R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR-Semester – III
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Mathematical Foundation of Artificial Intelligence	ML-3011	3L-1T-0P	4

Course Outcomes:

CO1 Students will be able to understand and apply concepts of vectors, matrices, eigenvalues, and eigenvectors

CO2 Students will be able to understand probability theory, random variables, and distributions, and apply Bayesian reasoning and statistical inference in AI tasks

CO3 Students will be able to apply differential and integral calculus to functions of multiple variables and use gradient-based methods for optimization problems in AI

CO4 Students will be able to understand entropy, mutual information, and KL divergence and apply these concepts in AI models

CO5 Students can analyze structures like graphs, trees, and networks used in knowledge representation and pathfinding and use Markov chains and HMMs in sequential decision-making processes

Course Contents:

UNIT I

Introduction: Artificial Intelligence, Data Science, Examples of real-world applications, **Linear Algebra:** Vectors, matrices, and tensor operations, Matrix decompositions (SVD, PCA, Eigenvalues), Linear transformations and applications in machine learning, Solving systems of equations (least squares, gradient descent)

UNIT II

Probability and Statistics: Basics of probability theory, Conditional probability and Bayes' theorem, Random variables and distributions (Gaussian, Binomial, Bernoulli, Poisson), Expectation, variance, covariance, Law of large numbers and central limit theorem, Bayesian inference and maximum likelihood estimation, Hypothesis testing (p-values, confidence intervals), Markov chains and hidden Markov models (HMMs)

UNIT III

Calculus and Optimization: Functions, limits, and continuity, derivatives, gradients, and Jacobians, Convex vs. non-convex optimization, Gradient descent (SGD, Adam, RMSProp), Lagrange multipliers for constrained optimization

Information Theory: Entropy, KL divergence, and cross-entropy, Mutual information and feature selection, Loss functions in ML (log loss, MSE, decision trees, feature selection)

UNIT IV

Network Science: Graph representations (adjacency matrices, edge lists), Centrality measures (PageRank, betweenness), Community detection (Girvan-Newman, spectral clustering)
Numerical Methods: Solving linear systems, Numerical stability (overflow, underflow), Monte Carlo simulations, Finite differences and approximations, Gradient checking, applications in backpropagation

UNIT V

Advanced Topics: Measure theory (for rigorous probability), Topological data analysis (persistence diagrams), Reinforcement learning (Markov decision processes)

References:

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press
2. Essential Math for AI: Next-Level Mathematics for Efficient and Successful AI Systems by Hala Nelson, O'Reilly Media
3. Math for Deep Learning: What You Need to Know to Understand Neural Networks by Ronald T. Kneusel, No Starch Press
4. Practical Mathematics for AI and Deep Learning by Tamoghna Ghosh, Shravan Kumar Belagalmath, BPB Publications
5. Mathematics of Machine Learning by Tivadar Danka, Santiago Valdarrama, Packt Publishing
6. Mathematical Foundation of Machine by Madhuri Sahu, Mangala Madankar, Minakshi Ramteke, and Ritesh Sule, Notion Press
7. Basic Math for AI by Andrew Hinton, Book Bound Studios
8. Artificial Mathematical Intelligence by Danny A. J. Gómez Ramírez, Springer

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – III
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Data structure & Algorithms	ML-3021	3L-1T-2P	6

Course Outcomes:

CO1 Understand the concept of Dynamic memory management, data types, algorithms, Big O notation.

CO2 Understand basic data structures such as arrays, linked lists, stacks and queues.

CO3 Describe the hash function and concepts of collision and its resolution methods

CO4 Solve problem involving graphs, trees and heaps.

CO5 Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data

Course Contents:

UNIT I

Introduction: to Notions of data type, abstract data type, and data structures, Relation to the notion of classes and objects in object oriented programming, Importance of algorithms and data structures in programming, Notion of Complexity covering time complexity and space complexity, Worst case complexity, Average case complexity, Big O Notation, Examples of simple algorithms and illustration of their complexity, Introduction to recurrence relations, Iteration and Recursion - Problem solving using iteration and recursion with examples such as binary search, Fibonacci numbers, and Hanoi towers, Tradeoffs between iteration and recursion

UNIT- II

List ADT, Implementation of lists using arrays and pointers, Stack ADT, Queue ADT, Implementation of stacks and queues, Dictionaries, Hash tables: open tables and closed tables. Analysis of hashing, Skip lists and analysis

UNIT- III

Binary Trees- Definition and traversals: preorder, postorder, inorder, Common types and properties of binary trees, Counting of binary trees, Huffman coding using binary trees, Binary search trees: worst case analysis and average case analysis. AVL trees, Red-Black Trees, Splay trees, Priority Queues - Binary heaps: insert and delete min operations and analysis. Binomial queues

UNIT- IV

Directed Graphs - Data structures for graph representation, Shortest path algorithms: Dijkstra (greedy algorithm) and Bellman-Ford (dynamic programming), Depth- first search and Breadth-first search. Directed acyclic graphs, Undirected Graphs - Depth-first search and breadth-first search, Minimal spanning trees and algorithms (Floyd and Kruskal) and implementation, Application to the travelling salesman problem

