomB.Brownetal.–*LanguageModelsareFew-ShotLearners(GPT-3Paper)*,OpenAI, 2020.

References

1. DanielJurafsky&JamesH. Martin– *Speech andLanguageProcessing*, Pearson.
2. SudharsanRavichandiran–*Hands-OnTransformersandNLPwithPyTorchandHugging Face*.
3. ThomasWolfetal.–*Transformers:State-of-the-ArtNaturalLanguageProcessing*,ACL 2020.

25MAM203a	**AIENHANCEDDATASCIENCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. Tointroducetheintegrationofartificialintelligenceintomoderndatasciencepipelines.
2. Tostudyintelligentdatapreprocessing,featureengineering,andfeatureselection techniques.
3. ToexploreAutoMLframeworksforautomatedmodeldesign,optimization,and deployment.
4. TounderstandExplainableAI(XAI)techniquesforinterpretableandethicaldata-driven decisions.
5. Todevelopreal-timeAIpipelinesforlarge-scaleanalyticsandMLOps-based workflows.

CourseOutcomes (COs)

Attheendofthiscourse,students willbeable to:

- **CO1:**PerformintelligentdatawranglingandfeatureengineeringusingAItechniques.
- **CO2:**ApplyAutoMLframeworksfor efficientmodelselectionandhyperparameter tuning.
- **CO3:**IntegrateexplainableAI(XAI)techniques intodatascience workflows.
- **CO4:**DesignandimplementAI-driven automateddatapipelinesforreal-timeanalytics.
- **CO5:**Evaluateand analyzereal-world data-centricAIcasestudies fordecision support.

UnitI–IntelligentDataWranglingandFeature Engineering

Automated data preprocessing using ML-based imputation and cleaning, Handling missing data, noise, and outliers using predictive models, AI-driven feature extraction and transformation (autoencoders, embeddings), Feature selection using mutual information, L1 regularization, and SHAPvalues,Datanormalization,encoding,anddimensionalityreductionwithPCA/t-SNE/UMAP, Integration of feature stores and metadata management for reuse, Automation tools – PyCaret, FeatureTools, and Scikit-learn pipelines.

UnitII– AutoMLFrameworks forModel Selectionand Optimization

Overview of Automated Machine Learning (AutoML) and its workflow, AutoML frameworks – Auto-sklearn, Google AutoML, H2O.ai, and TPOT, Neural Architecture Search (NAS) and Bayesian optimization methods, Hyperparameter optimization – grid search, random search, and genetic tuning, Model ensemble automation and stacking in AutoML, Cross-validation and automatic metric selection, Automated pipeline creation for end-to-end ML.

UnitIII–ExplainableAI(XAI)inData Science

Need for interpretability in AI-driven data science, Global vs local interpretability approaches, Model-agnostic methods: LIME, SHAP, and surrogate models, Counterfactual explanations and causal interpretability, Fairness, bias detection, and algorithmic accountability, Visualization tools for explainable data insights, ntegration of XAI with AutoML and data pipelines.

UnitIV–AIPipelinesforReal-TimeAnalytics

AI workflow orchestration and automation using pipelines, Data ingestion and streaming using Kafka and Spark Streaming, Real-time model serving and deployment – TensorFlow Serving, FastAPI,Flask,MLOpsforcontinuousintegrationanddelivery(CI/CD)inAIpipelines,Scalable

data architectures for AI analytics (Snowflake, Databricks), Monitoring and feedback loops in deployed models.

UnitV– CaseStudies withData-Centric AI

AI-driven anomaly detection and predictive analytics in IoT. Fraud detection and financial transaction analysis using AutoML, Customer churn prediction with explainable AI insights, Healthcare analytics – disease prediction and diagnostic support, Supply chain optimization with data-centric AI, Edge-based AI analytics for smart environments, Data-centric AI evaluation: data quality, diversity, and labeling accuracy.

Textbooks

1. AurélienGéron–*Hands-OnMachineLearningwithScikit-Learn,Keras,andTensorFlow*, O'Reilly.
2. MarkDaoust&YufengGuo–*AutoML:AutomatedMachineLearningontheCloudwith TensorFlow.*
3. ChristophMolnar–*InterpretableMachineLearning*,Leanpub.
4. AndrewNg–*Data-CentricAIPrinciples* (onlineresources).

