Curriculum and Syllabus
(Applicable to students admitted during AY 2024–25)

M. Tech-CSE –(Artificial Intelligence & Machine Learning)

M.Tech-CSE-Curriculum in Artificial Intelligence & Machine Learning-2024-2025

Semester-I										
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Total**	**Minor Test**	**Major Test**	**Credit**	**Duration of Exam (Hrs.)**
1	MAT560	Mathematical Foundations for Machine Learning	3	-	-	3	40	60	3	3
2	AML500	Advanced Algorithms and Analysis	3	-	-	3	40	60	3	3
3	AML501	Machine Learning Techniques	3	-	-	3	40	60	3	3
4	AML501L	Machine Learning Techniques Lab	-	-	4	4	40	60	2	3
5	AML502	Artificial Intelligence and Knowledge Representation	3	-	0	3	40	60	3	3
6	AML502L	Artificial Intelligence and Knowledge Representation Lab	-	-	4	4	40	60	2	3
7		Elective-I	3	-	0	3	40	60	3	3
8		Audit Course-I	2	-	0	2	100	-	2	-
		Total	17		8	25	380	420	21	

Semester-II										
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	Total	Minor Test	Major Test	**Credit**	**Duration of Exam (Hrs.)**
1	MAT561	Optimization Techniques	3	-	-	3	40	60	3	3
2	AML504	Data Warehousing and Pattern Mining	3	-	0	3	40	60	3	3
3	AML504L	Data Warehousing and Pattern Mining Lab	0	-	4	4	40	60	2	3
4	AML505	Deep Learning Techniques	3	-	-	3	40	60	3	3
5	AML505L	Deep Learning Techniques Lab	0	-	4	4	40	60	2	3
6	AML506	Natural Language Computing	3	-	-	3	40	60	3	3
7		Elective-II	3	-	-	3	40	60	3	3
8	RM101	Research Methodology and IPR	2	-	-	2	40	60	2	3
9		Audit Course-II	2	-	-	2	100	-	-	-
		Total	19	-	8	27	420	480	21	

Semester-III										
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	Total	Minor Test	Major Test	**Credit**	**Duration of Exam (Hrs.)**
1		Open Elective	3	-	-	3	40	60	3	3
2		Elective – III	3	-	-	3	40	60	3	3
3	AML580	Project Work-Phase I	-	-	20	20	100	-	10	3
		Total	6	-	20	26	180	120	16	

Semester-IV										
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	Total	Miner Test	Major Test	Credit	**Duration of Exam (Hrs.)**
1	AML581	Project Work-Phase II	-	-	32	32	100	200	16	-
						Total	100	200	16	

Total Credit -74

Program Elective-I					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
AML551	Modeling and Simulation of Digital Systems	3	0	0	3
AML552	Knowledge Engineering and Expert Systems	3	0	0	3
AML553	Information Retrieval	3	0	0	3

Program Elective-II					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
AML554	Pattern recognition	3	0	0	3
AML555	Problem Solving Methods in Artificial Intelligence	3	0	0	3
AML556	Cognitive system	3	0	0	3

Program Elective-III					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
AML557	Introduction to High Performance Computing	3	0	0	3
AML558	Computer Vision	3	0	0	3
AML559	Number theory and Cryptography	3	0	0	3

Open Elective					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
AML560	Agent Systems	3	0	0	3
AML561	Artificial Intelligence and Neural Networks	3	0	0	3
AML562	Statistical Modeling for Computer Sciences	3	0	0	3
AML563	Fuzzy Logic and its Applications	3	0	0	3
AML564	Electronic Design Automation	3	0	0	3

Audit Courses-I	
Course No.	**Subject**
MTAD-101	English for Research Paper Writing
MTAD-103	Disaster Management

Audit Course-II	
Subject	
MTAD-105	Sanskrit for Technical Knowledge
MTAD-107	Value Education

SEMESTER-I

Course Code	Course Name	Course Category	Credits							
			L	T	P	Cr	Major Test	Minor Test	Total	Time (Hrs.)
MAT560	Mathematical Foundations for Machine Learning	BS	3	0	0	3	60	40	100	3
Purpose	To familiarize the students with Mathematical Foundations for Machine Learning									
Course Outcomes(CO)										
CO1	Learn about the rules of probability.									
CO2	Learn about Discrete, Continuous and mixed random variable.									
CO3	Learn about stochastic Processes.									
CO4	Learn about "Linear Algebra".									

UNIT I

Classical, relative frequency, and axiomatic definitions of probability; addition rule and conditional probability; multiplication rule; total probability; Bayes' Theorem and independence.

UNIT II

Discrete, continuous, and mixed random variables; probability mass, probability density, and cumulative distribution functions; mathematical expectation; moments; moment generating function; Chebyshev's inequality.

UNIT III

Introduction to Stochastic Processes (SPs), Stationary Processes, Discrete-time Markov Chains (DTMCs), Continuous-time Markov Chains (CTMCs).

UNIT IV

Finite dimensional vector spaces over a field; linear combination, linear dependence and independence; basis and dimension; inner-product spaces, linear transformations; matrix representation of linear transformations. Eigenvalues and eigenvectors, rank and nullity, inverse and linear transformation, Cayley-Hamilton Theorem.

REFERENCES BOOKS :

1. Sheldon Ross, *A First Course in Probability*, 7th Edition, Pearson, 2006
2. J. Medhi, *Stochastic Processes*, 3rd Edition, New Age International, 2009
3. S. M. Ross, *Stochastic Processes*, 2nd Edition, Wiley, 1996
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Edition, Pearson, 2006
5. Kenneth M. Hoffman, Ray Kunz, *Linear Algebra*, 2nd Edition, Pearson

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

SEMESTER-I

Course Code	Course Name	Course Category	Credits							
			L	T	P	Cr	Major Test	Minor Test	Total	Time (Hrs.)
AML500	Advanced Algorithms and Analysis	C	3	0	0	3	60	40	100	3
Purpose	To impart advanced algorithms and analysis knowledge to students									
Course Outcomes(CO)										
CO1	Introduction about techniques of Algorithm.									
CO2	Learn about important NP completeness of problems.									
CO3	Know about the Use of probabilistic inequalities in analysis and methods.									
CO4	Learn about Geometric Algorithm & Evaluation of approximation methods.									

UNIT I

Defining Key Terms: Algorithm complexity, Greedy method, Dynamic Programming, Back tracking, Branch-and-bound Techniques; Examples for understanding above techniques; Memory model, linked lists and basic programming skills.

UNIT II

Overview-Class P-Class NP-NP Hardness-NP Completeness-Cook Levine Theorem-Important NPComplete Problems. Heuristic and Randomized algorithms.

UNIT III

Use of probabilistic inequalities in analysis, Amortized Analysis - Aggregate Method – Accounting Method-Potential Method, competitive analysis, applications using examples.

UNIT IV

Point location, Convex hulls and Voronoi diagrams, Arrangements, graph connectivity, Network Flow and Matching: Flow Algorithms - Maximum Flow – Cuts - Maximum Bipartite Matching – Graph partitioning via multi-commodity flow, Karger's Min Cut Algorithm, String matching and document processing algorithms. Approximation algorithms for known NP-hard problems - Analysis of Approximation Algorithms - Use of Linear programming and primal dual; local search heuristics; Parallel algorithms: Basic techniques for sorting, searching, merging, list ranking in PRAMs and Interconnection.

REFERENCES BOOKS :

1. Allan Borodin and Ran El-Yaniv: *Online Computation and Competitive Analysis*, Cambridge University Press, 2005.
2. Michael T. Goodrich and Roberto Tamassia: *Algorithm Design: Foundations, Analysis and Internet Examples*, John Wiley and Sons, 2002.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein: *Introduction to Algorithms*, Third Edition, The MIT Press, 2009.
4. Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani: *Algorithms*, Tata McGraw-Hill, 2009.
5. R. K. Ahuja, T. L. Magnanti, and J. B. Orlin: *Network Flows: Theory, Algorithms, and Applications*, Prentice Hall, Englewood Cliffs, NJ, 1993.
6. Joseph JáJá: *Introduction to Parallel Algorithms*, 1992.
7. Rajeev Motwani and Prabhakar Raghavan: *Randomized Algorithms*, Cambridge University Press, 1995.
8. Jiri Matousek and Bernd Gärtner: *Understanding and Using Linear Programming*, 2006.

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SEMESTER-I

Course Code	Course Name	Course Category	Credits							
			L	T	P	Cr.	Major Test	Minor Test	Total	Time (Hrs.)
AML501	Machine Learning Techniques	C	3	0	0	3	60	40	100	3
Purpose	To enhance the knowledge to students about basics of Machine Learning									

Course Outcomes (CO)

CO1	Introduction of Machine Learning and different types learning
CO2	Learn about tree learning and basic decision tree Algorithm.
CO3	Learn about Probability and Bayes
CO4	Introduction about Artificial Neural Networks & Talk about the k-mean clustering Python exercise.

UNIT I

Introduction: Introduction to Machine Learning: Introduction. Different types of learning, Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance.

Linear Regression: Introduction, Linear regression, Simple and Multiple Linear regression, Polynomial regression, evaluating regression fit.

UNIT II

Decision tree learning: Introduction, Decision tree representation, appropriate problems for decision tree learning, the basic decision tree algorithm, hypothesis space search in decision tree learning, inductive bias in decision tree learning, issues in decision tree learning, Python exercise on Decision Tree.

Instance based Learning: K nearest neighbor, the Curse of Dimensionality, Feature Selection: forward search, backward search, uni variate, multi variate features election approach, Featurer eduction (Principal Component Analysis) , Python exerciseon kNN and PCA.

Recommender System: Content based system, Collaborative filtering based.

UNIT III

Probability and Bayes Learning: Bayesian Learning, Naïve Bayes, Python exercise on Naïve Bayes, Logistic Regression. Support Vector Machine: Introduction, the Dual formulation, Maximum margin with noise, non linear SVM and Kernel function, solution to dual problem.

