Faculty Of Engineering & Technology

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

M. Tech in – Artificial Intelligence & Machine Learning

Semester-I						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MAT560	Mathematical Foundations for Machine Learning	3	0	0	3
2	AML500	Advanced Algorithms and Analysis	3	0	0	3
3	AML501	Machine Learning Techniques	4	0	0	4
4	AML501L	Machine Learning Techniques Lab	0	0	3	2
5	AML502	Artificial Intelligence and Knowledge Representation	3	0	0	3
6	AML502L	Artificial Intelligence and Knowledge Representation Lab	0	0	3	2
7		Elective-I	3	0	0	3
Total						**20**

Semester-II						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MAT561	Optimisation Techniques	3	0	0	3
2	AML504	Data Warehousing and Pattern Mining	3	0	0	3
3	AML504L	Data Warehousing and Pattern Mining Lab	0	0	3	2
4	AML505	Deep Learning Techniques	4	0	0	4
5	AML505L	Deep Learning Techniques Lab	0	0	3	2
6	AML506	Natural Language Computing	3	0	0	3
7		Elective-II	3	0	0	3
8	RM101	Research Methodology and IPR	2	0	0	2
Total						**22**

Semester-III						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	EGL501	English for Research Paper Writing	2	0	0	2
2	AML507	Big Data Analytics	4	0	0	4
3	AML508	Soft Computing	4	0	0	4
4	AML580	Project Work-Phase I	0	0	20	10
Total						**20**

	Semester-IV					
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	AML581	Project Work - Phase II	0	0	28	14
2	AML584L	AI in Edge Computing Lab	0	0	8	4
3						
		Total				**18**

List of Electives					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
AML551	Modelling 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
AML554	Pattern Recognition	3	0	0	3
AML555	Problem Solving Methods in Artificial Intelligence	3	0	0	3
AML556	Cognitive Systems	3	0	0	3
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
AML560	Agent Systems	3	0	0	3
AML561	Artificial Intelligence and Neural Networks	3	0	0	3
AML562	Statistical Modelling 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

SEMESTER - I

SEMESTER-I

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
MAT560	Mathematical Foundations for Machine Learning	BS	3	0	0	3

UNIT I: PROBABILITY
Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence.

UNIT II: RANDOM VARIABLES
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: STOCHASTIC PROCESSES
Introduction to Stochastic Processes (SPs), Stationary Processes, Discrete-time Markov Chains (DTMCs), Continuous-time Markov Chains (CTMCs)

UNIT IV: LINEAR ALGEBRA
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

UNIT V: LINEAR ALGEBRA
Eigen values 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.

SEMESTER-I

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML500	Advanced Algorithms and Analysis	C	3	0	0	3

UNIT I: INTRODUCTION TO AAA
Defining Key Terms: Algorithm complexity, Greedy method, Dynamic Programming, Backtracking, Branch-and-bound Techniques; Examples for understanding above techniques; Memory model, linked lists and basic programming skills.

UNIT II: NP COMPLETENESS
Overview - Class P - Class NP - NP Hardness - NP Completeness - Cook Levine Theorem - Important NP Complete 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: GEOMETRIC ALGORITHMS
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'r Min Cut Algorithm, String matching and document processing algorithms.

UNIT V: APPROXIMATION 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

1. Allan Borodin and Ran El-Yaniv: Online Computation and Competitive Analysis, Cambridge University Press, 2005.
2. Michael T Goodric 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. RK Ahuja, TL Magnanti and JB Orlin, “Network flows: Theory, Algorithms, and Applications”, Prentice Hall Englewood Cliffs, NJ 1993.
6. Joseph JáJá: Introduction to Parallel Algorithms 1992.
7. Rajeev Motwani, Prabhakar Raghavan: Randomized Algorithms, Cambridge University Press, 1995.
8. Jiri Matousek and Bernd Gärtner: Understanding and Using Linear Programming, 2006.

SEMESTER-I

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML501	Machine Learning Techniques	C	4	0	0	4

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, univariate , multivariate feature selection approach, Feature reduction (Principal Component Analysis) , Python exercise on 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, nonlinear 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 networks and the back propagation algorithm,

UNIT V

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.