References

1. FrancescaLazzeri – *MachineLearningfor TimeSeriesForecasting withPython*, Wiley.
2. AndriyBurkov–*TheMachineLearning Engineering Book.*
3. T.K. Sarkar et al. – *DataAnalyticswith Python andAI Techniques.*
4. Onlineresources:PyCaret,H2O.ai,GoogleCloudAIHub,MLflow documentation.

25MAM203b	**DEEPREINFORCEMENT LEARNING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- Tointroducethefoundationalprinciplesofreinforcementlearning(RL).
- Tounderstanddeepneuralarchitecturesused forvalue-basedandpolicy-basedRL.
- Toexplorepolicygradientand actor–criticalgorithms forcomplexdecision-making.
- Toapplydeepreinforcement learningtechniquestoreal-worldAIproblems.
- Toanalyzechallengessuchas exploration–exploitation,stability, andsampleefficiency.

CourseOutcomes (COs)

Uponsuccessful completionofthe course,thestudentwillbeableto:

- **CO1:**Explainthemathematicalfoundationsofreinforcementlearning.
- **CO2:**ImplementQ-learninganddeepQ-network (DQN) algorithms.
- **CO3:**Applypolicygradient and actor–critic approaches for continuous actionspaces.
- **CO4:**Design and train DRLagents forcontroland planningtasks.
- **CO5:**Evaluateand optimizeDRLmodels forreal-world applications.

UnitI:FoundationsofReinforcementLearning
Agent–environmentinteraction,rewards,states,actions,return,MarkovDecisionProcesses (MDPs), Bellman equations, dynamic programming, Monte Carlo methods, and Temporal Difference (TD) learning.

UnitII:Value-BasedMethods
Q-learningandSARSA,experiencereplayandtargetnetworks,deepQ-networks(DQN),Double DQN, Dueling DQN, and prioritized replay mechanisms.

UnitIII:Policy-BasedMethods
Policygradienttheorem,REINFORCEalgorithm,stochasticvsdeterministicpolicies,entropy regularization, baseline subtraction, and variance reduction techniques.

UnitIV:Actor–Critic Architectures
AdvantageActor–Critic(A2C/A3C),DeepDeterministicPolicyGradient(DDPG),TwinDelayed DDPG (TD3), Proximal Policy Optimization (PPO), and Soft Actor–Critic (SAC).

UnitV:ApplicationsandAdvancedTopics
Multi-agent reinforcement learning, hierarchical and model-based RL, transfer learning in RL, roboticscontrol,game-playingagents(Atari,AlphaGo),andDRLchallenges –stability,sample efficiency, and safety considerations.

Textbooks/References

1. **RichardS.SuttonandAndrewG.Barto**,*ReinforcementLearning:AnIntroduction*,2nd Edition, MIT Press.
2. **MaximLapan**,*DeepReinforcementLearningHands-On*,PacktPublishing.
3. **CsabaSzepesvári**,*AlgorithmsforReinforcementLearning*,Morgan&Claypool.
4. **PieterAbbeeletal.**,*Deep RLin Practice*(onlineresourcesandpapers).

25MAM203c	**ADVANCEDPROMPTDESIGNAND ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. Tounderstandthefundamentalsofpromptengineeringanditsroleinlargelanguagemodels (LLMs).
2. Toexploretechniquesfordesigning,optimizing,andchainingpromptsfordifferentAI tasks.
3. Toanalyze reasoningandcontextcontrolstrategiesingenerativeAIsystems.
4. Toapplyadvancedpromptingframeworksfortaskautomation,knowledgeextraction,and decision support.
5. Toevaluateprompt performanceusingsystematictestingand human–AIalignment metrics.