UNIT- V

Sorting- Bubblesort, selection sort, insertion sort, Shell sort; Quicksort; Heapsort; Mergesort; Radix sort; Analysis of the sorting methods. Selecting the top k elements, Lower bound on sorting

References:

1. Classic Data Structures, by Debasis Sumanta, PHI Learning Private Limited
2. Data Structures and Algorithms, by Alfred V. Aho, Jeffrey D. Ullman and John E. Hopcroft, Addison- Wesley Series
3. Schaum's Outline of Data Structures, by Seymour Lipschutz, Tata McGraw Hill Education
4. Data Structures And Algorithms Made Easy, by Narasimha Karumanchi, Careermonk Publications
5. Data Structures and Algorithms in Python, by Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser, Wiley
6. Fundamentals of Data Structures in C, 2e, by Sahni Horowitz, University Press
7. Data Structures Through C in Depth, by S.K.Srivastava and Deepali Srivastava, BPB Publications
8. Data Structures and Algorithms, by Reema Thareja, Oxford University Press
9. Data Structures Using C, by E. Balagurusamy, McGraw Hill Education
10. Data Structures, 2e, by R. Venkatesan and S. Lovelyn Rose, Wiley
11. Data Structures Through C, by Yashavant Kanetkar, BPB Publications

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – III
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Computer Organization & Architecture	ML-3031	3L-1T-0P	4

Course Outcomes:

CO1 Explain the organization of basic computer, its design and the design of control unit.

CO2 Understand basic data structures such as arrays, linked lists, stacks and queues.

CO3 Describe the operations and language of the register transfer, micro operations and input-output organization.

CO4 Understand the organization of memory and memory management hardware.

CO5 Elaborate advanced concepts of computer architecture, Parallel Processing, interprocessor communication and synchronization.

Course Contents:

UNIT I

Basic Structure of Computers

Functional units - Basic operational concepts - Bus structures - Software performance – Memory locations and addresses – Memory operations – Instruction and instruction sequencing – Addressing modes – Assembly language – Basic I/O operations – Stacks and queues.

UNIT II

Arithmetic Unit

Addition and subtraction of signed numbers – Design of fast adders – Multiplication of positive numbers - Signed operand multiplication and fast multiplication – Integer division – Floating point numbers and operations.

UNIT III

Basic Processing Unit

Fundamental concepts – Execution of a complete instruction – Multiple bus organization – Hardwired control – Microprogrammed control - Pipelining – Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration – Superscalar operation.

UNIT IV

Memory System

Basic concepts – Semiconductor RAMs - ROMs – Speed - size and cost – Cache memories - Performance consideration – Virtual memory- Memory Management requirements – Secondary storage

UNIT V

I/O Organization

Accessing I/O devices – Interrupts – Direct Memory Access – Buses – Interface circuits – Standard I/O Interfaces (PCI, SCSI, USB)

References:

1. Computer System Architecture, 3e, by M. Morris Mano, Pearson Education
2. Computer Organization and Architecture - Designing for Performance, 11e, by William Stallings, Pearson Education
3. Computer Architecture and Organisation: Schaum's Outlines Series, by Nicholas P. Carter, Raj Kamal, McGraw Hill Education
4. Computer Organization 5e, by Carl Hamacher, Zvonko Vranesic and Safwat Zaky, McGraw Hill Education
5. Computer Architecture and Organization, by John P. Hayes, McGraw Hill Education
6. Computer Organization and Design: The hardware/Software Interface, by David A. Patterson and John L. Hennessy, Morgan Kaufmann

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – III
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Digital Circuit and System	ML-3041	3L-1T-2P	6

Course Outcomes:

CO1 Develop a digital logic and apply it to solve real life problems.

CO2 Analyze, design and implement combinational logic circuits.

CO3 Classify different semiconductor memories.

CO4 Analyze, design and implement sequential logic circuits

Course Contents:

UNIT I

Digital Fundamentals

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization

UNIT II

Combinational Circuit Design

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder

UNIT III

Synchronous Sequential Circuits

Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register

UNIT IV

Asynchronous Sequential Circuits

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits

UNIT V

Memory Devices and Digital Integrated Circuits

Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM – Programmable Logic Devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) – Implementation of combinational logic circuits using PLA, PAL. Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS

References:

1. Digital Logic and Computer Design By M. Morris Mano
2. Digital Circuits and Design 5e, By S. Salivahanan and S. Arivazhagan, Oxford University Press
3. Fundamentals of Digital 4e, by A. Anand Kumar, PHI Learning Private Limited
4. Digital Principles and Applications, 6e, by Donald P.Leach and Albert Paul Malvino, McGraw Hill Education
5. Digital Design, Principles and Practices, by John. F. Wakerly, Pearson Education
6. Digital Logic Applications and Design, by John.M Yarbrough, Thomson Learning

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – III
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Value Education	ML-3051	3L-1T-2P	6

Course Outcomes:

CO1 To learn the philosophy of Life, personal value, social value, mind cultural value and personal health.

CO2 To learn professional ethical values, codes of ethics, responsibilities, safety, rights and related Global issues.

CO3 To know self-esteem, self-understanding, self-awareness.

CO4 To developing a social relationship.

