RAMAKRISHNA MISSION VIDYAMANDIRA

Belur Math, Howrah-711202, West Bengal, India
A Residential Autonomous College affiliated to the University of Calcutta,
A College with Potential for Excellence, DBT Star College

Department of Computer Science and Electronics

Syllabus for M.Sc. in Computer Science

DURATION: 4 SEMESTERS

TOTAL CREDIT: 84

FULL SYLLABUS WITH COURSE OUTCOME

RAMAKRISHNA MISSION VIDYAMANDIRA

Syllabus for M.Sc. Computer Science & Machine Intelligence

SEMESTER – I

Course code	Course title	Credits	Marks	No. of Hours/Week		
				L	T	P
Theoretical						
CC1	Artificial Intelligence (AI)	4	50	5	1	0
CC2	Essential Statistics and Mathematics for AI and Machine Learning (ML)	4	50	5	1	0
CC3	Advanced Algorithms and Data Structures	4	50	5	1	0
Practical						
CC4	AI Problem Solving Lab using Python & Statistics Essentials using R Programming Lab	4	25+25	0	2	6
CC5	Advanced Algorithms and Data Structures Lab	4	25+25	0	2	6
	Total	**20**	**250**			

SEMESTER – II

Course code	Course title	Credits	Marks	No. of Hours/Week		
				L	T	P
Theoretical						
CC6	Introduction to Machine Learning	4	50	5	1	0
CC7	Advanced Architecture and System Programming	4	50	5	1	0
CC8	Internet-of-Things (IoT)	4	50	5	1	0
Practical						
CC9	Machine Learning Lab, Advanced Architecture and System Programming Lab	2+2	25+25	0	2	6
CC10	IoT Lab using Raspberry Pi/Arduino, Minor Project and Presentation	2+2	25+25	0	2	6
	Total	**20**	**250**			

SEMESTER – III

Course code	Course title	Credits	Marks	No. of Hours/Week		
				L	T	P
Theoretical						
CC11	Introduction to Deep Learning	4	50	5	1	0
CC12	Data Science and Natural Language Processing (NLP)	4	50	5	1	0
CC13	Elective-I	4	50	5	1	0
Practical						
CC14	Deep Learning Lab, Data Science and NLP Lab	4	25+25	0	2	6
CC15	Elective-I Lab and Project Designing	4	25+25	0	2	6
	Total	**20**	**250**			

SEMESTER – IV

Course code	Course title	Credits	Marks	No. of Hours/Week		
				L	T	P
CC16	Elective-II	4	50	5	1	0
CC17	Dissertation/Project	14	125	0	2	16
CC18	Research Methodology and Presentation Lab	2	25	0	2	2
CC19	Grand Viva	4	50	0	0	0
	Total	**24**	**250**			

ELECTIVE PAPERS
(Choose Elective I and Elective II from the following lists)

Paper Name
Elective-I
Computer Vision
Cybersecurity
Big Data Analytics
Advanced Database Management Systems
Elective-II
Image Processing
Bioinformatics
VLSI Design
Blockchain

RAMAKRISHNA MISSION VIDYAMANDIRA

Syllabus M.Sc. Computer Science & Machine Intelligence

Semester-I (July-December)

Course Code: CC1 **Credit: 4**

Course Type: Core Course Theory

Course Outcome:

The Artificial Intelligence (AI) course is designed to help learners decode the mystery of AI and its business applications. The course provides an overview of AI concepts and workflows, machine learning and deep learning, and performance metrics. You'll learn the difference between supervised, unsupervised, and reinforcement learning; be exposed to use cases, and see how clustering and classification algorithms help identify AI business applications.