UNIT IV

Artificial Neural Networks: Introduction, Biological motivation, ANN representation, appropriate problem for ANN learning, Perceptron, multilayer network sand the back propagation algorithm,

Ensembles: Introduction, Bagging and boosting, Random forest, Discussion on some research papers. Clustering: Introduction, K-mean clustering, agglomerative hierarchical clustering, Python exercise on k-mean clustering.

TEXT BOOKS :

Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.Alpaydin,
Ethem. Introduction to machine learning. MIT press, 2020.

REFERENCES BOOKS :

KevinP.Murphy, “Machine Learning: A probabilistic Perspective”, MIT Press, 2012. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.

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SEMESTER-I

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML501L	Machine Learning Techniques Lab	C	0	0	4	2	40	60	100	3
Purpose	Students will acquire basic concept of Machine Learning									
Course Outcomes (CO)										
CO1	Students will learn about Basic of Python Machine Learning									
CO2	Students will learn about Basic of Pandas and Matplotlib									
CO3	Students will able to implement k-Nearest Neighbour algorithm									
CO4	Students will understand the implement of ADALINE and MADALINE									

LIST OF PROGRAMS:

1. Basic exercises on Python Machine Learning Packages such as Numpy, Pandas and mat plot lib.
2. Given a dataset. Write a program to compute the Covariance, Correlation between a pair of attributes. Extend the program to compute the Covariance Matrix and Correlation Matrix.
3. Given a set of sample points in N dimensional feature space. Write a program to fit the points with a hyper plane using Linear Regression. Calculate sum of residual error.
4. Write a program that provides option to compute different distance measures between two points in the N dimensional feature space. Consider some sample datasets for computing distances among sample points.
5. 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.
6. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.
7. Write a program to implement featurer eduction using Principle Component Analysis
8. Write a program to implement the naïve Bayesian classifier for a sample training data set stored asa.CSV file. Compute the accuracy of the classifier, considering few test data sets.
9. Given a data set for classification task. Write a program to implement Support Vector Machine and estimate it test performance.
10. Write a program to implement perceptron for different learning task.
11. Write programs to implement ADALINE and MADALINE for given learning task.
12. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
13. Write a program to implement K means clustering algorithm. Select your own data set to test the program. Demonstrate the nature of output with varying value of K.

SEMESTER-I

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML502	Artificial Intelligence and Knowledge Representation	C	3	0	0	3	40	60	100	3
Purpose	To learn about the Artificial Intelligence and Knowledge Representation									
Course Outcomes (CO)										
CO1	The students will able to find salient features of Artificial Intelligence and Knowledge Representation									
CO2	Learn about the multiplayer games and Evaluation Functions.									
CO3	To collect the knowledge about representing facts, logic and resolution.									
CO4	Learn about the Connectionist Models & Familiarize with Domain Knowledge, Reasoning with knowledge.									

UNIT I

Introduction: AI problems, foundation of AI and history of AI intelligent agents: Agent sand Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

UNIT II

Searching: Searching for solutions, uninformed search strategies – Breadth first search, depth first search. Search with partial information (Heuristic search) Greedy best first search, A* search.

Game Playing: Adversarial search, Games, minimax algorithm, optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search.

UNIT III

Knowledge Representation**:** Using Predicate logic, representing factsin logic, functions and predicates, Conversion to clause form, Resolution in propositional logic, Resolution in predicate logic, Unification.

Representing Knowledge Using Rules**:** Procedural Versus Declarative knowledge, Logic Programming, Forward versus Backward Reasoning

UNIT IV

Learning: What is learning, Rote learning, Learning by Taking Advice, Learning in Problem-solving, Learning from example: induction, Explanation-based learning.

Connectionist Models: Hopfield Networks, Learning in Neural Networks, Applications of Neural Networks, Recurrent Networks. Connectionist AI and Symbolic AI.

Expert System: Representing and using Domain Knowledge, Reasoning with knowledge, Expert System Shells, Support for explanation examples, Knowledge acquisition – examples.

REFERENCES BOOKS :

1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russell, Peter Norvig, PHI/Pearson Education.
2. Artificial Intelligence, Kevin Knight, Elaine Rich, B. Shivashankar Nair, 3rd Edition, 2008.
3. Artificial Neural Networks, B. Yagna Narayana, PHI.
4. Artificial Intelligence, 2nd Edition, E. Rich and K. Knight (TMH).
5. Artificial Intelligence and Expert Systems – Patterson, PHI.
6. Expert Systems: Principles and Programming – Fourth Edn, Giarrantana/Riley, Thomson.
7. PROLOG Programming for Artificial Intelligence, Ivan Bratka – Third Edition, Pearson Education.
8. Neural Networks, Simon Haykin, PHI.
9. Artificial Intelligence, 3rd Edition, Patrick Henry Winston, Pearson Edition.

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SEMESTER-I

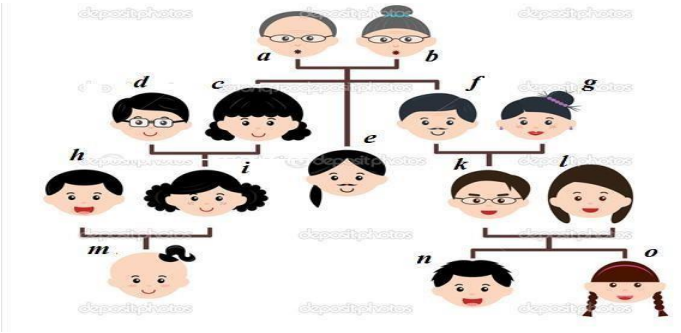
Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML502L	Artificial Intelligence and Knowledge Representation Lab	C	0	0	4	2	40	60	100	3
Purpose	To collect the knowledge Family Tree, eight queen problem and diagnosis system.									
CO1	Discover the real facts and reasoning by learning the AI technologies									
CO2	Learn about the Factorial, Fibonacci Series									
CO3	Learn about the Medical Diagnosis Expert System									
CO4	Learn about eight queen and towers of Hanoi problems									

LIST OF PROGRAMS:

1. Family Tree
2. Factorial, Fibonacci Series and Prime Number Checking
3. Lists
4. Eight Queens Problem
5. Towers of Hanoi Problem
6. Medical Diagnosis Expert System

LAB EXERCISE 1

Create a SWI Prolog program to represent the family tree shown in below diagram.



The topmost, nodes are parents and bottom most nodes are children nodes. Nodes in the middle are parent or child or both. All children have two arrows going to its parents.

Create the least number of relations that enables to answer the following questions related to the following relations viz. Grandfather, Grandmother, Father, Mother, Son, Daughter, Uncle (Father or Mother's brother), Aunt (Father or Mother's sister), Husband, Wife, Brother, Sister, nephew (brother or sister's son),niece (brother and sister's daughter), cousin(male or female), grandson, grand daughter etc. Questions can be like 1) who is ***n's*** grandmother or what is the relation between ***a*** and ***b***? Show your program works by answering at least 20 relation queries that cover all the relation smentioned above.

LAB EXERCISE 2

Q1.Find whether a number N is prime or not

Q2.Find factorial of a number N.

Q3.Find N^{th} term of Fibonacci series.

Q4.Translate the following text in to Prolog Logic to answer the queries:

Problem: A ,B and C belong to the Himalayan club. Every member in the club is either a mountain climber or askier or both. A likes what ever B dislikes and dislikes whatever B likes. A likes rain and snow. No mountain climber likes rain. Every skier likes snow.

Query1: Is the reamember who is amount a in climber and no taskier?

Query2: Is the reamember who is both a mountain climber and askier?

Query3: Is the reamember who likes both rain and snow

LAB EXERCISE 3

Lists are important in Prolog. You will of ten need to pattern match against lists. Create aprolog file named Lab3_ List_exercise.pl and create the following knowledge base.

Write rules for:

Is a_list/1% argument is a list /2% an element is a member of a list non member_of/ 2% an element is not a member of a list length_of_list/2%length of list bigger_than_one/1% the list has more than one element same_head/2% two lists have the same head regard less of their length prefix/2 % first list is the prefix of the second list all different/1% using non member_of/2 check whether the elements of a list are all different append_list/3% append an element to a list to make a new list insert_at/4 % insert an element to a specified position of a list to make a new list merge_lists/3% merge two lists to make a new list

LAB EXERCISE 4

Eight queens problem is a constraint satisfaction problem (CSP). The task is to place eight queensinthe 64 available squares in such a way that no queen attacks each other. So the problem can beformulated with variables x1, x2, x3, x4, x5, x6, x7, x8 and y1, y2, y3, y4, y5, y6, y7, y8; where thexsrepresenttherowsandysthecolumns.Nowasolutionforthisproblemistoassignvaluesforxandforysuchthattheconstraintissatisfied.Theproblemcanbeformulatedas:P={(x1,y1),(x2,y2),…
..... (x8,y8)}where(x1,y1)gives the position of the first queen And (x2,y2) of the second queen and soon. So,itcanbeclearlyseenthatthedomainsforxiandyiareDx = {1,2,3,4,5,6,7,8} and Dy = {1,2,3,4,5,6,7,8} respectively. And the constraints are: i. No twoqueensshouldbeinthesamerow,i.eyi≠yjfori=1to8;j=1to8;ori≠jii.Notwoqueensshouldbeinthesamecolumn,i.exi≠xjfori=1to8;j=1to8;ori≠jiii.Thereshouldnotbetwoqueensplacedonthesame diagonal line i.e (yi-yj) ≠ ±(xi-xj). Write the required predicates tosolve the Eight Queensplacementproblem.

LAB EXERCISE 5

The Tower of Hanoi puzzle was invented by the French mathematician Édouard Lucas in 1883. He was inspired by a legend that tells of a Hindu temple where the puzzle was presented to young priests. At the beginning of time, the priests were given three poles and a stack of 64 gold disks, each disk a little smaller than the one beneath it. Their assignment was to transfer all 64 disks from one of the three poles to another, with two important constraints. They could only move one disk at a time, and they could never place a larger disk on top of a smaller one.

The priests worked very efficiently, day and night, moving one disk every second. When they finished their work, the legend said, the temple would crumble into dust and the world would vanish. Although the legend is interesting, you need not worry about the world ending any time soon. The number of moves required to correctly solve the Tower of Hanoi puzzle of 64 disks is 264−1=18,446,744,073,709,551,615264−1=18,446,744,073,709,551,615,263.