Course Contents:

Chapter 1

Concepts of Values-Definition and Types of values –The need for Education in values-Challenges for Value adoption-Character development-Vision of a better world

Chapter 2

Inculcation of values
Classification of values- Personal Values-Family Values-Social Values-Spiritual values-Benefits of value adoption

Chapter 3

Values for Professional excellence
Definition-Purpose-implementation-situations to adopt-reflection questions-quotable quotes of Active listening-Decision making-Determination-Perseverance-Discipline-Responsibility

Chapter 4

Business ethics
Ethics and Entrepreneurship- Professional Ethics –Ethical choices- Resolving Ethical Dilemmas-Leadership and Social Responsibility- Corporate Social Responsibility

Chapter 5

Quality of Life
Dealing with change-Trends, Organizations and the Individual-Self and the world-Quality from within-Relating to others-The dynamics of personal powers

Chapter 6

Exploring the self
True Identity-Anatomy of the self-The cyclic processes within the self-States of the awareness-Innate and Acquired qualities-Empowering the

Chapter 7

Understanding Self-Esteem
Know self-esteem-Understanding the self-Components of self-esteem-Association with self-esteem-Levels of self-esteem-Reflection exercises

Chapter 8

Principles of living
Be introspective-Be an observer-Being optimistic - Appreciate differences - Don’t compare yourself with others-Live at present

Chapter 9

Practical Meditation
Why meditate? - Soul consciousness-The supreme-Karma-Timeless dimension-The eight powers

Chapter 10

Exercises for Practice
Quiet reflection- Practice introversion - Being an observer-Stand back and observe – Self-awareness (Soul consciousness) - Experiencing Body free stage-Reflect on original qualities - Visualize the Divine-Think attributes of the Supreme-Developing a living relationship-Surrender to God-Create Good wishes for all- Visualization in Meditation: Orbs of Light- The forest-The Balloon.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – III
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Software Lab 1 (C++)	ML-3061	0L-0T-2P	2

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Introduces Object Oriented Programming concepts using the C++ language.

CO2 Introduces the principles of data abstraction, inheritance and polymorphism.

CO3 Introduces the principles of virtual functions and polymorphism.

CO4 Introduces handling formatted I/O and unformatted I/O.

CO5 Introduces exception handling.

Course Contents:

UNIT I

Object-Oriented Thinking: Different paradigms for problem solving, need for OOP paradigm, differences between OOP and Procedure oriented programming, Overview of OOP concepts-Abstraction, Encapsulation, Inheritance and Polymorphism. C++ Basics: Structure of a C++ program, Data types, Declaration of variables, Expressions, Operators, Operator Precedence, Evaluation of expressions, Type conversions, Pointers, Arrays, Pointers and Arrays, Strings, Structures, References. Flow control statement-if, switch, while, for, do, break, continue, goto statements. Functions -Scope of variables, Parameter passing, Default arguments, inline functions, Recursive functions, Pointers to functions. Dynamic memory allocation and de-allocation operators - new and delete, Preprocessor directives.

UNIT –II

C++ Classes and Data Abstraction: Class definition, Class structure, Class objects, Class scope, this pointer, Friends to a class, Static class members, Constant member functions, Constructors and Destructors, Dynamic creation and destruction of objects, Data abstraction, ADT and information hiding.

UNIT –III

Inheritance: Defining a class hierarchy, Different forms of inheritance, Defining the Base and Derived classes, Access to the base class members, Base and Derived class construction, Destructors, Virtual base class. Virtual Functions and Polymorphism: Static and Dynamic binding, virtual functions, Dynamic binding through virtual functions, Virtual function call mechanism, Pure virtual functions, Abstract classes, Implications of polymorphic use of classes, Virtual destructors.

UNIT –IV

C++ I/O: I/O using C functions, Stream classes hierarchy, Stream I/O, File streams and String streams, Overloading operators, Error handling during file operations, Formatted I/O.

UNIT-V

Exception Handling: Benefits of exception handling, Throwing an exception, The try block, Catching an exception, Exception objects, Exception specifications, Stack unwinding, Rethrowing an exception, Catching all exceptions.

References:

1. C++ The Complete Reference, 4e, Herbert Schildt, Tata McGraw Hill
2. Problem solving with C++: The Object of Programming, 4e, Walter Savitch, Pearson Education
3. The C++ Programming Language, 3e, Bjarne Stroustrup, Pearson Education
4. Object Oriented Programming in C++, 3e, Robert Lafore, Galogotia Publications Pvt Ltd
5. Object Oriented Programming with C++, E. Balagurusamy, Tata McGraw Hill
6. Object Oriented Programming with C++, David Parsons, BPB Publications

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – IV
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Environmental Engineering	ML-4011	4L-0T-0P	4

Course Outcomes: After studying this course, students will be able to,

CO1-Convey a clear idea of use of renewable and non-renewable energy sources, its impact on environment. The ability to apply the fundamental knowledge of science and engineering to assess environmental and health risk and its effect on ecosystem.
CO2-Ability to understand environmental laws and regulations to develop guidelines, procedures and processes for health and safety issues due to air pollution and sound pollution.
CO3-Ability to understand environmental laws and regulations to develop guidelines, procedures and processes for health and safety issues due to water pollution
CO4-Understand what are professional ethics and how do ethics affect the outcomes of environmental laws and regulations.
CO5-Understanding the basic and causes of climate and weather change, global warming, climate variability