TEXTBOOKS

Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.

Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

REFERENCES

Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.

Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.

SEMESTER-I

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML501L	Machine Learning Techniques Lab	C	0	0	3	2

LIST OF PRACTICAL EXPERIMENTS

1. Basic exercises on Python Machine Learning Packages such as Numpy, Pandas and matplotlib.
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 feature reduction using Principle Component Analysis
8. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
9. Given a dataset 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 dataset 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
AML502	Artificial Intelligence and Knowledge Representation	C	3	0	0	3

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-Beta pruning, Evaluation functions, cutting of search.

UNIT III

Knowledge Representation**:** Using Predicate logic, representing facts in 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.

UNIT V

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

TEXTBOOKS/REFERENCES

1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, 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.

SEMESTER-I

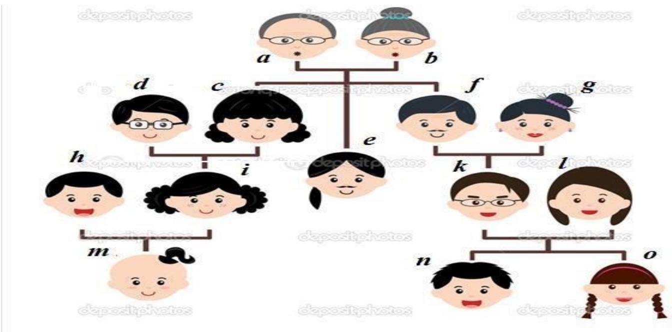
Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML502L	Artificial Intelligence and Knowledge Representation Lab	C	0	0	3	2

LIST OF PRACTICAL EXPRIMENTS

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- FAMILY TREE

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 middleare 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 (Fatheror 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, granddaughter 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 therelations mentioned above.

LAB EXERCISE 2- FACTORIAL, FIBONACCI SERIES AND PRIME NUMBER CHECKING

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 into 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 a skier or both. A likes whatever B dislikes and dislikes whatever B likes. A likes rain and snow. No mountain climber likes rain. Every skier likes snow.

Query 1: Is there a member who is a mountain climber and not a skier?

Query 2: Is there a member who is both a mountain climber and a skier?

Query 3: Is there a member who likes both rain and snow?

LAB EXERCISE 3 - LISTS

Lists are important in Prolog. You will often need to pattern match against lists. Create a prologfile named Lab3_List_exercise.pl and create the following knowledge base.

Write rules for:

isa_list/1 %argument is a list
member of/2 %an element is a member of a list
nonmember_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 regardless of their length
prefix/2 %first list is the prefix of the second list
allfifferent/1 %using nonmember_of/2 check whether the elements of a list areall 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 newlist
merge_lists/3 %merge two lists to make a new list

LAB ASSIGNMENT 4 - EIGHT QUEENS PROBLEM

Eight queens problem is a constraint satisfaction problem (CSP). The task is to place eight queensin the 64 available squares in such a way that no queen attacks each other. So the problem can be formulated with variables x1, x2, x3, x4, x5, x6, x7, x8 and y1, y2, y3, y4, y5, y6, y7, y8; where the xs represent the rows and ys the columns. Now a solution for this problem is to assign values for x and for y such that the constraint is satisfied. The problem can be formulated as: 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 so on. So, it can be clearly seen that the domains for xi and yi are Dx = {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 two queens should be in the same row, i.e yi≠yj for i=1 to 8; j=1 to 8; or i≠j ii. No two queens should be in the same column, i.e xi≠xj for i=1 to 8; j=1 to 8; or i≠j iii. There should not betwo queens placed on the same diagonal line i.e (yi-yj) ≠ ±(xi-xj). Write the required predicates tosolve the Eight Queens placement problem.

LAB EXERCISE 5 -TOWER OF HANOI

The Tower of Hanoi puzzle was invented by the French mathematician Edouard 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 golddisks, 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 ove a tower of 64 disks is 2 64−1=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 ofpaper will work. Write a Prolog program that efficiently keep track of the disk movements and that helps in recursively solving the problem of Tower of Hanoi.

