JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

VISION AND MISSION OF THE UNIVERSITY

VISION

The University is primarily promoting quality of education in the areas of Science, Technology, Engineering and Mathematics (STEM) as four academic pillars of education, to excel in teaching, learning, research, consultancy and placements through innovative practices with global perspective.

MISSION

1. Design an Industry relevant curriculum from time to time with a Global perspective
2. Promoting quality education by embracing ICT delivery mechanism with continuous pedagogy through e-learning mechanism
3. Spread across for industry collaborations with a focus to pre-training and placements for technology transfer to society
4. Establishing centers of excellence to promote research and innovations in multidisciplinary areas to bring in patent culture and consultancy practices
5. International Collaborations for student outreach
6. Facilitating international students to study in JNTUK to infuse cross culture learning practices.

Vision and Mission of the Institute

Vision and Mission of the Department

Programme Education Objectives (PEOs) of the M.Tech - CSE (ARTIFICIAL INTELLIGENCE)

PEO1: To equip students with a comprehensive understanding of mathematical foundations, machine learning techniques, and optimization strategies, enabling them to apply this knowledge effectively in solving complex real world problems.

PEO2: To foster a research-oriented mindset and encourage innovation in the field of machine learning. Graduates should be capable of conducting independent research, contributing to advancements in machine learning techniques, and developing novel solutions to emerging challenges.

PEO3: To promote ethical practices, intellectual property rights awareness, and holistic development. Graduates should possess strong communication skills, an understanding of societal implications, and a commitment to values such as sustainability, social responsibility, and continuous learning.

Mapping of Mission statements to PEOs:

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

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 these Specializations of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: Understanding of theoretical foundations of computing and, modelling and design of Artificial Intelligence (AI) systems.

PO5: Able to assess the significance of a complex AI problem and analyse its characteristics.

PO6: Ability to explore contemporary research issues and gaps, and to propose original ideas and solutions in AI

Note: Program may add up to three additional Pos Mapping of Programme Outcomes to PEOs:

Programme Outcomes (POs)	PEO1	PEO2	PEO3
PO1	2	3	1
PO2	1	2	3
PO3	3	2	1
PO4	3	2	1
PO5	3	2	1
PO6	2	3	1

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M.Tech

CSE (ARTIFICIAL INTELLIGENCE)

PROGRAMME COURSE STRUCTURE & SYLLABUS

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I – Semester

S.No	Course Title	L	T	P	C
1	**Program Core-1** Mathematics for Machine Learning	3	1	0	4
2	**Program Core-2** Advances in Artificial Intelligence	3	1	0	4
3	**Program Core-3** Knowledge Representation and Reasoning	3	1	0	4
4	**Program Elective-1** • Data Mining • Big Data Analytics • High Performance Computing	3	0	0	3
5	**Program Elective-2** • Cloud Computing • Internet of Things • Expert Systems	3	0	0	3
6	**Laboratory-1** Artificial Intelligence Lab	0	1	2	2
7	**Laboartory-2** Python Programming Lab	0	1	2	2
8	**Seminar-1**	0	0	2	1
	Total Credits	15	5	6	23

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

S.No.	Course Title
1	Data Mining
2	Big Data Analytics
3	High Performance Computing
4	Cloud Computing
5	Internet of Things
6	Expert Systems

@ Minimum 2/3 themes per elective

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II Semester

S.No	Course Title	L	T	P	C
1	**Program Core-4** Machine Learning	3	1	0	4
2	**Program Core-5** Soft Computing	3	1	0	4
3	**Program Core-6** Natural Language Processing	3	1	0	4
4	**Program Elective-3** • Deep Learning • Computational Intelligence • Computer Vision	3	0	0	3
5	**Program Elective-4** • Robotics and Intelligent Systems • Reinforcement Learning • AI Chatbots	3	0	0	3
6	**Laboratory-3** Machine Learning Lab	0	1	2	2
7	**Laboartory-4** Soft Computing Lab	0	1	2	2
8	**Seminar-2**	0	0	2	1
	Total Credits	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 Title
1	Deep Learning
2	Computational Intelligence
3	Computer Vision
4	Robotics and Intelligent Systems
5	Reinforcement Learning
6	AI Chatbots

@ Minimum 2/3 themes per elective

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III Semester

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

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

Comprehensive viva can be conducted courses completed upto second sem.

$ Dissertation – Part A, internal assessment

IV Semester

S.No	Course Code	Courses	L	T	P	C
1		Dissertation Part – B%	-	-	32	16
Total Credits						16

% External Assessment

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

Course Objectives:

1. To develop a strong foundational understanding of linear algebra, including systems of equations, vector spaces, basis, rank, and linear mappings, essential for data science and machine learning.
2. To provide insights into analytic geometry, focusing on norms, inner products, orthogonality, and projections, enabling students to geometrically interpret high-dimensional data and transformations.
3. To equip students with the knowledge of matrix decompositions such as eigen decomposition, singular value decomposition (SVD), and Cholesky decomposition, for use in data compression, dimensionality reduction, and system analysis.

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

		Knowledge Level (K)#
CO1	Understand the basic concepts of sets, vector space, subspace, basis and dimension	K2
CO2	Check linear dependency of vectors and identify Eigen values and Eigen vectors derivative of matrix, which will form the basis for Principal Component Analysis.	K3
CO3	Utilize matrix decompositions such as eigen decomposition, Cholesky, and SVD for computational and data analysis tasks.	K3
CO4	Apply vector calculus, gradients, and automatic differentiation techniques for multivariate functions and optimization.	K3
CO5	Develop proficiency in probability, distributions, and optimization methods including gradient descent and convex optimization for practical problem-solving	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

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, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations	12
UNIT – 3	**Matrix Decompositions:** Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition 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, Backpropagation 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.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd Edition, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer 2017.

Reference Books:

1. Machine Learning: An Applied Mathematics Introduction, Paul Wilmott, Panda Ohana Publishing 2019.

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

Course Objectives:

1. To introduce the fundamental concepts, historical evolution, and diverse applications of Artificial Intelligence, including intelligent systems and AI programming languages.
2. To develop problem-solving skills using state-space search strategies, including heuristic methods, A* algorithms, and constraint satisfaction techniques.
3. To impart knowledge on logical reasoning, including propositional and predicate logic, and their application in AI for knowledge inference and decision-making.
4. To explore various knowledge representation techniques such as semantic networks, frames, conceptual dependency, and script structures, and their role in intelligent behavior modeling.
5. To familiarize students with handling uncertainty and imprecision using probabilistic models, Bayesian networks, fuzzy logic, and Dempster-Shafer theory for real-world AI system development.

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

		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.	K4
CO2	Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing.	K3
CO3	Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.	K3
CO4	Solve problems with uncertain information using Bayesian approaches	K3
CO5	Design and implement fuzzy propositions, inference rules, and fuzzy systems for decision-making in uncertain environments.	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

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*, constraint satisfaction	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, SarojKaushik, 1st Edition, CENGAGE Learning, 2011.

Reference Books:

1. Artificial intelligence, structures and Strategies for Complex problem solving, 5th Edition, George F Lugar, PEA
2. Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer, 2017
3. Artificial Intelligence, A new Synthesis, 1st Edition, Nils J Nilsson, Elsevier, 1998
4. Artificial Intelligence- 3rd Edition, Rich, Kevin Knight, Shiv Shankar B Nair, TMH

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I Semester	KNOWLEDGE REPRESENTATION AND REASONING	L	T	P	C
		3	1	0	4

Course Objectives:

1. To understand the foundational concepts of knowledge, reasoning, and logic, and analyze their significance in the development of intelligent systems.
2. To explore the historical and philosophical basis of logic and ontology, and classify knowledge through top-level categories including sets, abstractions, space, and time.
3. To develop proficiency in various knowledge representation techniques such as frames, rules, object-oriented models, and natural language semantics.
4. To study the modeling of dynamic systems including processes, events, concurrent activities, and context-aware reasoning in intelligent environments.
5. To examine the challenges of uncertainty, vagueness, and non-monotonic logic, and apply fuzzy logic, contextual reasoning, and ontology sharing techniques for effective knowledge acquisition and reuse.