At a rate of one move per second, that is 584,942,417,355 years! Clearly, there is more to this puzzle than meets the eye. Figure 1 shows an example of a configuration of disks in the middle of a move from the first peg to the third. Notice that, as the rules specify, the disks on each peg are stacked so that smaller disks are always on top of the larger disks. If you have not tried to solve this puzzle before, you should try it now. You do not need fancy disks and poles – a pile of books or pieces of paper will work.

Write a Prolog program that efficiently keeps track of the disk movements and that helps in recursively solving the problem of Tower of Hanoi.

LAB EXERCISE 6

Expert systems are computer applications which embody some non-algorithmic expertise for solving certain types of problems. For example, expert systems are used in diagnostic applications servicing both people and machinery. They also play chess, make financial planning decisions, configure computers, monitor real-time systems, underwrite insurance policies, and perform many other services which previously required human expertise.

This Lab exercise is for Medical Diagnostic Expert system design which will hypothesis the name of the disease by learning the symptoms the patient have. The table below shows the expert knowledge about symptoms and name of the disease. A prolog program will represent this expert knowledge in terms of rules in its knowledge base.

Disease	**Symptoms**
Measles	cough, sneezing, runny_nose.
German measles	Fever,headache,runny_nose,rash
Common cold	headache, sneezing, sore_throat, runny_nose, chills.
Flu	Fever,headache,body_ache,conjunctivitis,chills,sorethroat.Runnynose,cough
Mumps	fever, swollen_glands.
Chickenpox	Fever,chills,body acherash

An expert system has several components as shown in the below figure. Other than the knowledge base, other main components are user interface, working storage, and the inference engine.

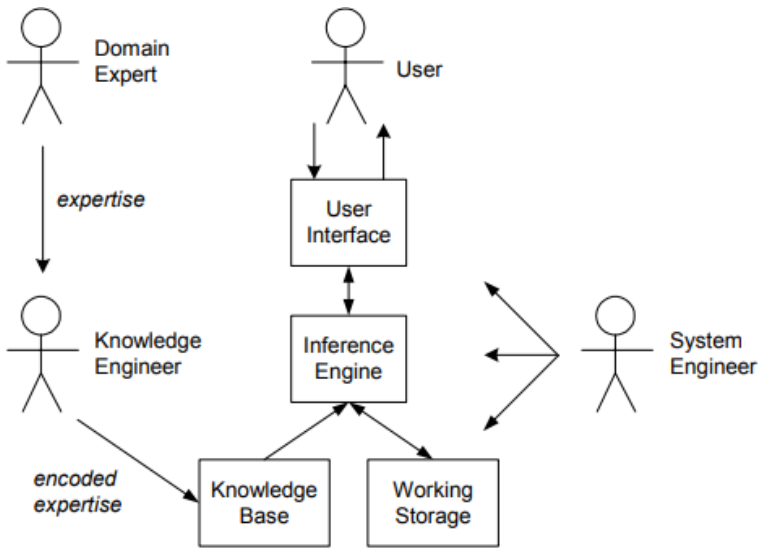


Figure 1.1 Expert system components and human interfaces

Prolog's inference engine is goal driven reasoning or backward chaining – an inference technique which uses IF-THEN rules to repetitively break a goal into smaller sub-goals, which are easier to prove. For example, to hypothesize that a patient has a particular disease, the patient should have all the symptoms of that disease as mentioned in the table.

The expert system can be dramatically improved by providing a user interface which prompts for symptom information from the patient when needed. Write a `ask/2` predicate which asks the patient about the symptoms he has to diagnose a disease. Store all this information gathered from the patient in the working storage one by one. Choose an appropriate data representation as attribute-value pair like `symptom(Patient, german_measles)` etc. As some symptoms are common in more than one disease, the same question should not be asked twice to the patient to diagnose a second disease.

Use Prolog's in-built predicate `assert/1` to put information in the working storage. Also, as your program will be run several times in the same session, make sure to flush the working storage before the next query. You can use Prolog's in-built predicate `retract/2` at the beginning of each query.

Attach a screenshot about how the program runs with various patient input and predicted disease output.

SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
MAT561	Optimization Techniques	BS	3	0	0	3	40	60	100	3
Purpose	To introduction about the Optimization Techniques									
Course Outcomes (CO)										
CO1	Learn about Optimization techniques –classical and advanced techniques									
CO2	To understand different optimization method									
CO3	Learn about the Transportation and MODI Method.									
CO4	Learn about the principle of optimality and Discrete versus continuous dynamic programming									

UNIT I

Historical Development; Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems. Classification of optimization problems, Optimization techniques – classical and advanced techniques,

Introduction to Operation Research: Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.

UNIT II

Linear Programming (LP): Introduction to LP and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.

UNIT III

Allocation problems and Game Theory: Introduction to Transportation problems, Transportation problem – Methods of basic feasible solution – Optimal solution – MODI Method.

Assignment problem – Hungarian method.

Game theory: Two people – zero sum game – mixed strategies – Dominance properties.

UNIT IV

Sequential optimization; Representation of multi-stage decision process; Types of multi-stage decision problems; Concept of sub optimization and the principle of optimality. Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming (DP), Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP; Problem formulation and application in Design of continuous beam and optimal geometric layout of a truss.

Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time-cost tradeoff, introduction to resource smoothing and allocation.

Sequencing: Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines.

Inventory Model: Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

REFERENCES BOOKS :

1. Hamdy A. Taha, *Operations Research*, Prentice Hall, Pearson.
2. J.S. Arora, *Introduction to Optimum Design*, 2nd Edition, Elsevier India Pvt. Ltd.
3. S.S. Rao, *Optimization: Theory and Application*, Wiley Eastern Ltd., New Delhi.
4. Wayne L. Winston, *Operations Research: Applications and Algorithms*, Duxbury Press, 2003.
5. Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, *Network Flows: Theory, Algorithms, and Applications*, Pearson.
6. J.K. Sharma, *Operations Research: Theory and Applications*, Macmillan India Ltd.
7. N.D. Vohra, *Quantitative Techniques in Management*, Tata McGraw Hill.
8. Payne T.A., *Quantitative Techniques for Management: A Practical Approach*, Reston Publishing Co. Inc., Virginia.
9. Achille Messac, *Optimization in Practice with MATLAB*, Cambridge University Press, 2015.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML504	Data Warehousing and Pattern Mining	C	3	0	0	3	40	60	100	3
Purpose	To gain knowledge in pattern mining and data warehousing									
Course Outcomes (CO)										
CO1	To learn more about data warehouse models, data warehouse principles, and data cubes									
CO2	Learn about the Partitioning methods, Hierarchical Methods									
CO3	Learn about the Methodologies for stream data processing and stream data systems									
CO4	Learn about the Web Mining and Distributed Data Mining									

UNIT I

Data warehouse concepts, Data warehouse modeling, Data Cube and OLAP, schemas for multidimensional data models, concept hierarchy, measures, and indexing techniques. Data warehouse – design and usage, implementation, architectural components, Role of Metadata, Dimensional Modeling, Data Extraction, Transformation and Loading, Data Quality.

UNIT II

Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns.

Mining Time series Data, Periodicity Analysis for time-related sequence data, Trend analysis, and Similarity search in Time-series analysis.

UNIT III

Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams.

UNIT IV

Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

Recent trends in Distributed Warehousing and Pattern Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis.

REFERENCES BOOKS :

1. Jiawei Han and M. Kamber, *Data Mining: Concepts and Techniques*, Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, *Introduction to Data Mining* - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. G. Dong and J. Pei, *Sequence Data Mining*, Springer, 2007.
4. Ralph Kimball, Margy Ross, *The Data Warehouse Toolkit*, 3rd Edition, Publisher: Wiley, 2013.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML504L	Data Warehousing and Pattern Mining Lab	C	0	0	4	2	40	60	100	3
Purpose	To understands the different technique of Data Warehousing and Pattern Mining									
Course Outcomes (CO)										
CO1	To understand the Basic exercises on Python Packages									
CO2	To understand the demonstrate graph mining									
CO3	To understand the implementation OLAP operations									
CO4	Explain the working of APRIORI algorithm									

LIST OF PROGRAMS:

1. Basic exercises on Python packages such as Numpy, Pandas, and Matplotlib.
2. Given a dataset, write a program to compute the Mean, Median, Mode, Standard deviation, Covariance, and Correlation between a pair of attributes.
3. Write a query to implement OLAP operations in a data cube.
4. Write a program to implement data pre-processing techniques.
5. Write a program to implement data transformation using different normalization techniques.
6. Write a program that provides an option to compute different distance measures between two points in the N-dimensional feature space. Consider some sample datasets for computing distances among sample points.
7. Write a program to demonstrate the working of the APRIORI algorithm. Use an appropriate dataset to generate frequent patterns.
8. Write a program to demonstrate the working of a stream mining algorithm. Use an appropriate dataset to generate frequent patterns.
9. Write a program to implement the K-means clustering algorithm. Select your own dataset to test the program. Demonstrate the nature of the output with varying values of K.
10. Write a program to demonstrate webpage layout structure, web link structure.
11. Write a program to demonstrate graph mining considering a suitable dataset.

SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML505	Deep Learning Techniques	AML505	3	0	0	3	40	60	100	3
Purpose	Introduction of machine learning, linear classifiers, activation Function and Deep learning Applications									
Course Outcomes (CO)										
CO1	Explain about Tensor Flow: Computational &Tensor Board									
CO2	To learn about the Artificial Neural Networks									
CO3	To learn about the Principles behind CNNs, Multiple Filters									
CO4	Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, GRU									

UNIT I

Introduction: Overview of machine learning, linear classifiers, loss functions.
Introduction to Tensor Flow: Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent, Tensor Board, Modularity, Sharing Variables, Keras.

UNIT II

Activation Functions: Sigmoid, ReLU, Hyperbolic Functions, Softmax.
Perceptrons: What is a Perceptron, XOR Gate.
Artificial Neural Networks: Introduction, Perceptron Training Rule, Gradient Descent Rule, Vanishing gradient problem and solution.