Unit –I

Energy- Sources of Energy : Renewable & Non Renewable, Fossil fuel, Biomass Geothermal, Hydrogen, Solar, Wind, hydal, nuclear sources.
Ecosystem – Segments of Environment: Atmosphere, hydrosphere, Lithosphere, biosphere. Cycles in Ecosystem – Water, Carbon, Nitrogen. Biodiversity: Threats and conservation,

Unit –II

Air Pollution & Sound Pollution - Air Pollution: Air pollutants, classification, (Primary & secondary Pollutants) Adverse effects of pollutants. Causes of Air pollution chemical, photochemical, Green house effect, ozone layer depletion, acid Rain. Sound Pollution: Causes, controlling measures, measurement of sound pollution (deciblage), Industrial and non – industrial.

Unit –III

Water Pollution– Water Pollution: Pollutants in water, adverse effects. Treatment of Domestic & Industrial water effluent.
Soil Pollution – Soil Profile, Pollutants in soil, their adverse effects, controlling measures.

Unit –IV

Society, Ethics & Human values– Impact of waste on society. Solid waste management (Nuclear, Thermal, Plastic, medical, Agriculture, domestic and e-waste). Ethics and moral values, ethical situations, objectives of ethics and its study . Preliminary studies regarding Environmental Protection Acts , introduction to value education, self exploration, sanyam & swasthya.

Unit –V

Basics of climate and weather, global warming, climate variability;
Causes of climate change – natural and anthropogenic, greenhouse gases, carbon cycle;
Mitigation strategies – renewable energy, energy efficiency, afforestation and reforestation,

carbon capture utilization and storage (CCUS), sustainable practices;
Adaptation strategies – climate-resilient infrastructure, agriculture adaptation, water management, disaster risk reduction;
Policies and global efforts – UNFCCC, IPCC, COP summits, Paris Agreement, Kyoto Protocol;
India's initiatives – National Action Plan on Climate Change (NAPCC), State Action Plans on Climate Change (SAPCC), green economy measures;
Sustainable Development Goals (SDGs) and climate action.

References:-

1. Harris, CE, Prichard MS, Rabin's MJ, "Engineering Ethics"; Cengage Pub.
2. Rana SVS ; "Essentials of Ecology and Environment"; PHI Pub.
3. Raynold, GW "Ethics in information Technology"; Cengage.
4. Svakumar; Energy Environment & Ethics in society; TMH
5. AK De "Environmental Chemistry"; New Age Int. Publ.
6. BK Sharma, "Environmental Chemistry" ; Goel Publ. House.
7. Bala Krishnamoorthy; "Environmental management"; PHI
8. Gerard Kiely, "Environmental Engineering" ; TMH
9. Miller GT JR; living in the Environment Thomson/cengage
10. Cunninghan WP and MA; principles of Environment Sc; TMH
11. Pandey, S.N. & Mishra, S.P. Environment & Ecology, 2011, Ane Books , Pvt. Ltd, New Delhi
12. Joseph, B. Environmental Studies, 2009 Tata Mcgraw Hill, Edu India Ltd. New Delhi.
13. Gour R.R, Sangal, R &Bagaria, G.P. , Excel Books, A-45, Naraina Pilovepdf_merged.pdfPage 118hase-I ,New Delhi.- 110028

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – IV
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Database Management System	ML-4021	4L-0T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand database concepts and structures and query language.

CO2 Understand the E-R model and relational model.

CO3 To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

CO4 Understand Functional Dependency and Functional Decomposition.

CO5 Apply various Normalization techniques.

Course Contents:

UNIT I

Introduction And Conceptual Modeling: Introduction to File and Database systems- Database system structure – Data Models – Introduction to Network and Hierarchical Models – ER model – Relational Model – Relational Algebra and Calculus.

UNIT II

Relational Model: SQL – Data definition- Queries in SQL- Updates- Views – Integrity and Security – Relational Database design – Functional dependencies and Normalization for Relational Databases (up to BCNF).

UNIT III

Data Storage and Query Processing: Record storage and Primary file organization- Secondary storage Devices- Operations on Files- Heap File- Sorted Files- Hashing Techniques – Index Structure for files – Different types of Indexes-B-Tree - B+ Tree – Query Processing.

UNIT IV

Transaction Management: Transaction Processing – Introduction- Need for Concurrency control- Desirable properties of Transaction- Schedule and Recoverability- Serializability and Schedules – Concurrency Control – Types of Locks- Two Phases locking- Deadlock- Time stamp-based concurrency control – Recovery Techniques – Concepts- Immediate Update- Deferred Update - Shadow Paging.

UNIT V

Current Trends: Object Oriented Databases – Need for Complex Data types- OO data Model- Nested relations- Complex Types- Inheritance Reference Types - Distributed databases- Homogenous and Heterogenous - Distributed data Storage – XML – Structure of XML- Data- XML Document- Schema- Querying and Transformation. – Data Mining and Data Warehousing.