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

COS		Knowledge Level (K)#
CO1	Analyze and design knowledge-based systems intended for computer implementation.	K4
CO2	Acquire theoretical knowledge about principles for logic-based representation and reasoning.	K2
CO3	Ability to understand the knowledge-engineering process	K2
CO4	Ability to implement production systems, frames, inheritance systems and approaches to handle uncertain or incomplete knowledge.	K3
CO5	Design and utilize ontologies, conceptual schemas, and tools for knowledge acquisition and sharing across multiple paradigms.	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	**The Key Concepts**: Knowledge, Representation, Reasoning, Why knowledge representation and reasoning, Role of logic **Logic:** Historical background, representing knowledge in logic, Varieties of logic, Name, Type, Measures, Unity Amidst diversity	12
UNIT – 2	**Ontology:** Ontological categories, Philosophical background, Top-level categories, Describing physical entities, Defining abstractions, Sets, Collections, Types and Categories, Space and Time	12
UNIT – 3	**Knowledge Representations:** Knowledge Engineering, Representing structure in frames, Rules and data, Object-oriented systems, Natural language Semantics, Levels of representation	12
UNIT – 4	**Processes:** Times, Events and Situations, Classification of processes, Procedures, Processes and Histories, Concurrent processes, Computation, Constraint satisfaction, Change **Contexts:** Syntax of contexts, Semantics of contexts, First-order reasoning in contexts, Modal reasoning in contexts, Encapsulating objects in contexts.	12
UNIT – 5	**Knowledge Soup**: Vagueness, Uncertainty, Randomness and Ignorance, Limitations of logic, Fuzzy logic, Non-monotonic Logic, Theories, Models and the world, Semiotics **Knowledge Acquisition and Sharing:** Sharing Ontologies, Conceptual schema, accommodating multiple paradigms, relating different knowledge representations, Language patterns, Tools for knowledge acquisition	12
	Total	60

Text Books:

1. Knowledge Representation Logical, Philosophical, and Computational Foundations by John F. Sowa, Thomson Learning.
2. Knowledge Representation and Reasoning by Ronald J. Brachman, Hector J. Levesque, Elsevier.

Reference Books:

1. Stuart Russell, Peter Norvig – *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, 2021.
2. Dov M. Gabbay, John Woods – *Handbook of the History of Logic, Volume 9: Computational Logic*, Elsevier, 2014.
3. Markus Krötzsch, Denny Vrandecic, Max Völkel – *Semantic Web: Ontology and Knowledge Bases*, Springer, 2012.

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

Course Objectives:

1. To introduce the fundamental concepts of data mining, including types of data, data quality, preprocessing techniques, and similarity/dissimilarity measures essential for data analysis.
2. To develop a comprehensive understanding of classification techniques such as decision trees, k-nearest neighbors, Bayesian classifiers, and Support Vector Machines, and to assess model performance using appropriate evaluation metrics.
3. To explore association rule mining for discovering interesting patterns, including frequent itemset generation and rule creation, using algorithms like Apriori and FP-Growth, and to handle different types of attributes and data hierarchies.
4. To understand and apply various clustering algorithms such as K-means, hierarchical clustering, and DBSCAN, and to evaluate clustering results using unsupervised cluster evaluation measures.
5. To study the principles and techniques of anomaly detection, including statistical, proximity-based, clustering-based, and reconstruction-based methods, for identifying rare and irregular patterns in large datasets.

Course Outcomes: After the completion of the course, student will be able to:

		Knowledge Level (K)#
CO1	Compare types of data, quality of data, suitable measures required to perform data analysis. (UNIT-I) - K2	K2
CO2	Choose appropriate classification technique to perform classification, model building and evaluation (UNIT-II)- K3	K3
CO3	Make use of association rule mining techniques on categorical and continuous data (UNIT III) - K3	K3
CO4	Identify and apply clustering algorithm (with open source tools), interpret, evaluate and report the result (UNIT IV) - K3	K3
CO5	Analyze and Compare anomaly detection techniques (UNI-V) - K4	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction to Data mining, types of Data, Data Quality, Data Processing, Measures of Similarity and Dissimilarity, Exploring Data: Data Set, Summary Statistics, Visualization, OLAP and multi-dimensional data analysis.	12
UNIT – 2	**Classification:** Basic Concepts, Decision Trees and model evaluation: General approach for solving a classification problem, Decision Tree induction, Model over fitting: due to presence of noise, due to lack of representation samples, Evaluating the performance of classifier. Nearest Neighborhood classifier, Bayesian Classifier, Support vector Machines: Linear SVM, Separable and Non Separable case.	12
UNIT – 3	**Association Analysis:** Problem Definition, Frequent Item-set generation, rule generation, compact representation of frequent item sets, FP-Growth Algorithms. Handling Categorical, Continuous attributes, Concept hierarchy, Sequential, Sub graph patterns	12
UNIT – 4	**Clustering:** Over view, K-means, Agglomerative Hierarchical clustering, DBSCAN, Cluster evaluation: overview, Unsupervised Cluster Evaluation using cohesion and separation, using proximity matrix, Scalable Clustering algorithm	12
UNIT – 5	**Anomaly Detection:** Characteristics of Anomaly Detection Problems and Methods, Statistical Approaches, Proximity-based Approaches, Clustering-based Approaches and Reconstruction-based Approaches	12
	Total	60

Text Books:

1. Introduction to Data Mining: Pang-Ning Tan; Michael Steinbach; AnujKarpatne; Vipin Kumar, 2nd edition.
2. Data Mining, Concepts and Techniques, 2nd edition, Jiawei Han, MichelineKamber, Elsevier, 2006.

Reference Books:

1. Fundamentals of data warehouses, 2ndedition,Jarke, Lenzerini, Vassiliou, Vassiliadis, Springer.

Suggested NPTEL Course and other Useful Websites:

1. **https://nptel.ac.in/courses/106105174/**
2. http://cse20-iiith.vlabs.ac.in/

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I Semester	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the concept and significance of Big Data, highlighting its evolution, key trends, unstructured data challenges, and industry-specific applications in domains such as marketing, healthcare, fraud detection, finance, and algorithmic trading.
2. To explore the architecture and ecosystem of Hadoop, including Hadoop Distributed File System (HDFS), fault tolerance, data replication, Map Reduce programming model, data flow, Hadoop I/O, and serialization techniques for scalable big data processing.
3. To develop hands-on understanding of NoSQL databases, covering aggregate data models (key-value, document, graph), replication strategies (master-slave, peer-to-peer), sharding, schema-less design, and practical applications using Cassandra for table operations and data management.