UNIT III

Convolutional Neural Networks: Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, Problem and solution of under fitting and over fitting.

UNIT IV

Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, GRU, Encoder-Decoder architectures.
Deep Learning applications: Image segmentation, Object detection, Attention model for computer vision tasks, Natural Language Processing, Speech Recognition, Video Analytics.

TEXTBOOKS :

1. Goodfellow, I., Bengio, Y., and Courville, A., *Deep Learning*, MIT Press, 2016.
2. Josh Patterson, Adam Gibson, *Deep Learning: A Practitioner's Approach*, O'Reilly, 2017.

REFERENCES BOOKS:

1. Bishop, C. M., *Pattern Recognition and Machine Learning*, Springer, 2006.
2. Yegnanarayana, B., *Artificial Neural Networks*, PHI Learning Pvt. Ltd, 2009.
3. Golub, G. H., and Van Loan, C. F., *Matrix Computations*, JHU Press, 2013.
4. Satish Kumar, *Neural Networks: A Classroom Approach*, Tata McGraw-Hill Education, 2004.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML505L	Deep Learning Techniques Lab	C	0	0	4	2	40	60	100	3
Purpose	To familiarize the students with different technique of deep learning									
Course Outcomes (CO)										
CO1	To implement a CNN for object detection & Implement a CNN for object detection.									
CO2	Understand a CNN for object detection.									
CO3	Installation and working of Num Py, Kera and Juypter									
CO4	Understand an Encoder-Decoder Recurrent									

LIST OF PROGRAMS:

1. Installation and working on Python, Jupyter, and its different libraries for deep learning (TensorFlow, NumPy, Keras, Pandas, Matplotlib, etc.).
2. To implement a Multilayer Perceptron (MLP) using Keras with TensorFlow, and fine-tune neural network hyperparameters for regression problem (house price prediction).
3. To implement a MLP using Keras with TensorFlow for classification problem (heart disease prediction).
4. To implement a Convolutional Neural Network (CNN) for dog/cat classification problem using Keras.
5. To implement a CNN for object detection in the given image.
6. To implement a Recurrent Neural Network (RNN) for predicting time series data.
7. To implement a Long Short-Term Memory (LSTM) for predicting time series data.
8. To implement a Seq2Seq Model for Neural Machine Translation in Keras.
9. To implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.
10. To implement a Gated Recurrent Unit (GRU) for time series data prediction.

SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML506	Natural Language Computing	C	3	0	0	3	40	60	100	3
Purpose	Introduction about the uncertainty in language, NLP tasks in syntax, Part of Speech Tagging, and Sequence Labeling.									
Course Outcomes (CO)										
CO1	Explain Natural Language Processing, machine translation, and the problem of ambiguity.									
CO2	Learn about the Lexical syntax, Simple N-gram models, and Estimating parameters.									
CO3	Learn about the Lexicalized PCFGs, Statistical parsing, and probabilistic parsing.									
CO4	Learn about Conditional Random Fields Maximum Entropy Markov Models and Maximum Entropy Classifiers									

UNIT I

Introduction and Overview: Welcome, motivations, what is Natural Language Processing, hands-on demonstrations. Ambiguity and uncertainty in language; The Turing test, NLP tasks in syntax, semantics, and pragmatics; Applications such as information extraction and machine translation; The problem of ambiguity; The role of machine learning.

UNIT II

N-gram Language Models: The role of language models; Simple N-gram models. Estimating parameters and smoothing; evaluating language models.

Part of Speech Tagging and Sequence Labeling: Lexical syntax. Hidden Markov Models (Forward and Viterbi algorithms and EM training).

UNIT III

Syntactic parsing: Grammar formalisms and tree banks. Efficient parsing for context-free grammars (CFGs); Statistical parsing and probabilistic CFGs (PCFGs); Lexicalized PCFGs; Neural shift-reduce dependency parsing.

Semantic Analysis: Lexical semantics and word-sense disambiguation. Compositional semantics; Semantic Role Labeling and Semantic Parsing.

UNIT IV

Maximum Entropy Classifiers, Maximum Entropy Markov Models & Conditional Random Fields, Dirichlet Multinomial Distributions, Unsupervised Language Discovery, Information Extraction & Reference Resolution. Named entity recognition and relation extraction. IE using sequence labeling.

Information Extraction:

Machine Translation: Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.

REFERENCES BOOKS :

1. James Allen, *Natural Language Understanding*, The Benjamins/Cummings Publishing Company Inc., 1994. ISBN: 0-8053-0334-0.
2. Tom Mitchell, *Machine Learning*, McGraw Hill, 1997. ISBN: 0070428077.
3. Cover, T.M. and J.A. Thomas, *Elements of Information Theory*, Wiley, 1991. ISBN: 0-471-06259-6.
4. Charniak, E., *Statistical Language Learning*, The MIT Press, 1996. ISBN: 0-262-53141-0.

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SEMESTER-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
RM101	Research Methodology and IPR	ES	2	0	0	2	40	60	100	3
Purpose	Introduction about the Errors in selecting are search problem, data collection and interpretation.									
Course Outcomes (CO)										
CO1	Learn about the research problem, Sources of research problem, data collection, analysis									
CO2	Learn about the analysis Plagiarism, Research ethics and data collection									
CO3	Learn about the Effective technical writing and Research Proposal									
CO4	Learn about the Patents, Designs, Copyright and Trade									

UNIT I

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.

UNIT II

Effective literature studies approaches, analysis, Plagiarism, Research ethics.

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT III

Effective technical writing, how to write a report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Patent Rights: Scope of Patent Rights.

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.

UNIT IV

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.

TEXTBOOKS :

1. Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science & Engineering Students."
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction."

REFERENCES BOOKS:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for Beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in the New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

SEMESTER-III

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML580	Project Work-Phase I	PR	0	0	20	10	100	0	100	3
Purpose	Students will learn to compare the performance metrics of their implementation with others' using industry standard software and powerful multicore CPU and GPU.									
Course Outcomes (CO)										
CO1	Students will learn to effectively communicate their research findings by writing and presenting papers and defending their dissertation.									
CO2	Conduct state-of-the-art literature review in the identified problem domain that requires AI and ML techniques.									
CO3	Develop an in-depth understanding of the concept of uncovering business intelligence from large amounts of web data mining.									
CO4	Design innovative products and software services by harnessing the power of AI & ML in broad application fields ranging from computer vision, internet of things to advanced autonomous systems.									

COURSE CONTENT

In project phase I, students will choose from a wide range of real-world problems that need knowledge and expertise of artificial intelligence, data science, and machine learning (AI/ML) techniques for solving them. Problems and concepts may be defined based on extensive literature survey of research articles published in highly reputed journals. Significance of the proposed problem and the state-of-the-art of the problem domain to be explored first. Then students will propose their innovative ideas that mitigate the challenges of the problem. Industry-relevant tools may be used for solving the problem and demonstrating the results. Students are required to publish their research findings in reputed journals and conferences. The progress of their projects will be regularly assessed by the designated project guides.

In the second phase of the project work, students will start writing their dissertation. Simultaneously, they will work on their project for better solutions and more publications. Students will submit their dissertation at least two weeks in advance to the internal and external examiners before the date of final viva-voce. Successful defense of the dissertation will be considered as partial requirement for awarding M. Tech degree in Artificial Intelligence and Machine Learning.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

SEMESTER-IV

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML581	Project Work-Phase II	PR	0	0	32	16	100	200	300	3
Purpose	Effectively communicate research findings in terms of reports and presentations.									
Course Outcomes (CO)										
CO1	Design innovative products and software services by harnessing the power of AI & ML in broad application fields ranging from computer vision, internet of things to advanced autonomous systems.									
CO2	Develop an in-depth understanding of the concept of uncovering business intelligence from large amounts of web data mining.									
CO3	Conduct state-of-the-art literature review in identified problem domain that requires AI and ML techniques.									
CO4	Inculcate independent research ability that addresses fundamental problems.									

COURSE CONTENT

In project phase I, students will choose from a wide range of real-world problems that need knowledge and expertise of artificial intelligence, data science, and machine learning (AI/ML) techniques for solving them. Problems and concepts may be defined based on extensive literature survey of research articles published in highly reputed journals. Significance of the proposed problem and the state-of-the-art of the problem domain to be explored first. Then students will propose their innovative ideas that mitigate the challenges of the problem. Industry-relevant tools may be used for solving the problem and demonstrating the results. Students are required to publish their research findings in reputed journals and conferences. The progress of their projects will be regularly assessed by the designated project guides.

In the second phase of the project work, students will start writing their dissertation. Simultaneously, they will work on their project for better solutions and more publications. Students will submit their dissertation at least two weeks in advance to the internal and external examiners before the date of final viva-voce. Successful defense of the dissertation will be considered as partial requirement for awarding M. Tech degree in Artificial Intelligence and Machine Learning.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

ELECTIVE-1

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML551	Modelling and Simulation of Digital Systems	E	3	0	0	3	40	60	100	3
Purpose	Modeling and simulation (M&S) of digital systems helps engineers and analysts understand and predict how systems behave without the need for physical experiments.									
Course Outcomes (CO)										
CO1	Learn about the Programmable Logic Devices, Simple Programmable Logic Devices and numbers systems									
CO2	Learn about the Boolean Algebra , Logic and Binary-Coded Decimal Representation									
CO3	Learn about the CAD Tool–Based Logic Design, Hardware Description Languages, VHDL Language, VHDL Programming Structure, Assignment Statements									
CO4	Learn about the Logic Signals; Logic Switches, NMOS and PMOS									

UNIT I

Digital System Modeling and Simulation: Objectives ,Objectives, Modeling, Synthesis, and Simulation Design, History of Digital Systems, Standard Logic Devices, Custom-Designed LogicDevices,ProgrammableLogicDevices,SimpleProgrammableLogicDevices,Complex Programmable Logic Devices, Field-Programmable Gate Arrays6Futureof Digital Systems.