LAB 6 -MEDICAL DIAGNOSIS EXPERT SYSTEM DESIGN

Expert systems are computer applications which embody some non-algorithmic expertise forsolving 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 representthis 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, sore throat.Runny nose, cough
Mumps	Fever, swollen glands
Chickenpox	Fever, chills, body ache rash

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 inferenceengine.

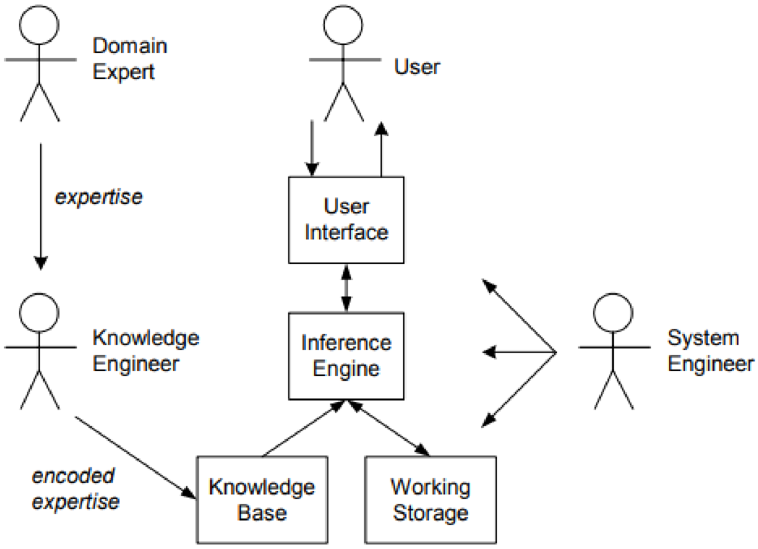


Figure 1.1 Expert system components and human interfaces

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 hypothesis 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 ask the patient about the symptoms he has to diagnose a disease. Store all these information gathered from the patient in the working storage one by one. Choose an appropriate data representation asattribute-value pair like symptom (Patient, german_measles) etc. As some symptoms are common in more than one disease the same question should not the asked twice to the patient to dignose 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 working storage before the next query. You can use prolog's in-built predicate retract/2 in the beginning of each query.

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

SEMESTER - II

SEMESTER-II

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
MAT561	Optimisation Techniques	BS	3	0	0	3

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 stages -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 atruss

UNIT V

Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time cost trade off, 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

1. Hamdy A. Taha, Operations Research, Prentice Hall, Pearso.
2. J. S Arora, Introduction to optimum design, IInd 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. AchilleMessac, Optimization in practice with MATLAB, Cambridge University Press, 2015.

SEMESTER-II

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML504	Data Warehousing and Pattern Mining	C	3	0	0	3

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.

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

REFERENCES

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.

SEMESTER-II

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML 504L	Data Warehousing and Pattern Mining Lab	C	0	0	3	2

LIST OF PRACTICAL EXPERIMENTS

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, Correlation between a pair of attributes.
3. Write a query to implementation 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 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 APRIORI algorithm. Use an appropriate data set to generate frequent patterns.
8. Write a program to demonstrate the working of stream mining algorithm. Use an appropriate data set to generate frequent patterns.
9. Write a program to implement K means clustering algorithm. Select your own dataset to test the program. Demonstrate the nature of output with varying value of K.
10. Write a program to demonstrate web page 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
AML505	Deep Learning Techniques	C	4	0	0	4

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 Fns, Soft max
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

UNIT V
Deep Learning applications: Image segmentation, Object detection, Attention model for computer vision tasks, Natural Language Processing, Speech Recognition, Video Analytics

TEXTBOOKS
1. Good fellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach, OReilly, 2017.

REFERENCES
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.

SEMESTER-II

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML505L	Deep Learning Techniques Lab	C	0	0	3	2

LIST OF PRACTICAL EXPERIMENTS

1. Installation and working on python, Juypter, and its different libraries for deep learning (Tensor Flow, NumPy, Kera, 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 predication).
4. To implement a Convolution 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 predicating time series data.
7. To implement a Long Short-Term Memory (LSTM) for predicating 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 predication.

SEMESTER-II

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML506	Natural Language Computing	C	3	0	0	3

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.