Course Outcomes: After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Illustrate on big data and its use cases from selected business domains.	K2
CO2	Interpret and summarize on NoSQL, Cassandra	K2
CO3	Analyze the HADOOP and Map Reduce technologies associated with big data analytics and explore on Big Data applications Using Hive.	K4
CO4	Make use of Apache Spark, RDDs etc. to work with datasets	K3
CO5	Assess real time processing with Spark Streaming	K4

#Based on suggested Revised BTL

Mapping of course outcomes 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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.	12
UNIT – 2	Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less databases, materialized views, distribution models, sharding, master-slave replication, peer- peer replication, sharding and replication, consistency, relaxing consistency, version stamps, Working with Cassandra ,Table creation, loading and reading data	12
UNIT – 3	Data formats, analyzing data with Hadoop, scaling out, Architecture of Hadoop distributed file system (HDFS), fault tolerance, with data replication, High availability, Data locality , Map Reduce Architecture, Process flow, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization. Introduction to Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, Logical joins, Window functions, Optimization, Table partitioning, Bucketing, Indexing, Join strategies.	12
UNIT – 4	Apache spark- Advantages over Hadoop, lazy evaluation, In memory processing, DAG, Spark context, Spark Session, RDD, Transformations- Narrow and Wide, Actions, Data frames ,RDD to Data frames, Catalyst optimizer, Data Frame Transformations, Working with Dates and Timestamps, Working with Nulls in Data, Working with Complex Types, Working with JSON, Grouping, Window Functions, Joins, Data Sources, Broadcast Variables, Accumulators, Deploying Spark- On-Premises Cluster Deployments, Cluster Managers- Standalone Mode, Spark on YARN , Spark Logs, The Spark UI- Spark UI History Server, Debugging and Spark First Aid	12
UNIT – 5	Spark-Performance Tuning, Stream Processing Fundamentals, Event-Time and State full Processing - Event Time, State full Processing, Windows on Event Time- Tumbling Windows, Handling Late Data with Watermarks, Dropping Duplicates in a Stream, Structured Streaming Basics - Core Concepts, Structured Streaming in Action, Transformations on Streams, Input and Output	12
	Total	60

Text Books:

1. Big Data, Big Analytics: Emerging, Michael Minnelli, Michelle Chambers, and AmbigaDhiraj
2. SPARK: The Definitive Guide, Bill Chambers &MateiZaharia, O'Reilley, 2018Edition
3. Business Intelligence and Analytic Trends for Today's Businesses", Wiley,2013
4. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World Polyglot Persistence", Addison-Wesley Professional,2012 5. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley,2012

Reference Books:

1. "Hadoop Operations", O'Reilley, Eric Sammer,2012
2. "Programming Hive", O'Reilley, E. Capriolo, D. Wampler, and J. Rutherglen,2012
3. "HBase: The Definitive Guide", O'Reilley, Lars George,2011
4. "Cassandra: The Definitive Guide", O'Reilley, Eben Hewitt,2010
5. "Programming Pig", O'Reilley, Alan Gates,2011

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

Course Objectives:

1. To introduce the fundamentals of heterogeneous parallel computing, focusing on GPU architecture, thread hierarchy, and memory organization for high-performance computing applications.
2. To develop the ability to design and implement GPGPU programs, covering core algorithms such as vector addition, matrix multiplication, stencil operations, and image processing tasks including blurring, grayscale transformation, histogramming, convolution, scan, and reduction.
3. To understand the architecture and programming model of Many Integrated Cores (MIC), particularly Intel Xeon Phi, including thread and memory hierarchy, bandwidth considerations, and performance tuning techniques.
4. To apply shared memory programming techniques using OpenMP, including concepts of thread creation, work-sharing constructs, synchronization, and efficient parallel region management in symmetric and distributed memory systems.
5. To implement distributed memory programming using MPI (Message Passing Interface), focusing on point-to-point and collective communication, data distribution strategies, and optimization of communication patterns in parallel applications.

Course Outcomes: After completion of this course

		Knowledge Level (K)#
CO1	Design, formulate, solve and implement high-performance versions of standard single threaded algorithms	K4
CO2	Demonstrate the architectural features in the GPU and MIC hardware accelerators.	K3
CO3	Design programs to extract maximum performance in a multicore, shared memory execution environment processor.	K4
CO4	Analyze Symmetric and Distributed architectures	K4
CO5	Develop and deploy large scale parallel programs on tightly coupled parallel systems using the message passing paradigm.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Graphics Processing Units-Introduction to Heterogeneous Parallel Computing, GPU architecture, Thread hierarchy, GPU Memory Hierarchy.	12
UNIT – 2	GPGPU Programming-Vector Addition, Matrix Multiplication algorithms. 1D, 2D, and 3D Stencil Operations, Image Processing algorithms – Image Blur, Gray scaling. Histogramming, Convolution, Scan, Reduction techniques.	12
UNIT – 3	Many Integrated Cores-Introduction to Many Integrated Cores. MIC, Xeon Phi architecture. Thread hierarchy. Memory Hierarchy, .Memory Bandwidth and performance considerations	12
UNIT – 4	Shared Memory Parallel Programming- Symmetric and Distributed architectures, OpenMP Introduction. Thread creation, Parallel regions. Worksharing, Synchronization.	12
UNIT – 5	Message Passing Interface-MPI Introduction, Collective communication, Data grouping for communication.	12
	Total	60

Text Books:

1. Programming Massively Parallel Processors A Hands-on Approach, 3e Wen-Mei W Hwu, David B Kirk, MorgannKaufmann,2013.
2. Using OpenMP, Scientific and Engineering edition, Barbara Chapman, Gabriele Jost, Ruud vander Pas, MIT Press,2008

Reference Books:

1. Intel Xeon Phi Coprocessor Architecture and Tools, RezaurRahman, Apress Open,2013.
2. Using MPI, Gropp, Lusk, Skjellum, The MIT press,2014.
3. High Performance Computing: Programming and Applications, John Levesque, CRC Press, 2010.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

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

Course Objectives:

1. To introduce the foundational principles of cloud computing, including network-centric computing, delivery models (IaaS, PaaS, SaaS), ethical concerns, and major challenges related to privacy, security, and scalability.
2. To provide a comprehensive understanding of cloud infrastructure and services, exploring real-world platforms like Amazon AWS, Google Cloud, and Microsoft Azure, along with open-source tools and ecological implications.
3. To impart knowledge on virtualization and cloud resource management, covering virtual machine monitors, performance isolation, scheduling policies, dynamic resource allocation, and workload management in distributed environments.
4. To explore distributed storage systems and cloud data management techniques, including distributed file systems, Google File System (GFS), Hadoop Distributed File System (HDFS), BigTable, and Amazon S3, emphasizing performance and security.
5. To enable hands-on skills in cloud application development and deployment, using tools and frameworks such as EC2, S3, Hadoop, Google App Engine, Microsoft Azure, and exploring case studies for real-time cloud services and simulations.

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

		Knowledge Level (K)#
CO1	Interpret the key dimensions of the challenge of Cloud Computing	K2
CO2	Examine the economics, financial, and technological implications for selecting cloud computing for own organization.	K4
CO3	Assessing the financial, technological, and organizational capacity of employer's for actively initiating and installing cloud-based applications	K4
CO4	Evaluate own organizations' needs for capacity building and training in cloud computing-related IT areas.	K5
CO5	Illustrate Virtualization for Data-Center Automation.	K2

#Based on suggested Revised BTL

Mapping of course outcomes 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)

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 systems, communication protocols, logical clocks, message delivery rules, concurrency, model concurrency with Petri Nets.	12
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, HPC on cloud, 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, vBlades, 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:** Evolution 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 (Text Book 2), Microsoft: Azure Services Platform, Windows live, Exchange Online, Share Point Services, Microsoft Dynamics CRM (Text Book2).	12
	Total	60

Text Books:

1. Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier
2. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH

Reference book:

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

I Semester	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the foundational concepts and technologies behind the Internet of Things (IoT), including M2M communication, IoT architecture, and design principles for connected devices and web-enabled systems.
2. To understand the communication protocols and network stacks adapted for IoT/M2M systems, such as HTTP, HTTPS, Telnet, FTP, and modified OSI models, focusing on device-level, network-level, and application-level communication.
3. To explore standardization, data management, and system integration techniques, including device management gateways, ETSI M2M domains, data enrichment, organizing and integrating IoT data into business processes and enterprise systems.
4. To develop knowledge of cloud computing for IoT, including data acquisition, storage, processing, and analytics using cloud platforms like Xively, Nimbits, and integration with Everything-as-a-Service (XaaS) and various cloud service models.