Key Learning Objectives:

- To understand the meaning, purpose, scope, stages, applications, and effects of AI
- To understand the fundamental concepts of Machine Learning and Deep Learning
- Distinguish between supervised, semi-supervised, and unsupervised learning
- Learn about Machine Learning workflow and how to implement the steps effectively
- Understand the role of performance metrics and how to identify their key methods

CC1: Artificial Intelligence (AI)

Credit: 4 **Marks: 50**

Overview: Foundations, scope, problems, and approaches of AI. **[2L]**

Intelligent agents: Reactive, deliberative, goal-driven, utility-driven, and learning agents Artificial Intelligence programming techniques. **[5L]**

Problem-solving through Search: Forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, evolutionary search algorithms, and sample applications. **[10L]**

Knowledge Representation and Reasoning: Ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, and sample applications. **[12L]**

Planning: Planning as search, partial order planning, construction, and use of planning graphs. [**5L]**

Representing and Reasoning with Uncertain Knowledge: Probability, connection to the logic, independence, Bayes rule, Bayesian networks, probabilistic inference, and sample applications. **[10L]**

Decision-Making: Basics of utility theory, decision theory, sequential decision problems, elementary game theory, and sample applications. **[6L]**

Machine Learning and Knowledge Acquisition: Learning from memorization, examples, explanation, and exploration. learning nearest neighbor, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, and sample Applications of AI. **[10L]**

Text/References:

1. "Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, Third Edition, Pearson.
2. "Artificial Intelligence", Kevin Knight, Elaine Rich, Shivashankar B. Nair, Third Edition, McGraw Hill Education.
3. "Introduction to AI & Expert System", Dan W. Patterson, PHI. [Edition is missing]
4. "Artificial Intelligence", Luger, Pearson Education.

Journals/Periodicals:

1. IEEE Transactions on Pattern Analysis and Machine Intelligence
2. IEEE Transactions on Neural Networks and Learning Systems
3. AI Magazine
4. Expert Systems With Applications
5. Complex & Intelligent Systems
6. Neural Processing Letters

RAMAKRISHNA MISSION VIDYAMANDIRA

Syllabus for M.Sc. Computer Science & Machine Intelligence

Course Code: CC2 **Credit: 4**

Course Type: Core Course Theory

Course Outcome:

The Essential Statistics and Mathematics for AI and Machine Learning (ML) course is designed to help learners to assign a probability to an event based on experiments. It is the application of quantitative principles to the collection, analysis, and presentation of numerical data. It will enable you to define statistics and essential terms related to it, explain measures of central tendency and dispersion, and comprehend skewness, correlation, regression, distribution. You will be able to make data-driven predictions through statistical inference.

Key Learning Objectives:

- Understand the fundamentals of statistics
- Work with different types of data
- How to plot different types of data
- Calculate the measures of central tendency, asymmetry, and variability
- Calculate correlation and covariance
- Distinguish and work with different types of distribution
- Estimate confidence intervals
- Perform hypothesis testing
- Make data-driven decisions
- Understand the mechanics of regression analysis
- Carry out regression analysis
- Use and understand dummy variables
- Understand the concepts needed for data science even with Python and R

CC2: Essential Statistics and Mathematics for AI and MachineLearning

Credit: 4 **Marks: 50**

Introduction to Linear Algebra: Vector spaces, Matrices and systems of linear equations, Eigen values and Eigen vectors. **[7L]**

Random Variables: Discrete and continuous random variables, Cumulative Distribution Function (C.D.F.) and its properties, Probability Mass Function (P.M.F.) and Probability Density Function (P.D.F.), Introduction to Markov Chain. **[6L]**

Univariate Distributions: Binomial, Poisson, Negative Binomial, Geometric distributions, and their properties. Normal, Exponential distributions, and their properties. **[7L]**

The P.M.F. and P.D.F. in the bivariate case. Marginal and Conditional distributions, Independence, Conditional Expectation. Theorems on sum and product of expectations of random variables. Bivariate Normal distribution and its properties. **[6L]**

Probability Inequalities: Markov's & Chebyshev's inequalities. Weak law of large numbers and Central limit theorem and their applications. **[4L]**

Concepts of Random Sampling, Statistics and Sampling Distributions of Statistics. **[4L]**

Distributions of the mean and variance of a random sample from a normal population, t and F distributions. **[4L]**

Point Estimation: Requirements of a good estimator – notions of Mean Square Error, Unbiasedness: Minimum Variance Unbiasedness and Best Linear Unbiasedness. **[3L]**

Least Squares and Linear Regression, Multivariable Regression: Gauss Markov theorem. [**8L**]

Elements of Hypothesis Testing: Null and Alternative hypotheses, Simple and Composite hypotheses, Critical Region, Type I and Type II Errors, Level of Significance and Size, p-value, Power. **[3L]**