References:

1. Database System Concepts, 4e, by Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGraw Hill Education
2. Database Management System, Raghu Ramakrishnan, Tata McGraw-Hill Education
3. Fundamental Database Systems 3e. by Ramez Elmasri and Shamkant B. Navathe, Pearson Education
4. An Introduction to Database Systems, 8e by CJ Date, Pearson Education
5. Database Systems: A Practical Approach to Design, Implementation and Management, 4e, by Thomas M. Connolly, Carolyn Begg, Pearson Education
6. Schaum's Outline of Fundamentals of Relational Databases by Ramon Mata-Toledo, Pauline Cushman, McGraw Hill Education

DBMS Lab (List of Experiments):

1. Data Definition Language (DDL) commands in RDBMS.
2. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
3. High-level language extension with Cursors.
4. High level language extension with Triggers
5. Procedures and Functions.
6. Embedded SQL.
7. Database design using E-R model and Normalization.
8. Design and implementation of Payroll Processing System.
9. Design and implementation of Banking System.
10. Design and implementation of Library Information System.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – IV
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Artificial Intelligence	ML-4031	3L-1T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Acquire the knowledge of basic artificial intelligence.

CO2 Acquire the knowledge of searching strategies of AI.

CO3 Acquire the knowledge of game playing techniques and planning of AI.

CO4 Understand the concept of statistical methods for reasoning and logic.

CO5 Acquire the knowledge of expert systems and other learning methods of AI.

Course Contents:

UNIT I

Introduction: Introduction to Artificial Intelligence (AI), Foundations of AI, History of AI, Real life examples of AI, Turing test for AI, AI techniques, Problem Solving- Formulating problems, problem types, states and operators, state space.

UNIT II

Search Techniques in AI: Search algorithms in AI, Types of AI search, Uninformed search, Informed search, heuristic functions, Depth first search, Breadth first search, Best first search, Hill climbing algorithm, A* algorithm, AO* algorithm, Iterative deepening A*(IDA), small memory A*(SMA).

UNIT III

Game Playing and Planning: Perfect decision game, imperfect decision game, evaluation function, alpha-beta pruning, Minimax search, Planning, Components of planning, Goal stack planning, partial order planning, planning in the blocks world, hierarchical planning, conditional planning.

UNIT IV

Reasoning and Logic: Probability and Bayes' Theorem, Bayesian networks, Dempster-Shafer theory, Representation, Inference, Propositional Logic, predicate logic (first order logic), logical reasoning, forward chaining, backward chaining.

UNIT V

Expert Systems and Other Learning Methods: Representation, Expert system shells, Knowledge acquisition, neural networks, reinforcement learning, genetic algorithm, natural language processing.

References:

1. Artificial Intelligence 3e by Elaine Rich, Kevin Knight, Shivashankar B Nair, Tata McGraw Hill
2. Artificial Intelligence A Modern Approach by Stuart Russell, Peter Norvig, Prentice Hall Series
3. A First Course in Artificial Intelligence by Deepak Khemani, Tata McGraw Hill
4. Grokking Artificial Intelligence Algorithms by RishalHurbans, Manning Pub.
5. Artificial Intelligence: Concepts and Applications, by Lavika Goel, Wiley
6. Artificial Intelligence for Dummies, by John Paul Mueller and Luca Massaron, Wiley
7. Fundamentals of Artificial Intelligence by K.R. Chowdhary, Springer
8. Artificial Intelligence, 3e, by Patrick Henry Winston, Pearson Education
9. Artificial Intelligence: Beyond Classical AI by Reema Thareja, Pearson Education

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – IV
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Design and Analysis of Algorithm	ML-4041	3L-1T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Analyze the asymptotic performance of algorithms.

CO2 Write rigorous correctness proofs for algorithms

CO3 Demonstrate a familiarity with major algorithms and data structures.

CO4 Apply important algorithmic design paradigms and methods of analysis.

CO5 Synthesize efficient algorithms in common engineering design situations.

Course Contents:

UNIT I

BASIC CONCEPTS OF ALGORITHMS

Introduction – Notion of Algorithm – Fundamentals of Algorithmic Solving – Important Problem types – Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes.

UNIT II

MATHEMATICAL ASPECTS AND ANALYSIS OF ALGORITHMS

Mathematical Analysis of Non-recursive Algorithm – Mathematical Analysis of Recursive Algorithm– Example: Fibonacci Numbers – Empirical Analysis of Algorithms – Algorithm Visualization.

UNIT III

ANALYSIS OF SORTING AND SEARCHING ALGORITHMS

Brute Force – Selection Sort and Bubble Sort – Sequential Search and Brute-force string matching– Divide and conquer – Merge sort – Quick Sort – Binary Search – Binary tree- Traversal and Related Properties – Decrease and Conquer – Insertion Sort – Depth first Search and Breadth First Search.

UNIT IV

ALGORITHMIC TECHNIQUES

Transform and conquer – Presorting – Balanced Search trees – AVL Trees – Heaps and Heap sort – Dynamic Programming – Warshall's and Floyd's Algorithm – Optimal Binary Search trees– Greedy Techniques – Prim's Algorithm – Kruskal's Algorithm – Dijkstra's Algorithm – Huffman trees.