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

		Knowledge Level (K)#
CO1	Explain concisely how the general Internet as well as Internet of Things work	K2
CO2	Understand constraints and opportunities of wireless and mobile networks for Internet of Things.	K2
CO3	Use basic sensing and measurement and tools to determine the real-time performance of network of devices	K3
CO4	Develop prototype models for various applications using IoT technology.	K3
CO5	Utilize cloud platforms and services for IoT data collection, storage, computing, and sensor-based technologies.	K3

#Based on suggested Revised BTL

Mapping of course outcomes 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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	**The Internet of Things:** An Overview of Internet of things, Internet of Things Technology, behind IoTs Sources of the IoTs, M2M Communication, Examples of IoTs, Design Principles For Connected Devices Internet Connectivity Principles, Internet connectivity, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet.	12
UNIT – 2	Business Models for Business Processes in the Internet of Things ,IoT/M2M systems LAYERS AND designs standardizations, Modified OSI Stack for the IoT/M2M Systems ,ETSI M2M domains and High- level capabilities ,Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability	12
UNIT – 3	Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for connected-Devices	12
UNIT – 4	Data Acquiring, Organizing and Analytics in IoT/M2M, Applications /Services /Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet Of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.	12
UNIT – 5	Data Collection, Storage and Computing Using a Cloud Platform for IoT/M2M Applications/Services, Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology, Sensing the World.	12
	Total	60

Text Books:

1. Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier 2. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH

Reference book:

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

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DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

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

Course Objectives:

1. To introduce the foundational principles and structure of expert systems, covering key components such as the problem domain, knowledge domain, rule-based systems, and procedural versus nonprocedural paradigms.
2. To explore various knowledge representation techniques, including formal and informal logic, semantic networks, propositional and predicate logic, and their implementation in expert systems using tools like PROLOG.
3. To develop an understanding of inference mechanisms such as AND-OR trees, forward and backward chaining, resolution, and other deductive techniques essential for reasoning and decision-making in expert systems.
4. To study reasoning under uncertainty, including probabilistic approaches, Markov models, hypothetical reasoning, belief networks, and the application of temporal and causal reasoning in complex decision scenarios.
5. To provide a practical framework for designing and implementing expert systems, addressing development stages, life cycle management, role of knowledge engineers, error handling, and real-world expert system design examples.

Course Outcomes By the end of the course

		Knowledge Level (K)#
CO1	Students will be able to explain and describe the concepts central to the creation of knowledge bases and expert systems	K2
CO2	Students will be knowledgeable about the tools and the processes used for the creation of an expert system	K2
CO3	Student will know methods used to evaluate the performance of an expert system	K3
CO4	Students will be able to conduct an in-depth examination of an existing expert system with an emphasis on basic methods of creating a knowledge base	K4
CO5	Students will be able to examine properties of existing systems in a case-study manner,comparing differing approaches.	K4

#Based on suggested Revised BTL

Mapping of course outcomes 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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	**Introduction to Expert Systems:** The meaning of an expert system, problem domain and knowledge domain, the advantages of an expert system, general stages in the development of an expert system, general characteristics of an expert system, history and uses of expert systems today, rule-based expert systems, procedural and nonprocedural paradigms, characteristics of artificial neural systems	12
UNIT – 2	**The Representation of Knowledge:** The study of logic, difference between formal logic and informal logic, meaning of knowledge, how knowledge can be represented, semantic nets, how to translate semantic nets into PROLOG, how to use logic and set symbols to represent knowledge, the meaning of propositional and first order predicate logic, quantifiers, imitations of propositional and predicate logic.	12
UNIT – 3	**Methods of Inference:** Trees, lattices, and graphs, state and problem spaces, AND-OR trees and goals, methods of inference, rules of inference, limitations of propositional logic, logic systems, resolution rule of inference, resolution systems, and deduction, shallow and causal reasoning, applying resolution to first-order predicate logic, forward and backward chaining, additional methods of reference, Meta knowledge, the Markov decision process.	12
UNIT – 4	**Reasoning Under Uncertainty:** The meaning of uncertainty and theories devised to deal with it, types of errors attributed to uncertainty, errors associate, with induction, features of classical probability, hypothetical reasoning and backward induction, temporal reasoning, Markov chains, odds of belief, sufficiency and necessity, role of uncertainty in inference chains, implications of combining evidence, role of inference nets in expert systems	12
UNIT – 5	**Design of Expert Systems:** How to select an appropriate problem, the stages in the development of an expert system, types of errors to expect in the development stages, the role of the knowledge engineer inthe building of expert systems, the expected life cycle of an expert system, how to do a life cycle model, Expert System Design Examples	12
	Total	60

Text Books:

1. Joseph C. Giarratano , Expert Systems : Principles and Programming, 4th Edition, cengage learning, 2004 2. Dan w. Patterson, Introduction to Artificial Intelligence and Expert Systems, 1st Edition, Pearson, 2015.

Reference Books:

1. Durkin, J., Expert systems Design and Development, Macmillan, 1994 2. Elias M. Awad, Building Expert Systems, West Publishing Company 1996 3. Peter Jackson, Introduction to Expert Systems, Addison Wesley Longman, 1999.ISBN 0 20187686-8.

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DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

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

Course Objectives:

1. To introduce foundational problem-solving techniques in Artificial Intelligence by implementing classic search algorithms such as Depth-First Search (DFS), Breadth-First Search (BFS), Hill Climbing, and A* in suitable AI programming languages (LISP, PROLOG, Java).
2. To demonstrate heuristic-based problem-solving approaches by applying informed strategies like Simulated Annealing and heuristic-based Traveling Salesman Problem (TSP) solving for effective search optimization.
3. To enable practical exploration of AI planning and reasoning through the implementation of classic AI problems like the Water Jug Problem, Monkey-Banana Problem, and 8-Puzzle using goal-driven search.

Course Outcomes Upon successful completion of the course, the student will be able to:

		Knowledge Level (K)#
CO1	Apply the basic principles of AI in problem solving using LISP/PROLOG	K3
CO2	Implement different algorithms using LISP/PROLOG	K3
CO3	Develop an Expert System using JESS/PROLOG	K4
CO4	Design and implement expert systems using forward and backward chaining with tools like JESS and CLIPS	K4
CO5	Demonstrate proficiency in AI programming languages and tools to solve real-world and theoretical AI problems.	K3
CO6	Apply simulated annealing and heuristic methods for optimization problems such as the traveling salesman problem.	K4

#Based on suggested Revised BTL

Mapping of course outcomes 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
CO6	H	M	H	H	H	M

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

E.NO	List of Experiments
EXP-1	Implementation of DFS for water jug problem using LISP/PROLOG
EXP-2	Implementation of BFS for tic-tac-toe problem using LISP/PROLOG/Java
EXP-3	Implementation of TSP using heuristic approach using Java/LISP/Prolog
EXP-4	Implementation of Simulated Annealing Algorithm using LISP/PROLOG
EXP-5	Implementation of Hill-climbing to solve 8- Puzzle Problem
EXP-6	Implementation of Monkey Banana Problem using LISP/PROLOG
EXP-7	Implementation of A* Algorithm using LISP/PROLOG
EXP-8	Implementation of Hill Climbing Algorithm using LISP/PROLOG
EXP-9	Implementation Expert System with forward chaining using JESS/CLIPS
EXP-10	Implementation Expert System with backward chaining using

Textbooks

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair – *Artificial Intelligence*, 3rd Edition, Tata McGraw Hill, 2009.
2. Stuart Russell, Peter Norvig – *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, 2021.
3. George F. Luger – *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 6th Edition, Pearson Education, 2009.

Reference Books

1. Nils J. Nilsson – *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann Publishers, 1998.
2. Patrick Henry Winston – *Artificial Intelligence*, 3rd Edition, Addison-Wesley, 1992.
3. Joseph C. Giarratano, Gary D. Riley – *Expert Systems: Principles and Programming*, 4th Edition, Thomson, 2005.