UNIT V

Information Extraction: Named entity recognition and relation extraction. IE using sequence labeling Machine Translation: Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.

REFERENCES

1. James Allen. Natural Language Understanding. The Benajmins/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.

SEMESTER-II

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
RM101	Research Methodology and IPR	ES	2	0	0	2

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,

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

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.

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

UNIT VI
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.

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

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 New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

SEMESTER - III

SEMESTER-III

Course Code	Course Name	Course Category	Credits			
			L	**T**	**P**	**C**
EGL501	English for Research Paper Writing	HS	1	0	0	1

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.

UNIT IV
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 V
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

UNIT VI

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.

SEMESTER-III

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML507	Big Data Analytics	C	4	0	0	4

UNIT I: INTRODUCTION TO BIG DATA
Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.

UNIT II: MINING DATA STREAMS
Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.

UNIT III: HADOOP
History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features Hadoop environment.

UNIT IV: FRAMEWORKS

Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM Info Sphere Big Insights and Streams.

UNIT V: PREDICTIVE ANALYTICS
Simple linear regression-Multiple linear regression- Interpretation of regression coefficients; Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications.

REFERENCES

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
5. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley& sons, 2012.
6. Glenn J. Myatt, “Making Sense of Data”, John Wiley & Sons, 2007.
7. Pete Warden, “Big Data Glossary”, O’Reilly, 2011.
8. Jiawei Han, MichelineKamber “Data Mining Concepts and Techniques”, 2 nd Edition, Elsevier, Reprinted 2008.
9. Da Ruan, Guoquing Chen, Etienne E.Kerre, Geert Wets, “Intelligent Data Mining”, Springer, 2007.
10. Paul Zikopoulos, DirkdeRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles , David Corrigan, “Harness the Power of Big Data The IBM Big Data Platform”, Tata McGraw Hill Publications, 2012.

11. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A Hands On Approach “,VPT, 2016
12. Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)”, John Wiley & Sons,2014.

SEMESTER-III

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML508	Soft Computing	C	4	0	0	4

UNIT I

Introduction: What is computational intelligence?- Biological basis for neural networks- Biological versus Artificial neural networks- Biological basis for evolutionary computation- Behavioral motivations for fuzzy logic, Myths about computational intelligence- Computational intelligence application areas, Evolutionary computation, computational intelligence-Adoption, Types, self-organization and evolution, Historical views of computational intelligence, Computational intelligence and Soft computing versus Artificial intelligence and Hard computing.

UNIT II

Evolutionary computation concepts and paradigms- History of evolutionary computation & overview, Genetic algorithms, Evolutionary programming &strategies, Genetic programming, Particle swarm optimization, Evolutionary computation implementations-Implementation issues, Genetic algorithm implementation, Particle swarm optimization implementation.

UNIT III

Neural Network Concepts and Paradigms- What Neural Networks are? Why they are useful, Neural network components and terminology- Topologies - Adaptation, Comparing neural networks and other information Processing methods- Stochastic- Kalman filters - Linear and Nonlinear regression - Correlation - Bayes classification -Vector quantization -Radial basis functions -Preprocessing - Post processing.

UNIT IV

Fuzzy Systems concepts and paradigms - Fuzzy sets and Fuzzy logic - Approximate reasoning, Developing a fuzzy controller - Fuzzy rule system implementation.

UNIT V

Performance Metrics- General issues- Partitioning the patterns for training, testing, and validation- Cross validation - Fitness and fitness functions - Parametric and nonparametric statistics, Evolutionary algorithm effectiveness metrics, Receiver operating characteristic curves, Computational intelligence tools for explanation facilities, Case Studies for implementation of practical applications in computational intelligence.

TEXTBOOKS

1. Russell C. Eberhart and Yuhui Shi. Computational Intelligence: concepts to implementations. Morgan Kaufmann Publishers is an imprint of Elsevier. 2007.
2. Andries P. Engelbrecht. Computational Intelligence: An introduction, Second Edition. Wiley. ISBN 978-0-470561-0. 2007.
3. John Fulcher and Lakshmi C. Jain. Computational Intelligence: A compendium, Springer. 2007.