CourseOutcomes (COs)

Atthe endofthe course,students willbe able to:

- **CO1:**Explainhowlarge languagemodelsinterpretandrespondtoprompts.
- **CO2:**DesignstructuredpromptsforvariousNLPandmultimodaltasks.
- **CO3:**Implementchain-of-thoughtandmulti-stepreasoningthroughpromptpatterns.
- **CO4:**Applyfew-shot,zero-shot, and instruction-tunedpromptingmethodseffectively.
- **CO5:**Evaluateandoptimizepromptsforaccuracy, interpretability,andethicalcompliance.

UnitI–FoundationsofPromptEngineering

Overview of large language models (LLMs) – GPT, Claude, LLaMA, Gemini, Tokenization, embeddings, and context windows in LLMs, Instruction-following behavior and modelconditioning, Principles of prompt design: clarity, specificity, constraints, and task alignment, Prompt evaluation metrics: success rate, relevance, and response quality, Ethical considerations and bias awareness in prompting.

UnitII–PromptTaxonomyandDesign Techniques

Zero-shot, one-shot, and few-shot prompting approaches, Role prompting and persona-baseddesign, Structured output promptingand formatting guidelines, Prompt templates, placeholders, and reusable patterns, Multi-turn and conversational prompting strategies.

UnitIII–AdvancedPromptingStrategies

Chain-of-thought (CoT) reasoning, Self-consistency and tree-of-thought frameworks, ReAct (Reason + Act) prompting for interactive reasoning, Multi-agent prompting strategies and collaborative prompt design, Reasoning scaffolds and prompt decomposition for complex tasks, Integrating context and memory for multi-step task completion.

UnitIV–PromptOptimizationandAutomation

Reinforcement Learning from Human Feedback (RLHF) in prompt optimization, Prompt tuning, prefix tuning, and soft prompting techniques, Parameter-efficient fine-tuning of LLMs, Automated prompt generation and evaluation frameworks, Metrics for prompt effectiveness: accuracy, coherence, and human alignment.

UnitV–ApplicationsandEthicsinPromptDesign

Applications in content generation, code synthesis, and knowledge extraction, Use of prompts in data analysis, education, and decision support systems, Bias detection and mitigation in generated responses, Hallucination reduction and safety guidelines, Explainability and transparency inprompt-based AI.

Textbooks/ References

1. JasonWeietal.–*PromptEngineeringforLargeLanguageModels*(StanfordResearch Papers).
2. AndrewNg–*GenerativeAIShortCourses onPromptEngineering*(DeepLearning.AI).
3. RileyGoodside –*Advanced PromptEngineeringGuide* (Anthropic).
4. OpenAI– GPTBest PracticesandAPIDocumentation (onlineresources).

25MAM204a	**VISUAL TRANSFORMERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. TounderstandtheevolutionfromConvolutionalNeuralNetworks(CNNs)toVision Transformers (ViTs).
2. Tolearnthearchitecture,attentionmechanisms,andtrainingofvisualtransformers.
3. Toexploretransformer-basedmodelsforimageclassification,detection,and segmentation.
4. Tostudyfine-tuningstrategies forpre-trainedvisual transformer models.
5. Toanalyzestate-of-the-artapplicationsofViTsincomputervision.

CourseOutcomes (COs)

Attheendofthiscourse,students willbeable to:

- **CO1:**Explaintheworkingprinciplesofvisiontransformersandattentionmechanisms.
- **CO2:**CompareCNNs andViTsforvarious visuallearningtasks.
- **CO3:**Implementandfine-tunepre-trainedtransformermodelsforimage analysis.
- **CO4:**Applytransformerstoimageclassification,detection,andsegmentation.
- **CO5:**Evaluatetheperformanceofvisualtransformerarchitecturesonreal-worlddatasets.

UnitI–Foundations ofVisual Transformers

Review of CNN-based vision models and their limitations, Motivation for Vision Transformers (ViTs), Overview of Transformer architecture, Tokenization of image patches and positional encoding, Comparison of sequential vs. spatial processing in images, Embedding techniques for vision tokens, Limitations and challenges of early ViTs.

UnitII–VisionTransformer Architecture

Standard ViT architecture and its components, Multi-head self-attention mechanisms, Feedforward networks and residual connections, Pre-training and fine-tuning strategies, Hybrid CNN–Transformer models, Layer normalization and positional embeddings.