Number Systems**:** Objectives, Bases and Number Systems, Number Conversions, Data Organization, Signed and Unsigned Numbers, Binary Arithmetic, Addition of Signed Numbers, Binary-Coded Decimal Representation, BCD Addition.

UNIT II

Boolean Algebra and Logic: Objectives, Boolean Theory, Logic Variables and Logic Functions, Boolean Axioms and Theorems, Basic Logic Gates and Truth Tables, Logic Representations and Circuit Design Truth Table, Timing Diagram, Logic Design Concepts, Sum-of-Products Design, Product-of-Sums Design, Design Examples, NAND and NOR Equivalent Circuit Design, Standard Logic Integrated Circuits, VHDL Design Concepts: Objectives, CAD Tool–Based Logic Design, Hardware Description Languages, VHDL Language, VHDL Programming Structure, Assignment Statements, VHDL Data Types

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UNIT III

VHDL Operators, VHDL Signal and Generate Statements, Sequential Statements, Loops and Decision-Making Statements, Sub circuit Design, Packages and Components VHDL Design Concepts: Objectives, CAD Tool–Based Logic Design, Hardware Description Languages, VHDL Language, VHDL Programming Structure, Assignment Statements, VHDL Data Types, VHDL Operators, VHDL Signal and Generate Statements, Sequential Statements, Loops And Decision-Making Statements, Sub circuit Design, Packages and Components.

UNIT IV

Integrated Logic: Objectives, Logic Signals; Logic Switches, NMOS and PMOS Logic Gates, CMOS Logic Gates, CMOS Logic Networks, Practical Aspects of Logic Gates, Transmission Gates. Logic Function Optimization: Objectives, Logic Function Optimization Process, Karnaugh Maps, Two Variable Karnaugh Map, Three-Variable Karnaugh Map, Four-Variable Karnaugh Map, Five-Variable Karnaugh Map, XOR and NXOR Karnaugh Maps, Incomplete Logic Functions, Quine–Mc Cluskey Minimization.

Combinational Logic: Objectives, Combinational Logic Circuits, Multiplexers, Logic Design withMultiplexers,Demultiplexers,Decoders, Encoders,CodeConverters,Arithmetic Circuits.

SequentialLogic**:**Objectives,SequentialLogicCircuits,Latches,Flip-Flops,Registers,

Counters,Problems.Synchronous Sequential Logic: Objectives, Synchronous Sequential Circuits, Finite-State MachineDesign Concepts, Finite-State Machine Synthesis, State Assignment, One-Hot Encoding Method,Finite-State Machine, Analysis, Sequential Serial Adder, Sequential Circuit Counters, StateOptimization,Asynchronous Sequential Circuits.

TEXT BOOKS :

1. IntroductiontoDigitalSystems:Modelling,Synthesis,andSimulationUsingVHDL.Ferdjallah,Mohammed.John Wiley & Sons, 2011.
2. FiniteStateMachinesinHardwareTheoryandDesign(withVHDLandSystemVerilog).VolneiA. Pedroni, 2013.

REFERENCES BOOKS :

1. HardwareDescriptionLanguagesandtheirApplications:Specification,modelling,verificationand synthesis of micro electronic systems.C. Kloos, E. Cerny. Springer;2013.
2. SystemVerilogforVerification:AGuidetoLearningtheTestbenchLanguageFeatures.Ch.Spear,G. Tumbush. Springer; 3rd edition, 2012.
3. AdvancedDigitalDesignwith theVerilogHDL. M. Ciletti.PrenticeHall; 2ndedition,2010.
4. M.Mano,C.Ciletti.DigitalDesign:WithanIntroductiontotheVerilogHDL.PrenticeHall;5th edition, 2012.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML552	Knowledge Engineering and Expert System	E	3	0	0	3	40	60	100	3
Purpose	Introduction about the Knowledge Engineering and Expert System									
Course Outcomes (CO)										
CO1	Learn about the applications of Expert Systems relationship of ExpertSystemstoArtificialIntelligenceandtoKnowledge-BasedSystems									
CO2	Learn about how it is built. Basic forms of inference: abduction induction and deduction.									
CO3	Learn about the logic-based representations, taxonomies and partitioned nets									
CO4	Learn about the Truth Maintenance Systems, Expert System Architectures and Handling of uncertainties									

UNIT I

The nature of Expert Systems Types of applications of Expert Systems relationship of ExpertSystemstoArtificialIntelligenceandtoKnowledge-BasedSystems.Thenatureof expertise Distinguishing features of Expert Systems. Benefits of using an Expert System Choosing an application.

UNIT II

Theoretical Foundations. What an expert system is; how it works and how it is built. Basic forms of inference: abduction; deduction; induction. Building Expert Systems. Methodologies for building expert systems: knowledge acquisition and elicitation; formalisation; representation and evaluation. Knowledge Engineering tools, Case Study

UNIT III

The representation and manipulation of knowledge in a computer; Rule-based representations (with backward and forward reasoning); logic-based representations (with resolution refutation); taxonomies; meronomies; frames (with inheritance and exceptions); semantic and partitioned nets (query handling).

UNIT IV

Basic components of an expert system; Generation of explanations; Handling of uncertainties; Truth Maintenance Systems; Expert System Architectures; An analysis of some classic expert systems; Limitations of first-generation expert systems; Deep expert systems; Co-operating expert systems and the blackboard model.

TEXTBOOKS :

1. P. Jackson, *Introduction to Expert Systems*, Addison Wesley, 1990 (2nd Edition).

REFERENCES BOOKS :

1. Elaine Rich, Kevin Knight, *Artificial Intelligence*, McGraw-Hill, Inc, 1991 (2nd Edition).
2. Jackson Jean-Louis Lauriere, *Problem Solving and Artificial Intelligence*, Prentice Hall, 1990.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML553	Information Retrieval	E	3	0	0	3	40	60	100	3
Purpose	Introduction of Information Retrieval, Architecture of a Search Engine									
Course Outcomes (CO)										
CO1	Learn about the Noise Detection and Removal and Document Conversion									
CO2	Learn Abstract Model of Ranking, Inverted indexes & Optimization techniques									
CO3	Learn about the different type of Retrieval Models, Overview of Retrieval Models and Boolean Retrieval									
CO4	Learn about the Test collections, Query logs, Effectiveness Metrics									

UNIT I

Introduction: Overview of Architecture of a Search Engine, Acquiring Data: Crawling the Web, Document Conversion, Storing the Documents, Detecting Duplicates, Noise Detection, and Removal.

Processing Text: Text Statistics, Document Parsing, Tokenizing, Stopping, Stemming, Phrases, Document Structure, Link Extraction, More detail on PageRank, Feature Extraction and Named Entity Recognition, Internationalization.

UNIT II

Ranking with Indexes: Abstract Model of Ranking, Inverted Indexes, Map Reduce. Query Processing: Document-at-a-time evaluation, Term-at-a-time evaluation, Optimization techniques, Structured queries, Distributed evaluation, Caching. Queries and Interfaces: Information Needs and Queries, Query Transformation and Refinement: Stopping and Stemming Revisited, Spell Checking and Query Suggestions, Query Expansion, Relevance Feedback, Context and Personalization. Displaying the Results: Result Pages and Snippets, Advertising and Search, Clustering the Results; Translation; User Behavior Analysis.

UNIT III

Retrieval Models: Overview of Retrieval Models; Boolean Retrieval, The Vector Space Model. Probabilistic Models: Information Retrieval as Classification, The BM25 Ranking Algorithm. Ranking based on Language Models: Query Likelihood Ranking, Relevance Models and Pseudo-Relevance Feedback. Complex Queries and Combining Evidence: The Inference Network Model, The Galago Query Language. Models for Web Search, Machine Learning and Information Retrieval: Learning to Rank (LeToR), Topic Models.

UNIT IV

Evaluating Search Engines: Test collections, Query logs, Effectiveness Metrics: Recall and Precision, Averaging and interpolation, focusing on the top documents. Training, Testing, and Statistics: Significance tests, setting parameter values, Classification and Clustering. Social Search: Networks of People and Search Engines: User tagging, searching within Communities, Filtering and recommending, Meta search.

Beyond Bag of Words: Feature-Based Retrieval Models, Term Dependence Models, Question Answering, Pictures, Pictures of Words, etc., XML Retrieval, Dimensionality Reduction and LSI.

TEXTBOOKS :

1. *Introduction to Information Retrieval*, Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, Cambridge University Press, 2007.

REFERENCES BOOKS :

1. *Search Engines: Information Retrieval in Practice*, Bruce Croft, Donald Metzler, and Trevor Strohman, Pearson Education, 2009.
2. *Modern Information Retrieval*, Baeza-Yates Ricardo and Berthier Ribeiro-Neto, 2nd edition, Addison-Wesley, 2011.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

ELECTIVE- II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML554	Pattern Recognition	E	3	0	0	3	40	60	100	3
Purpose	Introduction about the basis of Pattern Recognition									
Course Outcomes (CO)										
CO1	Learn about the Parametric estimation, Maximum Likelihood Estimation and Bayesian parameter Estimation									
CO2	Learn about the Graph theoretic approach to pattern Clustering, Validity of Clusters & Hierarchical clustering.									
CO3	Learn about the Feature Selection Algorithms - Branch and bound algorithm									
CO4	Learn about the Pattern Classification using Genetic Algorithms Fuzzy logic–Fuzzy Pattern Classifiers.									

UNIT I

Overview of Pattern Recognition – Basics of Probability and Statistics, Linear Algebra, Linear Transformations, Components of Pattern Recognition System, Learning and adaptation. Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach – Pattern classification by distance functions – Minimum distance pattern classifier.

UNIT II

Clustering for unsupervised learning and classification – Clustering concept – C Means algorithm – Hierarchical clustering – Graph theoretic approach to pattern Clustering – Validity of Clusters.

UNIT III

Feature Extraction and Feature Selection: Feature extraction – discrete cosine and sine transform, Discrete Fourier transform, Principal Component Analysis, Kernel Principal Component Analysis. Feature selection – class separability measures, Feature Selection Algorithms - Branch and bound algorithm, sequential forward/backward selection algorithms. Principal Component Analysis, Independent Component Analysis, Linear Discriminant Analysis, Feature selection through functional approximation – Elements of formal grammars, Syntactic description – Stochastic grammars – Structural Representation.