UNIT V

ALGORITHM DESIGN METHODS

Backtracking – n-Queen's Problem – Hamiltonian Circuit problem – Subset-Sum problem – Branch and bound – Assignment problem – Knapsack problem – Traveling salesman problem.

References:

1. Introduction to Algorithms 2e, by T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, PHI Pvt. Ltd.
2. Fundamentals of Computer Algorithms by Sartaj Sahni, Sanguthevar Rajasekaran and Ellis Horowitz, University Press
3. Anany Levitin, "Introduction to the Design and Analysis of Algorithm", Pearson Education Asia,
4. Sara Baase and Allen Van Gelder, "Computer Algorithms - Introduction to Design and Analysis",

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – IV
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Computer Network	ML-4051	3L-1T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand and describe the layered protocol model.

CO2 Understand and explain data communications System and its components

CO3 Identify the different types of network topologies and protocols.

CO4 Identify the different types of network devices and their functions within a network.

CO5 Understand and building the skills of subnetting and routing mechanisms.

Course Contents:

UNIT I

DATA COMMUNICATIONS

Components – Direction of Data flow – networks – Components and Categories – types of Connections – Topologies –Protocols and Standards – ISO / OSI model – Transmission Media – Coaxial Cable – Fiber Optics – Line Coding – Modems – RS232 Interfacing sequences.

UNIT II

DATA LINK LAYER

Error – detection and correction – Parity – LRC – CRC – Hamming code – low Control and Error control - stop and wait – go back-N ARQ – selective repeat ARQ- sliding window – HDLC. - LAN - Ethernet IEEE 802.3 - IEEE 802.4 - IEEE 802.5 - IEEE 802.11 – FDDI - SONET – Bridges.

UNIT III

NETWORK LAYER

Internetworks – Packet Switching and Datagram approach – IP addressing methods – Subnetting– Routing – Distance Vector Routing – Link State Routing – Routers.

UNIT IV

TRANSPORT LAYER

Duties of transport layer – Multiplexing – Demultiplexing – Sockets – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control – Quality of services (QOS) – Integrated Services.

UNIT V

APPLICATION LAYER

Domain Name Space (DNS) – SMTP – FTP – HTTP - WWW – Security – Cryptography.

References:

1. Computer Networks, 2e, by Andrew S. Tanenbaum, Pearson Education
2. Data Communication and Networking 2e, by Behrouz A. Forouzan, Tata McGraw-Hill
3. Data and Computer Communications 10e, by William Stallings, Pearson Education
4. Computer Networking: A Top-Down Approach Featuring the Internet, by James F. Kurose and Keith W. Ross, Pearson Education
5. Computer Networks 2e by Larry L. Peterson and Peter S. Davie, Harcourt Asia Pvt. Ltd.

NETWORKING LAB LIST OF EXPERIMENTS

All the programs are to be written using C:

1. Simulation of ARP / RARP.
2. Write a program that takes a binary file as input and performs bit stuffing and CRC Computation.
3. Develop an application for transferring files over RS232.
4. Simulation of Sliding-Window protocol.
5. Simulation of BGP / OSPF routing protocol.
6. Develop a Client – Server application for chat.
7. Develop a Client that contacts a given DNS Server to resolve a given host name.
8. Write a Client to download a file from a HTTP Server.
9. Study of Network Simulators like NS2/Glomosim / OPNET

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
SECOND YEAR, Semester – IV
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Data Analysis using Excel	ML-4061	0L-0T-2P	2

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1	Understand Excel Interface and Basic Functions, Demonstrate familiarity with Excel's user interface, basic formulas, and data handling tools
CO2	Perform Data Cleaning and Preparation, Use Excel tools to clean, format, sort, and filter raw datasets for analysis. Apply descriptive statistics (mean, median, mode, standard deviation) using built-in functions
CO3	Visualize Data Effectively, Create and interpret charts (bar, line, pie, scatter, histogram) to communicate insights from data
CO4	Perform What-If and Scenario Analysis, use tools like Goal Seek, Scenario Manager, and Data Tables for predictive analysis
CO5	Utilize Pivot Tables and Pivot Charts

Course Contents:

UNIT I

Introduction to Excel: Excel interface and navigation, Data entry, formatting, and basic formulas, Relative and absolute cell referencing, Data Cleaning and Preparation, Sorting and filtering data, removing duplicates and handling missing data, Using text functions for data parsing

UNIT II

Descriptive Statistics and Basic Analysis: Mean, median, mode, standard deviation, Data Analysis Toolpak, frequency distribution and histogram creation

Data Visualization: Charts: bar, line, column, pie, scatter, Conditional formatting for data highlights, Dashboards basics

UNIT III

Pivot Tables and Pivot Charts: Creating and modifying pivot tables, Filtering, grouping, and summarizing data, Pivot charts for dynamic visualization

UNIT IV

What-If and Scenario Analysis: Goal Seek and Solver, One-variable and two-variable data tables, Scenario Manager for modelling, Advanced Excel Functions, Logical functions: IF, IFERROR, AND,

OR Lookup functions: VLOOKUP, HLOOKUP, XLOOKUP, INDEX & MATCH, Date and text functions