UnitIII–AdvancedVisionTransformer Variants

Swin Transformer – shifted windows and hierarchical features, DeiT (Data-efficient Image Transformers) and training efficiency, BEiT – BERT-inspired vision transformers, ConvNeXt – CNN-Transformer hybrids, Visual Attention Networks and hierarchical attention mechanisms, Parameter efficiency and computational optimization techniques.

Unit IV– ApplicationsofVisual Transformers

Image classification tasks using ViTs, Object detection and segmentation pipelines, Vision–Language models: CLIP, BLIP, Flamingo, 3D vision and video transformers, Generative applications: diffusion models and transformer-based generation, Edge deployment and real-time inference considerations.

UnitV–Fine-tuning andCase Studies

Transfer learning and fine-tuning techniques, Knowledge distillation for ViTs, Low-Rank Adaptation (LoRA) for parameter-efficient tuning, Training with limited data: augmentation and regularization.

Textbook

- K.Khan,A.Naseer,M.Hayat,andF.Khan,*TransformersinVision:ASurvey*,ACM Computing Surveys, 2022.

References

1. AlexeyDosovitskiyetal.,*AnImageisWorth16x16Words:TransformersforImage Recognition at Scale*, ICLR 2021.
2. Vaswanietal., *AttentionisAllYouNeed*,NeurIPS2017.
3. Touvronetal.,*Training Data-efficientImageTransformers(DeiT)*, 2021.

25MAM204b	**AIFORSMARTCITIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. TounderstandtheroleofArtificialIntelligenceinbuildingsustainableandintelligenturban systems.
2. ToexploreAI-basedsolutionsforsmartinfrastructure,energy,transportation,and governance.
3. Tostudydata-drivenurban analyticsusingIoTand AIintegration.
4. Todevelop intelligentdecision-makingsystemsfor citymanagement.
5. Toevaluate ethical, privacy,andsecurityimplicationsofAIinsmart cities.

CourseOutcomes (COs)

Attheendofthiscourse,students willbeable to:

- **CO1:**Explain the architectureandcomponents of AI-enabled smart citysystems.
- **CO2:**Applymachine learninganddeep learningmodels forurban dataanalysis.
- **CO3:**DesignAIsolutions forsmart traffic,waste, and energymanagement.
- **CO4:** Integrate IoT,edge computing,and AIforintelligentcityservices.
- **CO5:**Evaluateprivacy,ethical,and governanceissuesinAI-drivenurbanecosystems.

UnitI–Introduction toSmartCitiesandAI

Overview of Smart Cities – definitions, frameworks, and challenges, Role of AI in urban development and sustainability, Smart city ecosystem: IoT sensors, cloud platforms, edge nodes, Urban data sources: geospatial, sensor, mobility, and environmental data, Smart city architecture, Urban analytics requirements and performance metrics.

UnitII–AI TechniquesforUrban Analytics

Machine learning applications in data analysis, Deep learning models for prediction and classification, Predictive modeling, Computer vision for surveillance, traffic monitoring, and infrastructure, Natural Language Processing (NLP) for citizen engagement and governance, Anomaly detection and pattern recognition in urban data streams.

UnitIII–AIApplicationsin SmartInfrastructure

Smarttransportationsystems–trafficpredictionandcongestionmanagement,Autonomousvehicles and AI-driven public transport optimization, Smart energy, Smart water and waste management, Urban mobilityand public safetysolutions using AI, IoT-enabled monitoring for cityinfrastructure.

UnitIV– AIIntegration withIoTand EdgeComputing

AI–IoT architectures for real-time data processing, Edge AI for low-latency decision-making and distributed computing, Federated learning for privacy-preserving, decentralized smart city systems, Cloud–edge orchestration and scalability challenges, Integration of AI with city-wide sensor networks.

UnitV– Ethics,Governance, andCase Studies

Ethical AI and privacy preservation in smart cities, Data governance frameworks and cybersecurity considerations,Policy,regulatory,andsocietalimpactsofAIinurbansystems,Lessonslearned

fromAIdeploymentinurbanplanning,Emergingtrends:AI-drivenurbansustainabilityand resilient cities.