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DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

I Semester	PYTHON PROGRAMMING LAB	L	T	P	C
		0	1	2	2

Course Objectives:

1. To introduce foundational data handling techniques using Python libraries such as Pandas and NumPy, enabling students to import and manipulate various types of data files including CSV, Excel, and text formats.
2. To equip students with data preprocessing skills, such as variable type conversions, date parsing, transposition, sorting, and cleaning operations for structured tabular data.
3. To develop practical skills in data exploration and visualization, using popular Python libraries like Matplotlib and Seaborn for generating essential plots like histograms, scatter plots, and box plots.
4. To enable students to generate synthetic data and perform frequency analysis, simulating real-world datasets using Python's random module and creating frequency tables using Pandas.
5. To provide hands-on experience in handling data quality issues, such as identifying and resolving missing values and outliers, and eliminating duplicates in datasets.

Course Outcomes Upon successful completion of the course, the student will be able to:

		Knowledge Level (K)#
CO1	Implement data science operations, such as data collection, management, and storage	K3
CO2	Apply Python programming concepts in data science, including their real-world applications	K3
CO3	Implement data collection and management scripts using Python's Pandas library	K3
CO4	Remove duplicates and perform grouping operations for statistical summaries in Pandas.	K3
CO5	Generate frequency tables and synthetic datasets using Pandas and random module.	K3

#Based on suggested Revised BTL

Mapping of course outcomes 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)

	List of Experiments
EXP-1	Demonstrate how to load data files using pandas. i. CSV files ii. Excel files iii. Txt files
EXP-2	Demonstrate how to convert a variable to a different data type using pandas? i. Convert numeric variables to string variables and vice versa ii. Convert character date to Date.
EXP-3	i. Demonstrate how to transpose a Data set or dataframe using Pandas? ii. Demonstrate how to sort a Pandas DataFrame?
EXP-4	Demonstrate how to create the following plots using matplotlib, seaborn? i. Histogram ii. Scatter Plot iii. Box Plot
EXP-5	i. Demonstrate how to generate frequency tables with Pandas? ii. Demonstrate how to generate sample Data set in Python using random?
EXP-6	i. Demonstrate how to remove duplicate values of a variable in a Pandas Dataframe? ii. Demonstrate how to group variables in Pandas to calculate count, average, sum?
EXP-7	i. Demonstrate how to recognize and Treat missing values and outliers in Pandas? ii. Demonstrate how to merge / join data sets and Pandas Dataframes?
EXP-8	Create a Dataframe and apply aggregations on it. i. On a single column ii. On multiple columns

Textbooks

1. Wes McKinney – *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, 2nd Edition, O'Reilly Media, 2017.
2. Jake VanderPlas – *Python Data Science Handbook: Essential Tools for Working with Data*, O'Reilly Media, 2016.
3. Joel Grus – *Data Science from Scratch: First Principles with Python*, 2nd Edition, O'Reilly Media, 2019.

Reference Books

1. Paul Barry – *Head First Python*, 2nd Edition, O'Reilly Media, 2016.
2. Matthias Muller & Sarah Guido – *Introduction to Machine Learning with Python*, O'Reilly Media, 2017.
3. Kyran Dale – *Data Visualization with Python and JavaScript*, O'Reilly Media, 2016.

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

Course Objectives:

1. To introduce the fundamental principles and evolution of machine learning by understanding its scope, applications in real-world domains, and its connection with data mining, artificial intelligence, and intelligent machines.
2. To equip students with a solid foundation in data representation, domain knowledge, and the diversity of data, including structured and unstructured formats, while emphasizing different forms of learning such as supervised, unsupervised, and statistical learning.
3. To explore the core concepts of supervised learning, including inductive learning, generalization error estimation, model evaluation metrics, and techniques to avoid overfitting using Occam's Razor and bias-variance trade-offs.
4. To develop a strong grasp of statistical learning theory, inferential statistics, and classification techniques including Bayesian reasoning, K-Nearest Neighbor (KNN), discriminant analysis, regression models, and principle-based models like Minimum Description Length.
5. To study and implement Support Vector Machines (SVM) by understanding both linear and non-linear classifiers, soft margins, and kernel-based learning for regression and classification tasks.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Domain Knowledge for Productive use of Machine Learning and Diversity of Data.	K2
CO2	Demonstrate on Supervised and Computational Learning	K3
CO3	Analyze on Statistics in learning techniques and Logistic Regression	K4
CO4	Illustrate on Support Vector Machines and Perceptron Algorithm	K3
CO5	Design a Multilayer Perceptron Networks and classification of decision tree	K4

#Based on suggested Revised BTL

Mapping of course outcomes 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)

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 seperable 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, Perceptrons, 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 weakness of decision tree approach.	12
	Total	60

Text Books:

1. Applied Machine Learning, M.Gopal, McGraw Hill Education, 2019 2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press,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.

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DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

II Semester	SOFT COMPUTING	L	T	P	C
		3	1	0	4

Course Objectives:

1. To introduce the foundations of soft computing and distinguish it from traditional hard computing paradigms by focusing on tolerance to imprecision, uncertainty, and approximation.
2. To study the architecture and learning mechanisms of Artificial Neural Networks (ANNs) by exploring models like McCulloch-Pitts neuron, Perceptrons, Adaline, Back-Propagation, Radial Basis Functions, and recurrent models such as Time Delay and Hopfield networks.
3. To provide an in-depth understanding of fuzzy logic and fuzzy systems, including classical vs fuzzy sets, fuzzy relations, membership functions, fuzzification and defuzzification techniques, fuzzy rule-based systems, and approximate reasoning.
4. To introduce the concept and implementation of fuzzy inference systems (FIS) and expert systems based on fuzzy rules for decision-making in uncertain environments.
5. To impart knowledge about Genetic Algorithms (GAs), their biological inspiration, evolutionary mechanisms, and implementation steps like selection, crossover, mutation, schema theorem, and application to optimization problems.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the fundamentals of soft computing and the evolution and models of artificial neural networks	K2
CO2	Implement supervised learning algorithms including Perceptron, Adaline, Backpropagation, RBF, Hopfield, and associative memory networks.	K3
CO3	Apply concepts of fuzzy logic including fuzzy sets, membership functions, fuzzification, and defuzzification techniques.	K3
CO4	Develop fuzzy inference systems, fuzzy reasoning methods, and expert systems for approximate reasoning.	K4
CO5	Apply genetic algorithms with appropriate operators, constraints, and schema theorem for optimization and problem solving.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to Soft computing, Artificial Neural Network: An Introduction, Evolution of Neural Networks, Basic Models of Artificial Neural Network, Important Terminologies of ANNs, McCulloch Pitts Neuron, Linear Separability, Hebb Network.	12
UNIT – 2	Supervised Learning Network, Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons, Back-Propagation Network, Radial Basis Function Network, Time Delay Neural Network, Associative Memory Networks, Hopfield Networks	12
UNIT – 3	Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Tolerance and Equivalence Relations, Noninteractive Fuzzy Sets, Membership Function, Features of the Membership Functions, Fuzzification, Methods of Membership Value Assignments, Methods of Membership Value Assignments, Defuzzification	12
UNIT – 4	Fuzzy Arithmetic and Fuzzy Measures, Measures of Fuzziness, Fuzzy Rule Base and Approximate Reasoning, Fuzzy Propositions, Formation of Rules, Decomposition of Rules (Compound Rules), Aggregation of Fuzzy Rules, Fuzzy Reasoning (Approximate Reasoning), Fuzzy Inference Systems (FIS), Overview of Fuzzy Expert System	12
UNIT – 5	Genetic Algorithm, Introduction, Biological Background, Genetic Algorithm and Search Space, Basic Terminologies in Genetic Algorithm, General Genetic Algorithm, Operators, Stopping Condition for Genetic Algorithm Flow, Constraints, Problem Solving Using Genetic Algorithm, The Schema Theorem, Classification of Genetic Algorithm, Advantages and Limitations of Genetic Algorithm, Applications of Genetic Algorithm.	12
	Total	60

Text Books:

1. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, 3ed, Wiley India. 2. Fakhreddine O. Karray, Clarence W. De Silva, Soft Computing and Intelligent Systems Design: Theory, Tools and Applications, 1e, Pearson.