UNIT –IV

State Machines – Hidden Markov Models – Training – Classification – Support Vector Machine – Feature Selection. Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception.

REFERENCES BOOKS :

1. Andrew Webb, “Statistical Pattern Recognition”, Arnold Publishers, London, 1999.
2. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
3. M. Narasimha Murthy and V. Susheela Devi, “Pattern Recognition”, Springer, 2011.
4. Menahem Friedman, Abraham Kandel, “Introduction to Pattern Recognition: Statistical, Structural, Neural and Fuzzy Logic Approaches”, World Scientific Publishing Co. Ltd, 2000.
5. Robert J. Schalkoff, “Pattern Recognition: Statistical, Structural and Neural Approaches”, John Wiley & Sons Inc., New York, 1992.
6. R. O. Duda, P. E. Hart and D. G. Stork, “Pattern Classification”, John Wiley, 2001.
7. S. Theodoridis and K. Koutroumbas, “Pattern Recognition”, 4th Ed., Academic Press, 2009.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML555	Problem Solving Methods in Artificial Intelligence	E	3	0	3	3	40	60	100	3
Purpose	Introduction of the Problem Solving Methods in Artificial Intelligence									
Course Outcomes (CO)										
CO1	Learn about the Reducing problems into sub problems, Problem representation									
CO2	Understand about the Operators, Goal states and Graph notation									
CO3	Understand about the Arc consistency algorithms; Implementation issues of CS Palgorithms									
CO4										

UNIT I

Problem solving and artificial intelligence; Puzzles and games; What is a solution? Problem states and operators; Reducing problems into sub problems; Problem representation; The use of logic in problem solving; Representation and search problems.

UNIT II

State descriptions; Operators; Goal states; Graph notation; Problem reduction; Problem Solving as Search; Uninformed or blind search; Informed search; Graph searching process: Breadth-first methods, Depth-first methods, Optimal search algorithms, A* search - admissibility, optimality; heuristics.

UNIT III

Constraint Satisfaction Problems (CSPs); Constraints as relations; Constraint modelling and solving; Map-Coloring Problem; Constraint Graph; Methods to solve CSPs – backtracking, Forward checking, Look ahead, Arc consistency algorithms; Implementation issues of CSP algorithms. Local search and meta heuristics; Single-solution based algorithms vs population based algorithms; Simulated Annealing; Tabu search; Genetic Algorithms; Scatter Search.

UNIT IV

Combinatorial Optimization Problems; Discrete optimization techniques: exact algorithms (linear programming), approximation algorithms, heuristic algorithms. Identifying various instances of problems such as Resource allocation, Knapsack, traveling salesman, etc. Ant Colony Optimization; Adaptive Memory Procedures; Variable Neighborhood Search; Evolutionary Algorithms; Memetic Algorithms; Particle Swarm, The Harmony Method, etc.

REFERENCES BOOKS :

1. Problem Solving Methods in Artificial Intelligence - Nils Nilson (McGraw-Hill).
2. How to Solve it by Computer - R. G. Dromey.
3. Artificial Intelligence for Humans Volume-1, 2, 3 - Jeff Heaton.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML556	Cognitive Systems	E	3	0	0	3	40	60	100	3
Purpose	Introduction To Cognitive Science –Computers in Cognitive Science – Applied Cognitive Science, The Cognitive view –Some Fundamental Concepts									
Course Outcomes (CO)										
CO1	Learn about the Interdisciplinary Nature of Cognitive Science & Evaluation of the Turing Test									
CO2	Learn about the Acquisition of Skill , Problem Solving ,Types of Memory and Memory Models									
CO3	Learn about the Estimating Firing Rates Artificial Intelligence II: Knowledge representation									
CO4	Learn about the Firing-Rate Dynamics-Feed forward and Recurrent Networks									

UNIT I

Introduction to Cognitive Science – The Cognitive view – Some Fundamental Concepts – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science. Artificial Intelligence I: AI Methodologies, The Computer as the Tool of AI Research, Alan Turing and the Great Debate – Evaluation of the Turing Test (TT) and Turing's Detractors – Battle Lines: The Future of the TT.

UNIT II

Cognitive Psychology – The Architecture of the Mind – The Nature of Cognitive Psychology – A Global View of The Cognitive Architecture – Propositional Representation – Schematic Representation – Cognitive Processes, The Acquisition of Skill – The Connectionist Approach to Cognitive Architecture. Cognitive Approach: Memory, Imagery, and Problem Solving: Types of Memory, Memory Models – Modal Model, ACT* Model, Working Memory Model, Problem Solving – The General Problem Solver Model, The SOAR Model.

UNIT III

Cognitive Neuroscience: Properties of Neurons – Neural Representation – Models of Neurons and Its Simulation – What Makes a Neuron Fire – Recording Neuronal Responses – Spike Trains and Firing Rates – Estimating Firing Rates.
Artificial Intelligence II: Knowledge Representation – The Nature of Artificial Intelligence – Knowledge Representation – Artificial Intelligence: Search, Control, and Learning.

UNIT IV

Network Models: Firing-Rate Models – Firing-Rate Dynamics – Feedforward and Recurrent Networks: Continuously Labeled Networks – Feedforward Networks – Recurrent Networks – Excitatory-Inhibitory Networks – Stochastic Networks.
Language Acquisition, Semantics and Processing Models: Milestones in Acquisition – Theoretical Perspectives – Semantics and Cognitive Science – Meaning and Entailment – Reference – Sense – Cognitive and Computational Models of Semantic Processing – Information Processing Models of the Mind – Physical Symbol Systems and Language of Thought – Applying the Symbolic Paradigm – Neural Networks and Distributed Information Processing – Neural Network Models of Cognitive Processes.

TEXTBOOKS :

1. "Cognitive Science: An Introduction", Second Edition, MIT Press, 1995.
2. "Cognitive Science: An Introduction to the Study of Mind", Jay Friedenberg, Gordon Silverman.

REFERENCES BOOKS :

1. Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems, MIT Press, 2001.
2. Speech and Language Processing (3rd ed.) Dan Jurafsky and James H. Martin.
3. Neuroscience, Fifth Edition by Dale Purves, George J. Augustine, David Fitzpatrick, William (5th Edition).

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

ELECTIVE-III

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML557	Introduction to High Performance Computing	E	3	0	0	3	40	60	100	3
Purpose	Introduction of Introduction to High Performance Computing									
Course Outcomes (CO)										
CO1	Learn about the BasicCompilerTechniquesforexposingILP-ReducingBranchcostswithprediction-OvercomingDatahazards									
CO2	Learn about the Distributed shared–memory architecture–Synchronization Multithreading - Multithreading-fined grained									
CO3	Learn about the Cache Optimizations-Virtual memory-Advanced optimizations of Cache performance									
CO4	Learn about the (Open MP, MPI, Open CL, Open ACC)									

UNIT I

Introduction to pipelining – Types of pipelining – Hazards in pipelining – Introduction to instruction level parallelism (ILP) – Challenges in ILP – Basic Compiler Techniques for exposing ILP – Reducing Branch costs with prediction – Overcoming Data hazards with Dynamic scheduling – Hardware-Based speculation – Exploiting ILP using multiple Issue and static scheduling – Exploiting ILP using dynamic scheduling, multiple issue and speculation – Tomasulo's approach, VLIW approach for multi-issue.

UNIT II

Introduction to multi processors and thread level parallelism – Characteristics of application domain – Systematic shared memory architecture – Distributed shared-memory architecture – Synchronization – Multithreading – Multithreading – fine grained and coarse grained, superscalar and super pipelining, hyper threading.
Vector architectures; organizations and performance tuning; GPU architecture and internal organization, Elementary concepts in CUDA programming.

UNIT III

Introduction to cache performance – Cache Optimizations – Virtual memory – Advanced Optimizations of Cache performance – Memory technology and optimizations – Protection: Virtual memory and virtual machines – Multi-banked caches, critical word first, early restart approaches, hardware pre-fetching, write buffer merging. Introduction to parallel computing platforms; (OpenMP, MPI, OpenCL, OpenACC) with performance improvement analysis done using real-life AI and ML applications.

UNIT IV

Introduction to interconnection networks and clusters – Interconnection network media – Practical issues in interconnecting networks – Examples – Clusters – Designing a cluster – System on Chip (SoC) Interconnects – Network on Chip (NOC).

TEXTBOOKS :

1. Sterling, Thomas, Maciej Brodowicz, and Matthew Anderson. "High Performance Computing: Modern Systems and Practices", Morgan Kaufmann, 2017.
2. Hennessy, John L., and David A. Patterson. "Computer Architecture: A Quantitative Approach", Elsevier, 2011.

REFERENCES BOOKS :

1. Wang,Endong,QingZhang,BoShen,GuangyongZhang,XiaoweiLu,QingWu,andYajuanWang." High-performancecomputingon the IntelXeonPhi."Springer 5,2014.
2. Sanders,Jason,andEdwardKandrot. “CUDAbyexample:anintroductiontogeneral-purposeGPUprogramming”, Addison-Wesley Professional, 2010.
3. Chandra,Rohit,LeoDagum,DavidKohr,RameshMenon,DrorMaydan,andJeffMcDonald.Parallel programming in Open MP. Morgan kaufmann, 2001.
4. Kaeli,DavidR.,PerhaadMistry,DanaSchaa,andDongPingZhang.Heterogeneous Computingwith Open CL 2.0. Morgan Kaufmann, 2015.
5. Farber,Rob.ParallelprogrammingwithOpenACC.Newnes,2016.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML558	Computer Vision	E	3	0	0	3	40	60	100	3
Purpose	Introduction about the Computer Vision different type of experiments									
Course Outcomes (CO)										
CO1	Learn about the Digital image formation									
CO2	Learn about the Feature extraction histogram, shape and color									
CO3	Learn about the Depth estimation and Multi-camera views									
CO4	Learn about the motion of background of Subtraction									

UNIT I

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc.; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, Introduction to Computer Vision.