Textbooks

1. Zanella,A.,etal.,*InternetofThingsforSmartCities*,IEEE InternetofThingsJournal, 2014.
2. McClellan,S.,*SmartCities:Applications,Technologies,Standards,andDrivingFactors*, Springer, 2017.

References

1. Mora,L., etal., *AIandUrbanAnalytics forSmart CityDevelopment*, Elsevier, 2021.
2. Bibri,S.E.,*AdvancesintheLeadingParadigmsofUrbanism:SmartCitiesandData-Driven Urbanism*, Springer, 2020.

25MAM204c	**AIFOREDGECOMPUTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. Tointroducetheprinciplesandarchitectureofedge computingintegrated withAIsystems.
2. ToexploreAImodeldeployment,optimization,andinferenceattheedge.
3. Tostudycommunication, energyefficiency, and latencychallenges in edge intelligence.
4. ToanalyzedistributedAIframeworksforreal-timeanalyticsanddecision-making.
5. Toevaluate edgeAIapplicationsinIoT,smartcities,andautonomoussystems.

CourseOutcomes (COs)

Attheendofthiscourse,students willbeable to:

- **CO1:**Explain thearchitectureandfunctioningof AI-enablededgecomputing systems.
- **CO2:**ImplementAImodelsoptimizedforlow-powerandreal-time edge deployment.
- **CO3:**Integrateedge,fog,andcloudsystemsfordistributedintelligence.
- **CO4:**Analyzeresource allocationandcommunicationefficiencyfor edge AI.
- **CO5:**Evaluateuse casesandchallengesindeployingAIattheedge fordifferent domains.

UnitI–Fundamentalsof EdgeComputingandAI

Overview of Edge, Fog, and Cloud Computing paradigms, Differences between cloud AI and edge AI, Edge computing architecture: sensors, gateways, micro data centers, AI pipelines from data acquisition to edge inference, Edge device types and hardware constraints, Latency, bandwidth, and real-time requirements in edge AI.

UnitII–AIModelDeploymentonEdgeDevices

Lightweight AI models: MobileNet, TinyML, and EdgeTPU, Model compression techniques: pruning, quantization, and knowledge distillation, Deployment frameworks: TensorFlow Lite, ONNX Runtime, NVIDIA Jetson, Hardware accelerators and GPU/TPU optimization.

UnitIII–DistributedIntelligenceandDataManagement

Federated learning and decentralized AI training, Communication-efficient learning protocols, Data synchronization and consistency in distributed edge networks, Edge–cloud collaboration for adaptive learning.

UnitIV–SystemOptimizationand Security

Energy-efficient inference and adaptive resource allocation, Real-time data analytics and decision-making frameworks at the edge, Privacy-preserving machine learning: differential privacy, homomorphic encryption, Secure model sharing and updates in edge environments, Fault tolerance, redundancy, and system reliability, Performance monitoring and edge system diagnostics.

UnitV–ApplicationsandEmergingTrends

AI-enabled smart manufacturing, healthcare monitoring, and autonomous vehicles, Edge AI for smart grids, predictive maintenance, and transportation systems, Emerging trends: edge federated transformers, 6G edge intelligence, neuromorphic computing.

Textbooks

1. MahadevSatyanarayanan –*EdgeComputing:APrimer*, IEEEComputerSociety,2017.
2. RajkumarBuyya,SatishNarayanaSrirama –*FogandEdgeComputing:Principlesand Paradigms*, Wiley, 2019.

References

1. YunchuanSunetal.–*AIattheEdge:ASystematicSurvey*,ACMComputingSurveys, 2022.
2. S.Yi,C.Li,Q. Li–*ASurveyofFogComputing:Concepts,Applications,andIssues*,ACM IoT Journal.

25MAM201P	**AGENTICAILAB**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives

1. Toimplementsingleandmulti-agentsystemsusingsimulationframeworks.
2. Toanalyze agentcommunication,coordination,anddecision-makingstrategies.
3. TodesignreactiveanddeliberativeagentsusingBDIandreinforcementlearningmodels.
4. Toapplyagent-based modelingfor solvingreal-world problems.