REFERENCES

1. David B. Fogel and Charles J. Robinson; Computational Intelligence: The experts speak. Wiley - Intersciece 2003.

SEMESTER-III

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML580	Project Work - Phase I	PR	0	0	20	10

COURSE OBJECTIVES

AML580 & AML581 is a mandatory two semesters long project work course (spreading over third and fourth semester), culminating to dissertation writing and defending. This course is aimed to prepare our graduate students for a career in the high growth field of artificial intelligence and machine learning (AIML). After extensive literature survey, students will learn how to define a real-world problem with its scopes and challenges and then after experimenting with cutting edge artificial intelligence, data science and machine learning techniques learn to propose a solution. Students will learn to compare the performance metrics of their implementation with others' using industry standard software and powerful multicore CPU and GPU. Students will also learn to effectively communicate their research findings by writing and presenting papers and defending their dissertation.

COURSE CONTENT

In project phase I students will choose from a wide range of real-world problems that needs knowledge and expertise of artificial intelligence, data science and machine learning (AIML) 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 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 in 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 Défense of the dissertation will be considered as partial requirement for awarding M. Tech degree in Artificial Intelligence and Machine Learning.

COURSE LEARNING OUTCOME

1. Conduct state-of-the-art literature review in identified problem domain that requires AI and ML techniques.
2. Develop an in-depth understanding in the concept of uncovering business intelligence from large amount of web data mining.
3. 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.
4. Evaluate the proposed solution through extensive performance experiments.
5. Effectively communicate research findings in terms of reports and presentations.
6. Inculcate independent research ability that addresses fundamental problems.

SEMESTER - IV

SEMESTER-IV

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML581	Project Work - Phase II	PR	0	0	28	14

COURSE OBJECTIVES

- To prepare students for real-world research in **Artificial Intelligence (AI)** and **Machine Learning (ML)**.
- To enhance skills in defining, implementing, and solving advanced problems using AI and ML techniques.
- To conduct extensive **performance analysis**, validate solutions, and compare against industry benchmarks.
- To develop professional skills in **academic writing** and **effective defense** of research findings.
- To encourage publication of research findings in **reputed journals** and conferences.

COURSE CONTENT

Phase II - Key Activities

1. **Final Implementation of Proposed Solution**
   - Refine and extend the prototype/model developed in Phase I.
   - Advanced implementation using AI/ML tools, techniques, and frameworks:
     - Deep Learning models (e.g., CNN, RNN, GAN, Transformer).
     - Reinforcement Learning algorithms.
     - Natural Language Processing (NLP).
     - Data Mining and Visualization tools.
   - Integration with real-world data or case studies.
2. **Performance Evaluation and Optimization**
   - Conduct **benchmarking experiments** using:
     - Metrics such as accuracy, F1-score, recall, RMSE, etc.
     - Computational efficiency (CPU/GPU optimization).
   - Comparative study of results with **existing research** or state-of-the-art methods.
   - Model validation, testing, and hyperparameter tuning for optimization.
3. **Research Paper Writing**
   - Document the results into publishable formats:
     - Structure papers based on IEEE/Springer formats.
     - Publish in indexed journals/conferences (e.g., Scopus, SCI).
4. **Dissertation Writing**
   - Prepare the dissertation adhering to university guidelines.
   - Contents:
     - **Abstract**
     - **Introduction** (Problem Statement, Scope, Significance)
     - **Literature Review**
     - **Methodology**
     - **Results and Discussion**
     - **Conclusion and Future Work**
   - Follow citation standards (e.g., IEEE, APA).
5. **Dissertation Submission**
   - Submit the finalized dissertation to internal and external examiners at least **two weeks prior** to the defense date.

6. **Viva-Voce Examination**
   - Final defense of the project before a committee:
     - Presentation of research findings.
     - Justification of methodology, results, and conclusions.
     - Handling queries and feedback from examiners.