References:

1. Fundamentals of Neural Networks – LaureneFauseett, Prentice Hall India, New Delhi, 1994. 2. Timothy J. Ross,Fuzzy Logic with Engineering Applications, 3 ed, Wiley India 3. E – Neuro Fuzzy and Soft computing – Jang J.S.R., Sun C.T and Mizutami, Prentice hall New Jersey, 1998

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DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

II Semester	NATURAL LANGUAGE PROCESSING	L	T	P	C
		3	1	0	4

Course Objectives:

1. To understand the fundamental concepts, origins, and challenges of Natural Language Processing (NLP), including statistical and rule-based approaches for language modeling, grammar design, and morphological analysis.
2. To introduce core techniques for lexical and word-level analysis, including tokenization, spelling correction using edit distance, part-of-speech (PoS) tagging, and unsmoothed and smoothed N-gram models.
3. To develop proficiency in syntactic analysis and parsing strategies, such as context-free grammars (CFG), probabilistic CFGs, dependency parsing, and feature structure unification for handling syntactic ambiguity.

Course Outcomes: After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Demonstrate a given text with basic Language features	K3
CO2	Explain a rule based system to tackle morphology/syntax of a language	K2
CO3	To design a tag set to be used for statistical processing for real-time applications	K4
CO4	To compare and contrast the use of different statistical approaches for different types of NLP applications.	K4
CO5	Implement word sense disambiguation techniques and compute word similarity using thesaurus and distributional methods.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**INTRODUCTION:** Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.	12
UNIT – 2	**WORD LEVEL ANALYSIS:** Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part- of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.	12
UNIT – 3	**SYNTACTIC ANALYSIS:** Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures	12
UNIT – 4	**SEMANTICS AND PRAGMATICS**: Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.	12
UNIT – 5	**DISCOURSE ANALYSIS AND LEXICAL RESOURCES:** Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).	12
	Total	60

Text Books:

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, 2ndEdition, Daniel Jurafsky, James H. Martin Pearson Publication,2014.
2. Natural Language Processing with Python, First Edition, Steven Bird, Ewan Klein and Edward Loper, OReilly Media,2009.

Reference Books:

1. Language Processing with Java and Ling Pipe Cookbook, 1stEdition, Breck Baldwin, Atlantic Publisher,2015.
2. Natural Language Processing with Java, 2ndEdition, Richard M Reese, OReilly Media,2015.
3. Handbook of Natural Language Processing, Second, NitinIndurkhya and Fred J. Damerau, Chapman and Hall/CRC Press, 2010.Edition
4. Natural Language Processing and Information Retrieval, 3rdEdition, TanveerSiddiqui, U.S. Tiwary, Oxford University Press,2008.

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

Course Objectives:

1. 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.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Understand the fundamentals of artificial neural networks by analyzing biological neurons, perceptrons, and the concept of linear separability.	K3
CO2	Design and implement feedforward neural networks using multilayer perceptrons and apply backpropagation with appropriate regularization techniques.	K2
CO3	Evaluate and apply advanced optimization techniques and regularization strategies to improve training performance and generalization of deep neural networks.	K4
CO4	Analyze and apply recurrent neural networks (RNNs), Long Short-Term Memory (LSTM), and convolutional neural networks (CNNs) for sequence and image data respectively.	K4
CO5	Explore and implement recent advancements in deep learning including generative models, Variational Autoencoders (VAEs), GANs, and multi-task/multi-view learning paradigms	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

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, autoencoders. **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 (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (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, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning . **Applications:** Vision, NLP, Speech.	12
	Total	60

Text Books:

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Reference Books:

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

II Semester	COMPUTATIONAL INTELLIGENCE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide foundational understanding of Computational Intelligence (CI) by exploring its background, evolution, and distinctions from traditional Artificial Intelligence and hard computing approaches.
2. To introduce behavioral motivations behind fuzzy logic and explore application domains, myths, and philosophical underpinnings of adaptation, self-organization, and generalization in intelligent systems.
3. To review the theoretical foundations and practical applications of evolutionary computation, including genetic algorithms, evolutionary strategies, genetic programming, and swarm optimization techniques.

Course Outcomes: After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Computational Intelligence is the successor to Artificial Intelligence	K2
CO2	Offering special benefits in its applications in certain areas like Classification, Regression, Pattern Matching, Control, Robotics, Data Mining etc.	K2
CO3	To introduce the basic tools and techniques in Computational Intelligence such as Neural Networks and Genetic Algorithms from an application perspective to the students.	K3
CO4	Describe neural network concepts, architectures, adaptation techniques, and their comparison with traditional information processing methods.	K2
CO5	Apply computational intelligence techniques to data mining and evaluate performance using relevant metrics.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	**Introduction:** Background and history of evolutionary computation, Behavioral Motivations for Fuzzy Logic, Myths and Applications areas of Computational Intelligence. Adaption, Self-organization and Evolution, Historical Views of Computational Intelligence, Adaption and Self organization for Computational Intelligence, Ability to Generalize, Computational Intelligence and Soft Computing Vs Artificial Intelligence and Hard Computing.	12
UNIT – 2	**Review of evolutionary computation theory and concepts:** History of Evolutionary Computation, Evolution Computation Overview, Genetic algorithms, Evolutionary programming, Evolution strategies, genetic programming, and particle swarm optimization.	12
UNIT – 3	**Review of basic neural network theory and concepts:** Neural Network History, What Neural Networks are and Why they are useful, Neural Networks Components and Terminology, Neural Networks Topology, Neural Network Adaption, Comparing Neural Networks and Other information Processing Methods, Preprocessing and Post Processing.	12
UNIT – 4	**Fuzzy Systems Concepts and Paradigms:** Fuzzy sets and Fuzzy Logic, Theory of Fuzzy sets, Approximate Reasoning, Fuzzy Systems Implementations, Fuzzy Rule System Implementation.	12
UNIT – 5	**Computational Intelligence Implementations:** Implementation Issues, Fuzzy Evolutionary Fuzzy Rule System Implementation, Best tools, Applying Computational Intelligence to Data Mining. **Performance Metrics:** General Issues, Percent Correct, Average Sum-squared Error.	12
	Total	60

Textbooks:

1. Computational Intelligence - Concepts to Implementations by Eberhart& Shi

References:

1. Introduction to Genetic Algorithms by Melanie Mitchell
2. Handbook of Genetic Algorithms by Davis
3. Machine Learning by Tom Mitchell

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

Course Objectives:

1. To introduce the fundamentals of computer vision, including its origin, applications, and the principles of image formation through geometric and photometric models.
2. To explore key techniques in feature detection and matching, such as feature descriptors, tracking algorithms, and edge/line detection with real-world applications like animation and shape analysis.
3. To develop understanding of image segmentation techniques, including region-based and graph-based approaches like active contours, mean shift, normalized cuts, and their applications in medical imaging.
4. To study geometric alignment and camera calibration methods, including 2D/3D alignment, pose estimation, intrinsic calibration, vanishing points, and distortion handling in vision systems.
5. To examine recognition techniques in computer vision, encompassing object detection, facial recognition, pedestrian detection, and advanced models like Eigenfaces and active appearance models for scene understanding and classification.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Provide an introduction to computer vision including fundamentals of image formation	K2
CO2	Enumerate the concepts of Feature detection and Matching	K2
CO3	Discuss about Image Segmentation Techniques	K3
CO4	Discuss applications of Feature based alignment like pose estimation	K3
CO5	Discuss different recognition techniques.	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Introduction:** What is computer vision, A brief history, Image Formation, Geometric primitives and transformations, Photometric image formation, The digital camera.	12
UNIT – 2	**Feature detection and matching:** Points and patches, Feature detectors, Feature descriptors, Feature matching, Feature tracking, Application: Performance-driven animation, Edges, Application: Edge editing and enhancement, Lines, Application: Rectangle detection.	12
UNIT – 3	**Segmentation:** Active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods, Application: Medical image segmentation.	12
UNIT – 4	**Feature-based alignment:** 2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration, Calibration patterns, Vanishing points, Application: Single view metrology, Rotational motion, Radial distortion.	12
UNIT – 5	**Recognition:** Object detection, Face detection, Pedestrian detection, Face recognition, Eigenfaces, Active appearance and 3D shape models, Application: Personal photo collections, Instance recognition, Category recognition, Context and scene understanding.	12
	Total	60