UNIT V

Case Studies and Project: Application to business, finance, marketing, and HR datasets, Data from "**www.kaggle.com**" involving real-world data analysis and dashboard/report generation

References:

1. Automated Data Analysis using Excel, 2e by Brian D. Bissett, CRC Press
2. Statistics Applied with Excel by Franz Kronthaler, Springer
3. Data Analysis with Excel by Manish Nigam, BPB Publications
4. Data Analysis and Business Modelling Using Microsoft Excel by Manohar Hansa Lysander, PHI Learning Pvt. Ltd.
5. Advanced Analytics with Power BI and Excel by Dejan Sarka, Jernej Rihar, Klemen Vončina, Orange Education Pvt. Ltd.
6. Basic Computational Techniques for Data Analysis: An Exploration in MS Excel by Nupur Narayana, D Ranjan, and Sharad Tyagi, Routledge India

List of Experiments to be perform (Expandable)

1. Installation of MS Office
2. Download and collect various datasets for Kaggle.com and other business datasets
3. Use AVERAGE, MEDIAN, MODE, STDEV, VAR, etc. and analyze monthly sales trends
4. Remove duplicates, correct formatting, fill missing values
5. Use tools like Text to Columns, Find & Replace, and TRIM()
6. Apply filters to find top-performing products or employees
7. Use multi-level sorting (e.g., by region then by sales).
8. Highlight cells based on value rules (e.g., sales below target in red).
9. Create heat maps or data bars for visual insights.
10. Create bar charts, line charts, and pie charts from sample datasets.
11. Create pivot tables to summarize sales by region, product, or time.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Operating Systems	ML-5011	4L-0T-2P	6

Course Outcomes:

CO1 Understand the basics of operating systems like kernel, shell, types and views of operating systems.

CO2 Describe the various CPU scheduling algorithms and remove deadlocks.

CO3 Explain various memory management techniques and concept of thrashing.

CO4 Use disk management and disk scheduling algorithms for better utilization of external memory.

CO5 Recognize file system interface, protection and security mechanisms.

Course Contents:

UNIT I

INTRODUCTION

Introduction - Mainframe systems – Desktop Systems – Multiprocessor Systems – Distributed Systems – Clustered Systems – Real Time Systems – Handheld Systems - Hardware Protection – System Components – Operating System Services – System Calls – System Programs - Process Concept – Process Scheduling – Operations on Processes – Cooperating Processes – Inter- process Communication.

UNIT II

SCHEDULING

Threads – Overview – Threading issues - CPU Scheduling – Basic Concepts – Scheduling Criteria– Scheduling Algorithms – Multiple-Processor Scheduling – Real Time Scheduling - The Critical-Section Problem – Synchronization Hardware – Semaphores – Classic problems of Synchronization– Critical regions– Monitors.

UNIT III

DEADLOCKS

System Model – Deadlock Characterization – Methods for handling Deadlocks -Deadlock Prevention– Deadlock avoidance – Deadlock detection – Recovery from Deadlocks - Storage Management– Swapping – Contiguous Memory allocation – Paging – Segmentation – Segmentation with Paging.

UNIT IV

PAGING AND FILE SYSTEM

Virtual Memory – Demand Paging – Process creation – Page Replacement – Allocation of frames– Thrashing - File Concept – Access Methods – Directory Structure – File System Mounting – File Sharing – Protection

UNIT V

FILE MANAGEMENT

File System Structure – File System Implementation – Directory Implementation – Allocation Methods – Free-space Management. Kernel I/O Subsystems - Disk Structure – Disk Scheduling – Disk Management – Swap-Space Management. Case Study: The Linux System, Windows

References:

1. Operating System Concepts, by Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, John Wiley & Sons
2. Operating Systems 2e, by Harvey M. Deitel, Pearson Education
3. Modern Operating Systems, by Andrew S. Tanenbaum, Pearson Education
4. Operating Systems Internal and Design, by William Stallings, Pearson Education
5. Operating System Design: The Xinu Approach, 2e, by Douglas E. Comer, CRC Press

List of Experiment

1. Write a program to implement FCFS CPU scheduling algorithm.
2. Write a program to implement SJF CPU scheduling algorithm.
3. Write a program to implement Priority CPU Scheduling algorithm.
4. Write a program to implement Round Robin CPU scheduling algorithm.
5. Write a program to compare various CPU Scheduling Algorithms over different Scheduling Criteria.
6. Write a program to implement classical inter process communication problem.
7. Write a program to implement classical inter process communication problem.
8. Write a program to implement classical inter process communication problem.
9. Write a program to implement & Compare various page replacement algorithms.
10. Write a program to implement & Compare various Disk & Drum scheduling Algorithms.
11. Write a program to implement Banker’s algorithms.
12. Write a program to implement Remote Procedure Call (RPC).
13. Write a Devices Drivers for any Device or peripheral.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Object Oriented Programming	ML-5021	3L-1T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Articulate the principles of object-oriented problem solving and programming.

CO2 Apply the concepts of class, method, constructor, instance, data abstraction, function abstraction, inheritance, overriding, overloading, and polymorphism

CO3 Program using objects and data abstraction, class, and methods in function abstraction

CO4 Analyze, write, debug, and test basic C++ codes using the approaches introduced in the course.