COURSE LEARNING OUTCOMES (CLOs)

Upon completion of Phase II, the students will be able to:

1. **Conduct State-of-the-Art Research**:
   - Perform extensive literature reviews to identify and refine real-world AI/ML problems.
2. **Develop Innovative AI/ML Solutions**:
   - Demonstrate expertise in uncovering business intelligence, solving computer vision, IoT, or autonomous system problems.
3. **Experimentation and Validation**:
   - Evaluate and compare performance metrics with the latest industry solutions using benchmark datasets.
4. **Communicate Research Findings**:
   - Effectively write **dissertation reports** and publish results in reputable journals/conferences.
   - Defend research outcomes through professional presentations and viva-voce.
5. **Independent Research**:
   - Develop strong research skills to address fundamental challenges using AI/ML techniques.

ASSESSMENT CRITERIA

Component	Weightage (%)
Implementation of Solution	30%
Performance Evaluation & Analysis	20%
Research Publications	10%
Dissertation Writing	20%
Viva-Voce Examination	20%

TOOLS & RESOURCES

1. **Programming Languages**: Python, R, MATLAB
2. **AI/ML Frameworks**: TensorFlow, PyTorch, Keras, Scikit-Learn
3. **Visualization Tools**: Matplotlib, Seaborn, Tableau
4. **Cloud Platforms**: AWS, Google Cloud, Azure (GPU/TPU instances)
5. **Research Tools**: LaTeX, Overleaf, EndNote, GitHub

EXPECTED OUTCOMES

By the end of the course, students will produce:

1. A fully functional AI/ML model or system.
2. A comprehensive dissertation report.
3. A minimum of one **research publication** in an indexed conference/journal.
4. A successful defense of their work in the **viva-voce** examination.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML 584L	AI in Edge Computing Lab	C	0	0	8	4

LIST OF PRACTICAL EXPERIMENTS –

Experiment 1: Introduction to Edge Devices

- Set up Raspberry Pi/Jetson Nano/Coral and configure development environments.

Experiment 2: Running a Pre-trained AI Model on Edge Devices

- Deploy an image classification model using TensorFlow Lite.
- Measure latency and performance.

Experiment 3: AI Model Optimization for Edge Computing

- Perform quantization and pruning on a pre-trained model.
- Compare accuracy and inference time before and after optimization.

Experiment 4: Real-time Object Detection at the Edge

- Implement object detection using MobileNet SSD on edge devices.

Experiment 5: Streaming Data Processing

- Process live video streams with AI inference at the edge.

Experiment 6: Real-Time Traffic Monitoring Application

- Deploy an edge AI model for vehicle detection and traffic analysis.

Experiment 7: Edge Impulse for Custom AI Models

- Train a custom AI model for sound or image recognition using Edge Impulse.

Experiment 8: Hands-on OpenVINO Toolkit

- Deploy optimized deep learning models using Intel OpenVINO on edge hardware.

Experiment 9: Integration of Edge AI with IoT

- Combine IoT sensor data and AI inference for anomaly detection.

Experiment 10: Energy Consumption and Performance Analysis

- Measure energy consumption during AI model execution on edge devices.

ELECTIVES

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML551	Modelling and Simulation of Digital Systems	E	3	0	0	3

UNIT I
Digital System Modeling and Simulation: Objectives, Objectives, Modeling, Synthesis, and Simulation Design, History of Digital Systems, Standard Logic Devices, Custom-Designed Logic Devices, Programmable Logic Devices, Simple Programmable Logic Devices, Complex Programmable Logic Devices, Field-Programmable Gate Arrays 6 Future of 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.

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–McCluskey Minimization.
Combinational Logic: Objectives, Combinational Logic Circuits, Multiplexers, Logic Design with Multiplexers, De multiplexers, Decoders, Encoders, Code Converters, Arithmetic Circuits.

UNIT V
Sequential Logic**:** Objectives, Sequential Logic Circuits, Latches, Flip-Flops, Registers, Counters, Problems.
Synchronous Sequential Logic: Objectives, Synchronous Sequential Circuits, Finite-State Machine Design Concepts, Finite-State Machine Synthesis, State Assignment, One-Hot Encoding Method, Finite-State Machine, Analysis, Sequential Serial Adder, Sequential Circuit Counters, State Optimization, Asynchronous Sequential Circuits.