UNIT II

Feature Extraction: Shape, histogram, color, spectral, texture, Feature analysis, feature vectors, distance/similarity measures, data preprocessing, Edges - Canny, LOG, DOG; Scale-Space Analysis - Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT; Line detectors (Hough Transform), Orientation Histogram, SIFT, SURF, GLOH, Corners - Harris and Hessian Affine.

UNIT III

Depth estimation and Multi-camera views: Perspective, Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Binocular Stereopsis: Camera and Epipolar Geometry; Auto-calibration.
Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

UNIT IV

Motion Analysis: Optical Flow, KLT, Spatio-Temporal Analysis, Background Subtraction and Modeling, Dynamic Stereo; Motion parameter estimation.
Shape from X: Light at Surfaces; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges, Albedo estimation; Photometric Stereo; Phong Model; Reflectance Map.

TEXTBOOKS/REFERENCES

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited, 2011.
2. Computer Vision: A Modern Approach, D.A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison-Wesley, 1992.
5. K. Fukunaga, Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML559	Number theory and Cryptography	E	3	0	0	3	40	60	100	3
Purpose	Introduction about the Number Theory and Cryptography									
Course Outcomes (CO)										
CO1	Provide foundational knowledge of cryptographic principles, techniques and mathematical concepts essential for secure communication and data protection									
CO2	To understand secure data encryption through block ciphers, algorithms, and cryptographic principles.									
CO3	Explores fundamental concepts of modular arithmetic and number theory, providing the mathematical foundation for cryptography									
CO4	equip students with an understanding of cryptographic hash functions, blockchain technology, decentralization in security, and emerging cryptographic techniques									

UNIT I

Cryptography, Cryptanalysis and Brute-Force Attack, Basic introduction to Cryptography, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques.
Induction and recursion; number systems; prime and composite numbers; divisibility theory, Divisibility and Unique Factorization and the Euclidean algorithm; congruence; introduction to finite fields, and examples.

UNIT II

Block ciphers, Attacks on block ciphers, Block Cipher Principles, The Data Encryption Standard (DES), Block Cipher Design Principles, Block cipher modes of operation, The Euclidean Algorithm, Finite Fields of the Form GF(2n), Advanced Encryption Standard (AES), Stream Ciphers, RC4.

UNIT III

Modular Arithmetic, Arithmetic modulo primes, Euclid's Algorithm, The Theorems of Fermat and Euler, Testing for Primality, The Chinese Remainder Theorem, Building Blocks for Cryptography, Introduction to Public Key Cryptography, The RSA Algorithm, Primitive Roots and Discrete Logarithms, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Elgamal Cryptographic systems, Digital signatures: definitions and applications.

UNIT IV

Introduction to Hash Functions, Cryptographic Hash Functions, Hash Functions Based on Cipher Block Chaining, Collision resistant hashing, Message integrity: definition and applications, Secure Hash Algorithm (SHA), SHA-3.
Application of Cryptographic Hash Functions, Introduction of decentralization in security; Block Chaining; Bitcoin; Some other new techniques in Cryptography; Zero knowledge protocols; Cryptography in the age of quantum computers.

REFERENCES BOOKS :

1. Stallings, William. Cryptography and Network Security, 4/E. Pearson Education India, 2006.
2. D. Stinson, Cryptography, Theory and Practice (Third Edition).
3. Handbook of Applied Cryptography by A. Menezes, P. Van Oorschot, S. Vanstone.
4. An Introduction to Number Theory with Cryptography by J.S. Kraft & L.C. Washington.
5. Numbers, Groups, and Cryptography by G. Savin.
6. Introduction to Modern Cryptography (2nd edition) by J. Katz and Y. Lindell.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

OPEN ELECTIVE

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML560	Agent Systems	E	3	0	0	3	40	60	100	3
Purpose	To study the design, implementation, and application of intelligent agents and multi-agent systems for problem-solving, decision-making, and automation in various domains.									
Course Outcomes (CO)										
CO1	To provide students with an understanding of intelligent agent concepts, architectures, and programming									
CO2	To equip students with the knowledge to design and implement practical, reactive, and hybrid reasoning agents									
CO3	To enable students to understand and apply mechanisms for agent communication, negotiation, coordination, and cooperative									
CO4	To provide students with the ability to analyze, design, and implement agent-based solutions across various applications									

UNIT I

Introduction – the vision thing, some views of the field and objections to multi-agent systems.
Intelligent Agents – Environment; Intelligent agents; what is an agent? Agents and objects; agents and Expert systems; agents as intentional systems, abstract architecture for intelligent agents, how to tell an agent what to do; synthesizing agents.
Deductive Reasoning Agents – Agents as theorem provers; Agent-Oriented Programming; Concurrent Meta-Programming.

UNIT II

Practical Reasoning Agents – Practical Reasoning Equals Deliberation Plus Means-Ends Reasoning; Means-Ends Reasoning; Implementing a Practical Reasoning Agent; HOMER: an Agent That Plans; The Procedural Reasoning System.
Reactive and Hybrid Agents – Books and the subsumption Architecture; The Limitations of Reactive Agents; Hybrid Agents.
Multi-agent Interactions – Utilities and preferences; Multi-agent Encounters; Dominant Strategies and Nash Equilibria; Competitive and Zero-sum interactions; The Prisoner's Dilemma.
Dependence relations in multi-agent systems.

UNIT III

Reaching Agreements – Mechanism Design; Auctions; Negotiation; Communication – Speech Acts; Agent Communication Languages; Ontologies for Agent Communications; Coordination Languages.
Working Together – Cooperative distributed problem solving; Task sharing and result sharing; Combining task and result sharing; Handling inconsistency; Coordination; Multi-agent planning and synchronization.

UNIT IV

Methodologies – When is an agent-based solution appropriate?; Agent-oriented analysis and design techniques; Pitfalls and agent development; Mobile agents.
Applications – Agents for: Workflow and business process management; For distributed sensing; For information retrieval and management; For electronic commerce; For human-computer interfaces; For virtual environments; For social simulation; For Logics for Multi-agent Systems – Why model logic? Possible-worlds semantics for model logics; Normal modal logics; Epistemic logic multi-agent system; Pro-attitudes: Goals and desires; Common and distributed knowledge; Integrated theory of agency.

TEXTBOOKS:

1. An Introduction to Multi-Agent Systems, Michael Wooldridge, John Wiley & Sons, 2009.
2. Multi-Agent Systems by Gerhard Weiss, 2nd edition, The MIT Press.

REFERENCES BOOKS :

1. Multi-agent Systems: A Modern Approach to Distributed Artificial Intelligence, Gerhard Weiss (Ed.), MIT Press, 1999. ISBN 0-262-23203-0.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML561	Artificial Intelligence and Neural Networks	E	3	0	3	3	40	60	100	3
Purpose	To introduce students to AI concepts and techniques, with a focus on neural networks and their applications in problem-solving, learning, and pattern recognition.									
Course Outcomes (CO)										
CO1	Foundations of AI, intelligent agents, and problem-solving approaches in various environments.									
CO2	To study search strategies, heuristic methods, and algorithms for problem-solving and game-playing in AI									
CO3	To understand knowledge representation, reasoning, and logical inference techniques in AI.									
CO4	Explore neural networks' principles, types, learning laws, and their applications in pattern recognition and classification tasks.									

UNIT I

Introduction: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

UNIT II

Searching: Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A* search Game Playing: Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Alpha-Betapruning, Evaluation functions, cutting of search.

UNIT III

Knowledge Representation & Reasons logical Agents, Knowledge – Based Agents, the Wumpus world, logic, propositional logic, Resolution patterns in proposional logic, Resolution, Forward &Backward. Chaining. First order logic. Inference in first order logic, propositional Vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution.

UNIT IV

Characteristic of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units.
Feed forward Neural Networks: Introduction, Analysis of Pattern Association Networks, Analysis of Pattern Classification Networks, Analysis of Pattern Storage Networks, Analysis of Pattern Mapping Networks.
Feedback Neural Networks: Introduction, Analysis of Linear Auto associative FF Networks, Analysis of Pattern Storage Networks.
Competitive Learning Neural Networks & Complex Pattern Recognition: Introduction, Analysis of Pattern Clustering Networks, Analysis of Feature Mapping Networks, and Associative Memory.

REFERENCES BOOKS :

1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russell, Peter Norvig, PHI/Pearson Education.
2. Artificial Neural Networks B. Yagna Narayana, PHI.
3. Artificial Intelligence, 2nd Edition, E. Rich and K. Knight (TMH).
4. Artificial Intelligence and Expert Systems – Patterson PHI.
5. Expert Systems: Principles and Programming - Fourth Edn, Giarrantana/Riley, Thomson.
6. PROLOG Programming for Artificial Intelligence. Ivan Bratka - Third Edition – Pearson Education.
7. Neural Networks Simon Haykin PHI.
8. Artificial Intelligence, 3rd Edition, Patrick Henry Winston, Pearson Education.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML562	Statistical Modelling for Computer Science	E	3	0	3	3	40	60	100	3
Purpose	To equip students with the statistical methods and techniques needed to model, analyze, and interpret data in various computational and data-driven applications									
Course Outcomes (CO)										
CO1	To understand data types, sampling strategies, data analysis, and representation using various software tools and visualizations									
CO2	To study probability, random variables, distributions, and key statistical concepts like normal, binomial, and Poisson distributions									
CO3	To understand statistical inference techniques for categorical and numerical data, including hypothesis testing, confidence intervals									
CO4	Explore linear, multiple, and logistic regression techniques, model fitting, inference, and outlier analysis in regression analysis.									

UNIT I

Introduction to Data - Definition of data; Different kinds of variables; Sampling principles and strategies; Difference between observation and experiment; Examining numerical data; Considering categorical data; Case studies and examples; Analysis and Representation of data, different kinds of existing software tools (Example: Python, Pandas, scipy.stats, numpy, matplotlib, etc.). Line Plot, Bar chart, Histogram plot, Box and Whisker Plot, Scatter Plot, etc.