Textbooks:

1. Richard Szeliski,"Computer Vision: Algorithms and Applications", Springer, 2010. 2. Rafael C. Gonzalez "Digital Image Processing", Pearson Education; Fourth edition (2018)

Reference Books:

1. Forsyth /Ponce, "Computer Vision: A Modern Approach", Pearson Education India; 2nd edition (2015) 2. S.Nagabhushana, "Computer Vision and Image Processing", New Age International Pvt Ltd; First edition (2005)

II Semester	ROBOTICS AND INTELLIGENT SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the fundamental principles of robotics and artificial intelligence, including key differences between classical AI and modern robotics approaches, and their integration into advanced intelligent systems.
2. To provide hands-on exposure to robotic development environments, particularly using Robot Operating System (ROS), Python, and Linux for implementing real-time control systems and decision-making frameworks.
3. To familiarize students with robotic system setup, including the physical assembly, wiring, and configuration of robotic components, understanding robot anatomy, and software-hardware integration for motion and task execution.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	To understand the use of robotics in building intelligent systems.	K2
CO2	Enumerate the fundamentals of robotics and Artificial Intelligence (AI).	K2
CO3	Demonstrate how to setting up a Robot.	K3
CO4	Discuss Object Recognition Using Neural Networks and Supervised Learning	K3
CO5	Implement object recognition using neural networks and supervised learning for robotic vision tasks.	K4
CO6	Develop and train robotic arms using reinforcement learning techniques for task automation and manipulation.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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
CO6	H	M	H	H	H	M

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

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Foundation for Advanced Robotics and AI: The basic principle of robotics and AI, What is AI and what is it not, The example problem, Artificial intelligence and advanced robotics techniques, Introducing the robot and our development environment, Software components (ROS, Python, and Linux), Robot control systems and a decision-making framework, The robot control system – a control loop with soft real-time control	12
UNIT – 2	Setting Up Your Robot: Technical requirements, What is a robot, Robot anatomy, Subsumption architecture, Software setup, Hardware, Assembling the tracks, Mounting the tracks, Arm base assembly, Wiring.	12
UNIT – 3	A Concept for a Practical Robot Design Process, A systems engineering-based approach to robotics, Use cases, The problem –put away the toys, Project goals, Decomposing hardware needs, Breaking down software needs.	12
UNIT – 4	Object Recognition Using Neural Networks and Supervised Learning: Technical requirements, The image recognition process, The image recognition training and deployment process – step by step, The convolution neural network process, Build the toy/not toy detector	12
UNIT – 5	Picking up the Toys: Technical requirements, Task analysis, Summary of robot arm learning process, Teaching the robot arm, Version one – action state reinforcement learning, Adaptive learning rate, Q learning implementation, Google's SAC-X, Amazon Robotics Challenge	12
	Total	60

Text Books:

1. Francis X. Govers, Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques, PACKT
2. J. J. Craig, Introduction to Robotics, Addison Wesley Publishers, 2005

Reference Books:

1. M. Negnevitsky, Artificial Intelligence – A guide to intelligent systems Addison-Wesley, 2005

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

Course Objectives:

1. To introduce the fundamental concepts of reinforcement learning (RL), including agent-environment interaction, reward-based learning, and value-based decision making through real-world examples and case studies like Tic-Tac-Toe.
2. To provide a deep understanding of the Multi-armed Bandit problem, enabling learners to explore action-value estimation techniques, optimistic initialization, gradient methods, and contextual bandits for balancing exploration and exploitation.
3. To explore the formulation and solution of Finite Markov Decision Processes (MDPs) by understanding key components such as rewards, returns, policies, value functions, and the Markov property in both episodic and continuing tasks.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Enumerate the elements of Reinforcement Learning	K2
CO2	Demonstrate how to setting up a Robot.	K3
CO3	Compare different Finite Markov Decision Process	K4
CO4	Discuss about Monte Carlo Methods in solving real world problems	K4
CO5	Discuss about Monte Carlo Methods in solving real world problems	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	**The Reinforcement Learning Problem:** Reinforcement Learning, Examples, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe, Summary, History of Reinforcement Learning.	12
UNIT – 2	**Multi-arm Bandits:** An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandits, Associative Search (Contextual Bandits)	12
UNIT – 3	**Finite Markov Decision Processes:** The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation.	12
UNIT – 4	**Monte Carlo Methods:** Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns	12
UNIT – 5	**Applications and Case Studies:** TD-Gammon, Samuel's Checkers Player, The Acrobot, Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling.	12
	Total	60

Text Books:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning-An Introduction",2ndEdition,The MIT Press,2018 2. Marco Wiering , Martijn van Otterlo Reinforcement Learning: State-of-the-Art (Adaptation, Learning, and Optimization (12)) 2012th Edition

Reference Books:

1. Vincent François-Lavet, Peter Henderson , Riashat Islam, An Introduction to Deep Reinforcement Learning (Foundations and Trends(r) in Machine Learning) , 2019.

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

Course Objectives:

1. To understand the role of chatbots in modern businesses by exploring industry-specific applications, including finance and insurance, with a customer-centric focus that enhances user engagement and service automation.
2. To explore data-driven chatbot design and training methodologies, focusing on sourcing, annotating, and using conversational datasets while ensuring compliance with data protection regulations such as the GDPR.
3. To learn the fundamentals of Finite Markov Decision Processes (MDPs) and their application in dialog management systems through reinforcement learning techniques, value function estimation, and optimal policy derivation.
4. To develop a deep understanding of natural language technologies, including Natural Language Processing (NLP), Understanding (NLU), and Generation (NLG), and their integration into chatbot architecture using modern open-source tools.

Course Outcomes After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Learn how artificial intelligence powers chatbots, get an overview of the bot ecosystem and bot anatomy, and study different types of bots and use cases.	K2
CO2	Identify best practices for defining a chatbot use case, and use a rapid prototyping framework to develop a use case for a personalized chatbot. Course Outcomes:	K3
CO3	Develop an in-depth understanding of conversation design, including onboarding, flows, utterances, entities, and personality.	K4
CO4	Design, build, test, and iterate a fully-functional, interactive chatbot using a commercial platform.	K4
CO5	Deploy the finished chatbot for public use and interaction.	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
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)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	**Introduction:** Benefits from Chatbots for a Business, A Customer-Centric Approach in Financial Services, Chatbots in the Insurance Industry, Conversational Chatbot Landscape, Identifying the Sources of Data: Chatbot Conversations, Training Chatbots for Conversations, Personal Data in Chatbots, Introduction to the General Data Protection Regulation (GDPR).	12
UNIT – 2	**Foundations of Chatbot Design & AI Principles:** Rule-Based vs. AI-Based, Machine Learning Basics for Chatbots: Supervised, Unsupervised, Reinforcement Learning, Dialogue Management: State Tracking, Context Handling, Intent Recognition & Entity Extraction, Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, Ethical & Responsible AI in Chatbots: Bias, Transparency, Fairness, Case Studies: University Admission Chatbots, E-Commerce Assistants.	
UNIT – 3	**Finite Markov Decision Processes:** The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation.	12
UNIT – 4	**Natural Language Processing, Understanding, and Generation:** Chatbot Architecture, Popular Open Source NLP and NLU Tools, Natural Language Processing, Natural Language Understanding, Natural Language Generation, Applications.	12
UNIT – 5	**Introduction to Microsoft Bot, RASA, and Google Dialog flow:** Microsoft Bot Framework, Introduction to QnA Maker, Introduction to LUIS, Introduction to RASA, RASA Core, RASA NLU, Introduction to Dialog flow Chatbot Integration Mechanism: Integration with Third-Party APIs, Connecting to an Enterprise Data Store, Integration Module .	12
	Total	60

Text Books:

1. Abhishek Singh, Karthik Ramasubramanian, ShreyShivam, “Building an Enterprise Chatbot: Work with Protected Enterprise Data Using Open Source Frameworks”, ISBN 978-1-4842-5034 1, Apress,2019.