TEXTBOOKS

1. Introduction to Digital Systems: Modelling, Synthesis, and Simulation Using VHDL. Ferdjallah, Mohammed. John Wiley & Sons, 2011.
2. Finite State Machines in Hardware Theory and Design (with VHDL and System Verilog). Volnei A. Pedroni, 2013.

REFERENCES

1. Hardware Description Languages and their Applications: Specification, modelling, verification and synthesis of microelectronic systems. C. Kloos, E. Cerny. Springer; 2013.
2. System Verilog for Verification: A Guide to Learning the Test bench Language Features. Ch. Spear, G. Tumbush. Springer; 3rd edition, 2012.
3. Advanced Digital Design with the Verilog HDL. M. Ciletti. Prentice Hall; 2nd edition, 2010.
4. M. Mano, C. Ciletti. Digital Design: With an Introduction to the Verilog HDL. Prentice Hall; 5th edition, 2012.

Course Code	Course Name	Course Category	CREDITS			
			L	T	P	C
AML552	Knowledge Engineering and Expert System	E	3	0	0	3

UNIT I
The nature of Expert Systems Types of applications of Expert Systems relationship of Expert Systems to Artificial Intelligence and to Knowledge-Based Systems. The nature of 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.

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.

UNIT V
Building Expert Systems Methodologies for building expert systems: knowledge acquisition and elicitation; formalisation; representation and evaluation. Knowledge Engineering tools, Case Study.

TEXTBOOKS

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

REFERENCES

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.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML553	Information Retrieval	E	3	0	0	3

UNIT I

Introduction: Overview of Information Retrieval, 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 Page Rank, 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 (Le ToR), 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

UNIT V
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 Schuetze, Cambridge University Press, 2007.

REFERENCES

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 BerthierRibeiro-Neto. 2nd edition, Addison-Wesley, 2011.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML554	Pattern Recognition	E	3	0	0	3

UNIT I: PATTERN CLASSIFIER
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
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 STRUCTURAL PATTERN RECOGNITION
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. Principle 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: HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE
State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.

UNIT V: RECENT ADVANCES
Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception

TEXTBOOKS/REFERENCES

1. Andrew Webb, “Stastical 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.

FUTURE UNIVERSITY
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Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML555	Problem Solving Methods in Artificial Intelligence	E	3	0	0	3

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.

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, travelling salesman etc

UNIT V
Local search and met heuristics; Single-solution based algorithms vs population based algorithms; Simulated Annealing; Tabu search; Genetic Algorithms; Scatter Search; Ant Colony Optimization; Adaptive Memory Procedures; Variable Neighborhood Search; Evolutionary Algorithms; Memetic Algorithms; Particle Swarm, The Harmony Method etc.

REFERENCES

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.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML556	Cognitive Systems	E	3	0	0	3

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- Feed forward and Recurrent Networks: - Continuously Labeled Networks –Feed forward Networks - Recurrent Networks -Excitatory-Inhibitory Networks - Stochastic Networks.

UNIT V

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 Frieden berg, Gordon Silverman.

REFERENCES

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 (fifth) Edition.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML557	Introduction to High Performance Computing	E	3	0	0	3

UNIT I: INTRODUCTION TO PIPELINING AND INSTRUCTION LEVEL PARALLELISM
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: MULTI PROCESSORS AND THREAD – LEVEL PARALLELISM
Introduction to multi processors and thread level parallelism - Characteristics of application domain - Systematic shared memory architecture - Distributed shared – memory architecture – Synchronization – Multithreading - Multithreading-fined 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: MEMORY HIERARCHY
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.

UNIT IV: PARALLEL PROGRAMMING
Introduction to parallel computing platforms; (Open MP, MPI, Open CL, Open ACC) with performance improvement analysis done using real-life AI and ML applications

UNIT V: INTER CONNECTION AND NETWORKS
Introduction to inter connection 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

1. Wang, Endong, Qing Zhang, Bo Shen, Guangyong Zhang, Xiaowei Lu, Qing Wu, and Yajuan Wang. "High-performance computing on the Intel Xeon Phi." Springer 5, 2014.
2. Sanders, Jason, and Edward Kandrot. "CUDA by example: an introduction to general-purpose GPU programming", Addison-Wesley Professional, 2010.
3. Chandra, Rohit, Leo Dagum, David Kohr, Ramesh Menon, Dror Maydan, and Jeff McDonald. Parallel programming in Open MP. Morgan kaufmann, 2001.
4. Kaeli, David R., Perhaad Mistry, Dana Schaa, and Dong Ping Zhang. Heterogeneous computing with Open CL 2.0. Morgan Kaufmann, 2015.
5. Farber, Rob. Parallel programming with Open ACC. Newnes, 2016.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML558	Computer Vision	E	3	0	0	3

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.