Tests of Significance related to the mean(s) and variance(s) of a single univariate normal distribution, and two independent normal distributions. **[4L]**

Tests related to regression coefficients **[2L]**

Principal Component Analysis. **[2L]**

Text/References:

1. Higher Algebra (Abstract and Linear) . S.K Mapa
2. An Introduction to Probability Theory & Math. Statistics, Rohatgi V.K., John Wiley.
3. Introduction to Probability Theory (Vol-1), Hoel P.J., Port S.C. & Stone C.J., Mifflin & UBS
4. An Outline of Statistical Theory (Vol-1), Goon A.M., Gupta M.K. & Dasgupta B., World Press
5. An Outline of Statistical Theory (Vol-2), Goon A.M., Gupta M.K. & Dasgupta B., World Press
6. An Introduction to Probability Theory & its Applications, Feller W., John Wiley
7. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, Sixth Edition, Wiley.

Journals/Periodicals:

1. Journal of Applied Statistics Taylor and Francis
2. Advances in Data Analysis and Classification
3. AStA Advances in Statistical Analysis
4. Machine Learning
5. International Journal of Machine Learning and Cybernetics

RAMAKRISHNA MISSION VIDYAMANDIRA

Syllabus M.Sc. Computer Science & Machine Intelligence

Course Code: CC3 **Credit: 4**

Course Type: Core Course Theory

Course Outcome:

By the end of the course, the students will be able to design and analyse programming problem statements, choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem, understand the necessary mathematical abstraction to solve problems, come up with analysis of efficiency and proofs of correctness, comprehend and select algorithm design approaches in a problem specific manner.

Key Learning Objectives:

The course is intended to provide the foundations of the practical implementation and usage of Algorithms and Data Structures.

- One objective is to ensure that the student evolves into a competent programmer capable of designing and analysing implementations of algorithms and data structures for different kinds of problems.

- The second objective is to expose the student to the algorithm analysis techniques, to the theory of reductions, and to the classification of problems into complexity classes like P, NP, NP-complete, and NP-hard.

CC3: Advanced Algorithms and Data Structures

Credit: 4 **Marks: 50**

Review of Foundations of Algorithms: [5L]

Requirements and Methodologies for Analysing Algorithms, Growth of Functions, Asymptotic Notations and their Properties: Big-Oh Notation, Big-Theta Notation, Big-Omega Notation, Little-Oh Notation, Little-Omega Notation. [2L]

Recurrence Relation, Solving Recurrence Relation using Substitution Method, Recursion Tree and Master Method. [1L]

Amortized Analysis: Aggregate Analysis, Accounting Method, Potential Method, Proof of Correctness. [2L]

Algorithm Design Techniques: [4L]

Basic Concepts and Case Studies of Divide and Conquer, Dynamic Programming, Greedy Algorithm, Backtracking, Branch-and-Bound.

Graph Algorithms: [4L]

Graph Representation, Graph Traversal Algorithms: Breadth-First Search, Depth-First Search, Minimum Spanning Tree Algorithms: Prim's Algorithm, Kruskal's Algorithm, Shortest Path Algorithms: Bellman Ford Algorithm, Dijkstra's Algorithm, Floyd-Warshall Algorithm.

Network Flow Algorithms: [2L]

Introduction to Flow Network and Cut, Finding Maximum Flow, Ford-Fulkerson Method.

Lower Bound Theory: [2L]

Concept of Lower Bound and Decision Trees, Lower Bounds for Bubble Sort, Binary Search**.**

Randomized Algorithms: [2L]

Basic Concepts and Allied Theories, Randomized Quick Sort, Randomized Find.

String Matching Algorithms: [2L]

Basic Concepts and Terminologies, Naive Algorithm, Knuth-Morris-Pratt Algorithm.

Polynomials and Number Theoretic Algorithms: [3L]

Introduction, Representation of Polynomial, Polynomial Arithmetic, Fast Fourier Transform, Modular Arithmetic, Solving Modular Linear Equations, Chinese Remainder Theorem.

Computational Complexity: [2L]

Basic Concepts and Terminologies, P, NP, NP-Hard and NP-Complete Classes, Their Relation and Case Study, Satisfiability Problem, Reducibility.