UNIT II

Probability, Distributions of random variables, Foundations of random variables - Defining probability, Conditional probability, Sampling from small population; Random variables, Continuous distributions. Normal distribution; Binomial distribution; Negative binomial distribution; Poisson distribution; Central tendencies, Law of large numbers, Central limit theorem.

UNIT III

Foundations of Inference, Inference for categorical data, Inference for numerical data - Point estimates and sampling variability, Confidence intervals for a proportion, Hypothesis testing, Critical values, Covariance and correlation, Significance tests, Effect size. Inference for a single proportion, Difference of two proportions; Testing for goodness of fit using chi-square. One-sample means with the t-distribution, Paired data, Difference of two means, Power calculations for a difference of means, Comparing many means with Analysis of variance (ANOVA).

UNIT IV

Introduction to linear regression - Fitting a line, residuals, and correlation; Least square regression, Types of outliers in linear regression; Inference for linear regression.
Multiple and logistic regression - Introduction to multiple regression, Model selection, Checking model conditions using graphs, Multiple regression case studies, Introduction to logistic regression.

REFERENCES BOOKS :

1. OpenIntro Statistics - David Diez, Christopher Barr, and Mine Çetinkaya-Rundel.
2. Introduction to Probability – by Dimitri Bertsekas.
3. Statistical Methods and Machine Learning - Jason Brownlee.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML563	Fuzzy Logic and its Applications	E	3	0	0	3	40	60	100	3
Purpose	To understand fuzzy logic principles and explore its applications in various fields like control systems, classification, and image recognition									
Course Outcomes (CO)										
CO1	To understand fuzzy logic principles and explore its applications in various fields like control systems, classification, and image recognition									
CO2	To understand the basic fuzzy logic operators and their role in fuzzy set theory.									
CO3	To understand fuzzy inference systems, approximate reasoning, and the application of possibility theory in fuzzy logic									
CO4	To study fuzzy control systems, including Mamdani and Sugeno models, defuzzification methods, and their applications in various fields									

UNIT I

Introduction and Motivation: History of fuzzy theory; Limitations of classical logic; Introduction tofuzzy set theory in contrast with classical set theory; Introduction to fuzzy logic.

UNIT II

Fuzzy Logical Operators -Fundamental concepts of fuzzy theory: sets, relations, and logic operators Conjunction, Disjunction, Negation.

UNIT III

Fuzzy Inference Systems - Approximate reasoning, fuzzy inference, possibility theory. Separation from probability, Generalized Modus Ponens, Generalized Modus Tollens, Approximate Reasoning.

UNIT IV

Fuzzy Control Systems - The Mamdani Model, The Sugeno Model, Defuzzification methods, Families of implication operators, Hierarchy of implication operators.

Applications - Fuzzy Classification Algorithms, Fuzzy Logic and Neural Networks, Fuzzy Graph Theory, Fuzzy Character Recognition, Fuzzy Expert Systems, Fuzzy Markov Chains, Fuzzy Ranking Algorithms, Fuzzy Facial Recognition, Fuzzy Image Stabilization, Fuzzy Logic in Computer Games.

REFERENCES

1. Bede - Mathematics of Fuzzy Sets and Fuzzy Logic.
2. Fuzzy Logic: Intelligence, Control, and Information, J. Yen, R. Langari, Prentice Hall, 1999.
3. Chen and Pham - Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems.
4. Fuzzy Systems Toolbox - Student edition for use with MATLAB, by Mark Beale and Howard Demuth, PWS Publishing Company, 1996.
5. Fuzzy Set Theory – Foundations and Applications, George J. Klir, Ute St. Clair, and Bo Yuan, Prentice Hall PTR, 1997.
6. Fuzzy Engineering, Bart Kosko, Prentice Hall, 1997.
7. Fuzzy Logic with Engineering Applications, by Timothy J. Ross, McGraw Hill, 1995.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
AML564	Electronic Design Automation	E	3	0	0	3	40	60	100	3
Purpose	To explore electronic design automation techniques for efficient design, synthesis, placement, routing, and optimization in VLSI system									
Course Outcomes (CO)										
CO1	To introduce electronic design automation, design and data flow, scheduling, hardware description languages, and concepts of hardware reliability and security in VLSI design.									
CO2	To understand logic synthesis techniques for optimizing and mapping digital designs efficiently.									
CO3	To explore optimization techniques for partitioning, clock-tree synthesis, and placement in VLSI design to improve circuit performance and minimize congestion.									
CO4	To introduce routing techniques and clock design methods, focusing on optimization for reliability, manufacturability, and efficient circuit performance									

UNIT I

Introduction to Electronic Design Automation (EDA):
Design flow, data flow graph, control flow graph, scheduling, allocation, binding, technology scaling and its impact on VLSI design. Introduction to Hardware Description Languages (HDLs): Verilog, VHDL. Additional Topics: Hardware reliability, hardware security.

UNIT II

Logic Synthesis: Two-level minimization, multi-level minimization, technology-dependent optimization, technology-independent optimization, library modeling, sequential optimization, physical synthesis, multi-valued logic synthesis, netlist, technology mapping.

UNIT III

Partitioning: Clock-tree synthesis (CTS). Introduction to placement problem, min-cut placer, simulated-annealing based placers, timing-driven placement, congestion-driven placement, heuristic-based placement techniques.

UNIT IV

Here is the text with proper spacing: Introduction to Routing: Shapes, vias, wires and shape checking, custom routing, single-net point-to-point routing, single-net multi-point routing, classic multi-net two-layer routing, global routing, congestion analysis, routability-driven placement, parallel routing, interconnect synthesis.
Introduction: Global clock distribution, local clock distribution; electrical and physical optimization; design constraints and design closure; design for manufacturability and design for reliability.

TEXTBOOKS/REFERENCES

1. Electronic Design Automation for IC Implementation, circuit design and process Technology, By L.Lavagno, Igor Markov ,Grant Martin, and Louis Scheffer, CRC Press2016 (2nd Ed.).
2. Low-power High-Level Synthesis for Nanoscale CMOS Circuits, by Saraju P. Mohanty,NagarajanRanganathan,EliasKougianos,andPriyardarsanPatra,Spring.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

AUDIT COURSE-I

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
MTAD-101	English for Research Paper Writing		3	0	0	3	40	60	100	3
Purpose	To develop clear, concise, and effective research writing skills for academic and professional excellence.									
Course Outcomes (CO)										
CO1	To enhance clarity, conciseness, and structure in research writing.									
CO2	To improve clarity, attribution, and structure in research writing.									
CO3	To develop key skills for writing titles, abstracts, introductions, and literature reviews effectively									
CO4	To enhance writing skills for Methods, Results, Discussion, Conclusions, and ensure a strong first-time submission.									

UNIT I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

UNIT IV

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

TEXTBOOKS :

1. Gold bort R (2006) Writing for Science, Yale University Press (available on Google Books).
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
MTAD-103	Disaster management		3	0	0	3	40	60	100	3
Purpose	To provide students with the knowledge and skills to effectively plan, respond to, and recover from natural and man-made disasters									
Course Outcomes (CO)										
CO1	To provide students with a clear understanding of disasters, their causes, types, and magnitudes, and the distinction between hazards and disasters.									
CO2	To equip students with an understanding of the economic, environmental, and human impacts of both natural and man-made disasters									
CO3	To provide students with the knowledge to assess disaster-prone areas, evaluate risks using various data sources, and understand preparedness									
CO4	To equip students with the concepts, techniques, and strategies for disaster risk assessment, reduction, and mitigation									

Unit –1

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Unit 2

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks AndSpills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit 3

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit 4

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.

REFERENCES BOOKS :

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep&Deep Publication Pvt. Ltd., New Delhi.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

AUDIT COURSE-II

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
MTAD-105	Sanskrit for Technical Knowledge		3	0	0	3	40	60	100	3
Purpose	To enable students to explore and understand the use of Sanskrit in scientific, mathematical, and technical contexts									
Course Outcomes (CO)										
CO1	To provide students with a foundational understanding of Sanskrit alphabets, tenses, and sentence structure for effective communication									
CO2	To familiarize students with the structure, roots, and technical aspects of Sanskrit literature									
CO3	To provide students with an understanding of technical concepts in Sanskrit related to electrical and mechanical engineering, bridging ancient									
CO4	To introduce students to technical concepts in Sanskrit related to engineering fields like architecture and mathematics									

Unit-1

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

Unit – 2

Order, Introduction of roots, Technical information about Sanskrit Literature

Unit –3

Technical concepts of Engineering: Electrical, Mechanical

Unit –4

Technical concepts of Engineering: Architecture, Mathematics

REFERENCES BOOKS :

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.

Course Code	Course Name	Course Category	Credits							
			L	T	P	C	Minor Test	Major Test	Total	Time (Hrs)
MTAD-107	Value Education		3	0	0	3	40	60	100	3
Purpose	To promote moral, ethical, and social values, fostering holistic development and responsible citizenship among students									
Course Outcomes (CO)										
CO1	To help students develop a strong sense of social and individual values, work ethics, and moral reasoning									
CO2	Instill essential values such as duty, self-reliance, truthfulness, honesty, patriotism									
CO3	To enhance students' personality and behavior by promoting positive thinking, integrity, discipline, emotional									
CO4	To foster character development and competence by promoting values like self-management, nonviolence, humility									

Unit-1

Values and self-development –Social values and individual attitudes.Work ethics, Indian vision of humanism. Moral and non- moral valuation.Standards and principles.Value judgements.

Unit 2

Importance of cultivation of values.Sense of duty.Devotion, Self-reliance.Confidence, Concentration. Truthfulness, Cleanliness.Honesty, Humanity.Power of faith, National Unity.Patriotism.Love for nature, Discipline

Unit 3

Personality and Behavior Development - Soul and Scientific attitude.Positive Thinking.Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood
and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

Unit 4

Character and Competence –Holy books vs Blind faith.Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind,
Self-control. Honesty, Studying effectively

REFERENCES BOOKS :

1.Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Note for paper setter: Nine questions will be set in all. Question No. 1, which will be objective/ short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise, with two questions from each unit. The candidate will be required to attempt FIVE questions in all with Q.1 (compulsory) and four other questions, selecting one question from each unit. A question paper template will also be provided.