UNIT V
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.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML559	Number theory and Cryptography	E	3	0	0	3

UNIT I

Cryptography, Cryptanalysis and Brute-Force Attack, Basic introduction 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(2^n), 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

UNIT V

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

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.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML560	Agent Systems	E	3	0	0	3

UNIT I

Introduction – the vision thing, some views of the field and objections to multiagent 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 MetateM

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
Multiagent Interactions – Utilities and preferences; Multiagent 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.

UNIT IV

Working Together – Cooperative distributed problem solving; Task sharing and result sharing; Combining task and result sharing; Handling inconsistency; Coordination; multiagent planning and synchronization.
Methodologies – When is an agent-based solution appropriate?; Agent-oriented analysis and design techniques; pitfalls and agent development; mobile agents.

UNIT V

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 Multiagent 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. Multiagent Systems by Gerhard Weiss, 2nd edition, The MIT Press.

REFERENCES

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

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML561	Artificial Intelligence and Neural Networks	E	3	0	0	3

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-Beta pruning, Evaluation functions, cutting of search.

UNIT III

Knowledge Representation & Reasons logical Agents, Knowledge – Based Agents, the Wumpus world, logic, propositional logic, Resolution patterns in propos ional 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

Characteristics 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.

UNIT V

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.

TEXTBOOKS/REFERENCES

1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, 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 Edition.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML562	Statistical Modelling for Computer Science	E	3	0	0	3

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 kind 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.

UNIT V

Multiple and logistic regression- Introduction to multiple regression, Model selection, Checking model conditions using graphs, Multiple regression case studies, Introduction to logistic regression.

REFERENCES

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

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML563	Fuzzy Logic and its Applications	E	3	0	0	3

UNIT I
Introduction and Motivation: History of fuzzy theory; Limitations of classical logic; Introduction to fuzzy 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.

UNIT V
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 2).
5. Fuzzy Set Theory –Foundations and Applications, George J. Klir , Ute St. Clair, and Bo Yuan, Prentice Hall PTR, 1997 3) .
6. Fuzzy Engineering, Bart Kosko, Prentice Hall, 1997 4) Fuzzy Logic with Engineering Applications, by Timothy J. Ross, McGraw Hill, 1995.

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
AML564	Electronic Design Automation	E	3	0	0	3

UNIT I: HIGH LEVEL SYNTHESIS
Introduction to Electronic Design Automation, Design flow, Data flow graph, Control flow graph, Scheduling, Allocation, Binding, technology scaling and its impact on VLSI design, Introduction to Hardware description languages (Verilog/VHDL), Hardware reliability, Hardware Security.

UNIT II: REGISTER TRANSFER LEVEL
Logic Synthesis, Two-level Minimization, Multi-level Minimization, Technology-dependent optimization, Technology-independent optimization, Library modelling, Sequential optimization, Physical Synthesis, Multi-valued Logic Synthesis, Net list, technology mapping.

UNIT III: FLOOR PLANNING AND PLACEMENT
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: ROUTING
Introduction to routing: shapes, vias, wires and shape checking, custom routing, Single-net point-to-point routing, Single-net multi-point routing, classic mutinet two layer routing, global routing, congestion analysis, Routability-driven placement, Parallel routing, interconnect synthesis.

UNIT V: CLOCK DESIGN AND 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 Press 2016 (2nd Ed.).
2. Low-power High-Level Synthesis for Nanoscale CMOS Circuits, by Saraju P. Mohanty, Nagarajan Ranganathan, Elias Kougianos, and Priyardarsan Patra, Spring.