Approximation Algorithms: [2L]

Basic Concepts, Approximation Algorithm for Vertex Cover Problem and Travelling Salesman Problem.

Parallel Algorithms: [3L]

Need for Parallel Algorithms, Models of Computation, Analysing Parallel Algorithms, Parallel Algorithms for Sorting and Searching.

Review of Linear and Non-Linear Data Structures: [4L]

Vector, List, Sequence ADT: Array, Stack, Queue, Linked List; Different Sorting and Searching Algorithms; Binary Tree, Binary Search Tree, Threaded Binary Tree; Height Balanced Tree: AVL Tree, B-Tree, and B*-Tree; Hashing.

Advanced Data Structures: [5L]

Heap: Binary Heap, Binomial Heap, Fibonacci Heap. [2L]
Huffman Coding, Red-Black Tree. [2L]
Sets and Disjoint Set Data Structure. [1L]

Texts/References:

1. Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, 3rd Edition, PHI Learning.
2. Algorithm Design by K. Tardos, Pearson.
3. Randomized Algorithms by R. Motwani and P. Raghavan, Cambridge University Press.
4. Parallel Computing: Theory & Practice by Michael J. Quinn, Second Edition, Tata McGraw Hill.
5. Parallel Computers: Architecture and Programming by V. Rajaraman and C Siva Ram Murthy, PHI learning.
6. The Design and Analysis of Parallel Algorithms by S. G. Akl, Prentice Hall
7. Data Structures using C by A. S. Tanaenbaum, Y. Langram, and M. J. Augestein, Pearson Education, 2004.
8. Fundamentals of Data structures in C++ by E. Horowitz, S. Sahni and Dinesh Mehta, University Press, 2007
9. Data structures, Algorithms and Applications in C++ by S. Sahni, University Press (India) Pvt. Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.
10. Data structures and Algorithms in C++ by M. T. Goodrich, R. Tamassia, and Mount, Wiley student edition, John Wiley and Sons.
11. Data structures and Algorithm Analysis in C++ by Mark Allen Weiss, Pearson Education Ltd., Second Edition.
12. Data structures and algorithms in C++, Third Edition by A. Drozdek, Thomson.
13. Data structures using C and C++ by Y. Langsam, M. J. Augestein, and A. S. Tanenbaum, PHI.
14. Problem solving with C++, The OOP, Fourth edition, by W. Savitch, Pearson Education.

Journals/Periodicals:

1. Journal of Algorithms, Elsevier
2. ACM Transactions on Algorithms
3. Algorithmica, Springer
4. Theoretical Computer Science, Science Direct
5. Theoretical Computer Science, Elsevier
6. International Journal of Computational Complexity and Intelligent Algorithms, Inderscience Publishers

RAMAKRISHNA MISSION VIDYAMANDIRA

Syllabus M.Sc. Computer Science & Machine Intelligence

Course Code: CC4 **Credit: 4**

Course Type: Practical

AI Problem Solving Lab using Python & Statistics

Essentials using Programming Lab I

Credit: 4 **Marks: 50**

Implementation of various AI problems using Python.

Text/References:

1. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, William McKinney, Second Edition, Shroff/O'Reilly.
2. Automate the Boring Stuff with Python: Practical Programming for Total Beginners, Al Sweigart, Second Edition, No Starch Press
3. Data Visualization in Python, Daniel Nelson
4. Python Data Science Handbook: Essential Tools for Working with Data, Jake VanderPlas, O'Reilly Media.
5. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, Hadley Wickham, Garrett Grolemund, Shroff/O'Reilly

RAMAKRISHNA MISSION VIDYAMANDIRA

Syllabus M.Sc. Computer Science & Machine Intelligence

Course Code: CC5 **Credit: 4**

Course Type: Practical

Advanced Algorithms and Data Structures Lab

Credit: 4 **Marks: 50**

Implementation of various algorithmic and data structures problems.

Text/References:

1. Data Structures using C by A. S. Tanaenbaum, Y. Langram, and M. J. Augestein, Pearson Education, 2004.
2. Data structures, Algorithms and Applications in C++ by S. Sahni, University Press (India) Pvt. Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.
3. Data structures and algorithms in C++, Third Edition by A. Drozdek, Thomson..