CourseOutcomes (COs)

- **CO1:**Implementsingleandmulti-agentsystems withenvironmentalinteraction.
- **CO2:**Modelagentcommunication,coordination,andnegotiation.
- **CO3:**ApplyBDIand learning-based modelsto agentdesign.
- **CO4:**Simulateintelligentagent behaviorinreal-world applications.

ListofExperiments(10 Total)

1. ReactiveAgentImplementation–Developasimplereflexagentthatrespondstoenvironmental changes.
2. Goal-BasedAgentSimulation–Designagoal-drivenagentcapableofachievingdefined objectives.
3. BDIAgentModelImplementation–BuildaBelief–Desire–Intentionagentusingarule-based reasoning framework.
4. Multi-Agent Coordination – Implement task-sharing or resource allocation among multiple agents.
5. AgentCommunication–Simulateinteractionusingmessagepassing(ACLin JADE).
6. NegotiationandGame-TheoreticDecisionMaking–Modelcooperativeandcompetitive negotiation scenarios.
7. Reinforcement LearningAgent – Train an agent to adapt to dynamic environments usingRL techniques.
8. Swarm Intelligence-Based Agents – Implement ant colony or particle swarm behaviors in a simulated environment.
9. Agent-BasedTrafficSimulation–Simulateintelligenttrafficsystemswithautonomous decision-making agents.
10. Agentic Simulation Mini-Project – Develop a collaborative multi-agent system using JADE or AnyLogic for a real-world problem (e.g., disaster response, supply chain optimization).

SoftwareTools

1. SimulationFrameworks:JADE(JavaAgentDEvelopmentFramework),AnyLogic, NetLogo, or Python-based Mesa Framework
2. AI&LearningLibraries:TensorFlow,PyTorch(forRL-basedagents)
3. DevelopmentEnvironment:Eclipse/IntelliJ /VSCodeforJava/Pythoncoding

25D97201P	**XAIANDRESPONSIBLEAI LAB**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives

1. ToimplementexplainableAImodels andvisualization tools.
2. ToapplyinterpretableMLmethodsfor large-scaledataanalysis.
3. TounderstandethicalandresponsibleAIpracticesthroughcasestudies.
4. Tousebigdata frameworkslikePySpark forexplainablemodel deployment.

CourseOutcomes (COs)

Atthe endofthis lab,students willbe able to:

- **CO1:**Applyexplainable AIframeworks for modelinterpretation.
- **CO2:**Implement interpretableMLmodels forlarge-scaledata.
- **CO3:**Evaluatefairness,bias,andtransparencyinAImodels.
- **CO4:**Designinteractive visualizationdashboardsforresponsibleAI.

ListofExperiments(10 Total)

1. IntroductiontoXAITools–ImplementSHAPandLIMEexplainersforclassificationmodels.
2. Decision Tree Interpretability – Train and visualize interpretable decision tree models using Scikit-learn.
3. RuleFit and Explainable Boosting Machines (EBM) – Build transparent models and analyze decision rules.
4. FeatureImportance Analysis– Compare globaland localfeature importance using SHAP values.
5. CounterfactualExplanations–Generatecounterfactualexamplestointerpretmodelpredictions.
6. Fairness and Bias Detection – Evaluate ML models for gender or group bias using AIF360or Fairlearn.
7. BigDataPreprocessingusingPySpark–Clean,transform,andpreparelargedatasetsfor ML training.
8. Explainable Model Deployment – Integrate SHAP/LIME explanations in Flask or Streamlit dashboards for transparency.
9. VisualizationDashboardsforModelInterpretability–Buildinteractivedashboardsusing Plotly/Dash or Streamlit.
10. Case Studyon Responsible AI – Analyze a real-world AI ethics case (healthcare, finance, or hiring) and prepare an interpretability report.

SoftwareTools

- **Programming&ML:**Python(Scikit-learn,PyTorch,SHAP,LIME,Fairlearn, AIF360)
- **BigData:**PySpark