References:

1. Janarthanam and Srini, Hands-on chatbots and conversational UI development: Build chatbots and voice user interfaces with C (1 ed.), Packt Publishing Ltd, 2017. ISBN 978-1788294669.
2. Galitsky, Boris., Developing Enterprise Chatbots (1 ed.), Springer International Publishing, 2019. ISBN 978-303004298
3. Kelly III, John E. and Steve Hamm, Smart machines: IBM's Watson and the era of cognitive computing (1 ed.), Columbia University Press, 2013. ISBN 978- 0231168564.
4. Abhishek Singh, Karthik Ramasubramanian and ShreyShivam, Building an Enterprise Chatbot (1 ed.), Springer, 2019. ISBN 978-1484250334.

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

Course Objectives:

1. To familiarize students with foundational machine learning algorithms by implementing core techniques such as PCA, SVD, decision trees, k-NN, and Naïve Bayes from scratch and using appropriate libraries.
2. To develop students' practical understanding of supervised and unsupervised learning paradigms through hands-on experience with classification (e.g., ID3, k-NN, Naïve Bayes), clustering (e.g., k-Means, EM), and hypothesis learning (Find-S, Candidate Elimination).
3. To enable students to work with real-world datasets by loading, preprocessing, and extracting patterns from structured data stored in CSV format, and evaluating model accuracy, precision, and recall.
4. To train students in building and testing neural networks using the backpropagation algorithm for predictive modeling tasks.
5. To provide experience in implementing probabilistic models such as Bayesian networks for decision-making and diagnosis in domains like healthcare.

Course Outcomes Upon successful completion of the course, the student will be able to:

		Knowledge Level (K)#
CO1	Implement machine learning algorithms to real-world problems	K3
CO2	Choose appropriate machine learning algorithm for a problem	K3
CO3	Interpret the results of two different machine learning algorithms	K4
CO4	Develop and evaluate decision tree models using the ID3 algorithm for classification tasks.	K4
CO5	Implement and test Naïve Bayes classifiers for structured and unstructured data with performance evaluation	K4

#Based on suggested Revised BTL

Mapping of course outcomes 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)

	List of Experiments
EXP-1	Implement **Principal Component Analysis (PCA) and Singular Value Decomposition (SVD)**using NumPy.
EXP-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.
EXP-3	For a given set of training data examples stored in a .CSV file, implement and demonstrate the **Candidate-Elimination algorithm** to output a description of the set of all hypotheses consistent with the training examples.
EXP-4	Write a program to demonstrate the working of the decision tree based **ID3 algorithm.** Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
EXP-5	Build an Artificial Neural Network by implementing the **Back propagation algorithm** and test the same using appropriate data sets.
EXP-6	Write a program to implement the **naïve Bayesian classifier** for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
EXP-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.
EXP-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.
EXP-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.
EXP-10	Write a program to implement **k-Nearest Neighbor algorithm** to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem
EXP-11	Implement the non-parametric **Locally Weighted Regression algorithm** in order to fit data points. Select appropriate data set for your experiment and draw graphs.
EXP-12	Create the following **plots** using Matplotlib, Pandas Visualization, Seaborn on iris dataset, wine reviews datasets. a) Scatter Plot b) Line chart

	c) Histogram d) Heatmap.

Textbooks

1. **Tom M. Mitchell** – *Machine Learning*, McGraw-Hill, 1997.
2. **Ethem Alpaydin** – *Introduction to Machine Learning*, 4th Edition, MIT Press, 2020.
3. **Christopher M. Bishop** – *Pattern Recognition and Machine Learning*, Springer, 2006.

Reference Books

1. **Kevin P. Murphy** – *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
2. **Trevor Hastie, Robert Tibshirani, Jerome Friedman** – *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2nd Edition, Springer, 2009.
3. **Ian Goodfellow, Yoshua Bengio, Aaron Courville** – *Deep Learning*, MIT Press, 2016.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE (AI) COURSE STRUCTURE AND SYLLABUS

II Semester	SOFT COMPUTING LAB	L	T	P	C
		0	1	2	2

Course Objectives:

1. To impart foundational understanding of neural networks through implementation of perceptrons, Hebb's rule, Delta rule, and simple Artificial Neural Networks with and without backpropagation.
2. To enable practical exploration of fuzzy logic systems by implementing fuzzy set operations (union, intersection, complement, difference), fuzzy relations (Cartesian product), and composition methods such as max-min.
3. To apply genetic algorithms to optimization problems such as the Travelling Salesman Problem (TSP) and demonstrate the use of evolutionary computation for real-world problem-solving.
4. To analyze and visualize statistical properties of datasets using correlation plots, ANOVA, and regression analysis for both simple and multivariate cases.

Course Outcomes Upon successful completion of the course, the student will be able to:

		Knowledge Level (K)#
CO1	Implement and train perceptron's using fixed increment learning algorithms to determine optimal weights.	K3
CO2	Develop artificial neural networks with and without backpropagation for predictive modeling.	K4
CO3	Perform fuzzy set operations, create fuzzy relations, and execute max-min composition for relational analysis.	K3
CO4	Solve optimization problems like the Traveling Salesperson Problem using genetic algorithms.	K4
CO5	Perform SVM classification enhanced by fuzzy logic concepts.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	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)

	List of Experiments
EXP-1	1. Create a perceptron with appropriate number of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weights.
EXP-2	2. Write a program to implement artificial neural network without back propagation. Write a program to implement artificial neural network with back propagation.
EXP-3	3. Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
EXP-4	4. Implement travelling sales person problem (tsp) using genetic algorithms.
EXP-5	5. Plot the correlation plot on dataset and visualize giving an overview of relationships among data on soya bins data. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.
EXP-6	6. Implement linear regression and multi-regression for a set of data points
EXP-7	7. Implement crisp partitions for real-life iris dataset
EXP-8	8. Write a program to implement Hebb's rule Write a program to implement Delta rule.
EXP-9	9. Write a program to implement logic gates.
EXP-10	10. Implement SVM classification by fuzzy concepts.
EXP-11	11. Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
EXP-12	12. Build a Convolution Neural Network for simple image (dogs and Cats) Classification

Textbooks

1. S. N. Sivanandam, S. N. Deepa – Principles of Soft Computing, Wiley India, 2nd Edition, 2011.
2. Laurene Fausett – Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson, 1994.
3. David E. Goldberg – Genetic Algorithms in Search, Optimization and Machine Learning, Pearson, 1989.

Reference Books

1. Simon Haykin – Neural Networks and Learning Machines, 3rd Edition, Pearson, 2009.
2. George J. Klir, Bo Yuan – Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning, MIT Press, 2016.

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

Course Outcomes: On completion of this course, the student will be able to:

		Knowledge Level (K)#
CO1	Identify and formulate research problems, design investigative approaches, and apply appropriate data collection and analysis methods.	K3,K4
CO2	Conduct effective literature reviews, maintain research ethics, and prepare structured technical reports and research proposals.	K2,K6
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

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

REFERENCES:

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 & Francis Ltd ,2007.
5. Mayall, “Industrial Design”, McGraw Hill, 1992.
6. Niebel, “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in NewTechnological Age”, 2016.T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.