CO5 Analyze problems and implement simple C++ applications using an object-oriented software engineering approach

Course Contents:

UNIT I

Principles of OOP, procedure oriented programming vs. object oriented programming, basic concepts, advantages, application of OOPs, object oriented languages. Beginning with C++: structure of C++ program, creating, compiling, linking & executing a C++ program, Tokens, expressions & control structures, keywords, identifiers, basic data types, user-defined data types, derived data types, symbolic constants, type compatibility, variable declaration, dynamic initialization of variables, reference variables, operators in C++.

UNIT II

Scope resolution operator, memory management operators, manipulators, type cast operators, operator precedence, control structures. Main function, function prototyping, call by reference, call by value, inline functions, default arguments, constant arguments, function overloading. Introduction to constructors and destructors, operator overloading & type conversions.

UNIT III

Specifying a class, defining member functions, making an outside function inline, private member function; array within a class, memory allocation for objects , static data members, static member functions, array of objects, objects as function arguments, returning objects.

UNIT IV

Friend functions, Inheritance and its various types along with programs, introduction to pointers, pointers to object, pointers to derived classes, virtual functions and polymorphism, this pointer.

UNIT V

Managing console I/O operations: introduction, C++ streams, C++ stream classes, unformatted I/O operations, formatted console I/O operations, managing O/P with manipulators. Working with Sequential Date Files: Introduction, opening & closing a file, detecting EOF, sequential input & output operations.

References:

1. C++ The Complete Reference, 4e, Herbert Schildt, Tata McGraw Hill
2. Problem solving with C++: The Object of Programming, 4e, Walter Savitch, Pearson Education
3. The C++ Programming Language, 3e, Bjarne Stroustrup, Pearson Education
4. Object Oriented Programming in C++, 3e, Robert Lafore, Galogotia Publications Pvt Ltd
5. Object Oriented Programming with C++, E. Balagurusamy, Tata McGraw Hill
6. Object Oriented Programming with C++, David Parsons, BPB Publications

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Discrete Structure	ML-5031(A)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Write an argument using logical notation and determine if the argument is or is not valid.

CO2 Demonstrate the ability to write and evaluate a proof or outline the basic structure of and give examples of each proof technique described.

CO3 Understand the basic principles of sets and operations in sets.

CO4 Demonstrate an understanding of relations and functions and be able to determine their properties.

CO5 Model problems in Computer Science using graphs and trees.

Course Contents:

UNIT I

Set Theory- Introduction, Elements & Description, Types, Venn-Euler Diagrams, Operations, Inclusion and Exclusion Principle, Fuzzy sets, Functions- Introduction, Types, Range & Domain, Identity Function, Relations-Binary relation, Types, Partial Order, Equivalence relation, Hasse Diagram.

UNIT II

Principle of Mathematical Induction, Pigeonhole Principle, Mathematical Logic- Introduction, propositional calculus, Logical operation, Statement, Converse, Inverse & Contra-positive Statement, Tautologies, Contradiction, Quantifiers, Predicate calculus.

UNIT III

Algebric Structures- Introduction, Mathematical Operations, Binary operations, Groups- Permutation Groups, Cyclic Groups, Subgroup, Semigroup and Monoid, Homeomorphism and Isomorphism, Rings, Fields, Poset and Lattices – Introduction, Chain, Lattice, Duality, Types of Lattices.

UNIT IV

Graph Theory- Introduction, Types, Path, Cycles, Subgraph, Isomprphic Graph, Homeomorphic Graph, Eularian and Hamiltonian graphs, Shortest Path Problem, Planar Graph, Graph Colouring and Chromatic Polynomials, Trees-Introduction, Properties, Binary tree, Computer representation of General Trees, Binary search Tree, Spanning Trees.

UNIT V

Recurrence Relations and Generating Functions- Introduction, Linear Recurrence Relations with Constant Coefficients, Methods of Solving Recurrence relations, Non-homogeneous Recurrence Relations, Methods of Generating Functions.

References:

1. Schaum's Outlines Discrete Mathematics 3e, by Seymour Lipschutz, Marc Laras Lipson, Varsha H. Patil, McGraw Hill Education
2. Discrete Mathematics and Its Applications 8e by Kenneth H. Rosen, Kamala Krithivasan, McGraw Hill Education
3. Discrete Mathematics with Ducks 2e, by Sarah-Marie Belcastro, CRC Press
4. Discrete Mathematics with Applications (Metric Version) 5e, by Susanna S. Epp, Cengage Learning India Pvt. Ltd.
5. Elements of Discrete Mathematics: A Computer Oriented Approach 4e, by C Liu, D. Mohapatra, McGraw Hill Education
6. Discrete Mathematics 4e, by JK Sharma, Trinity Press
7. Discrete Mathematics with Graph Theory 3e, by Edgar Goodaire and Michael Parmenter, Pearson Education

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Microprocessor and Interfacing	ML-5031(B)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the architecture, instruction set, and addressing modes of 8085 and 8086 microprocessors.

CO2 Write and analyze assembly language programs for 8085/8086 for various computational and logical tasks.

CO3 Interface microprocessors with memory and I/O devices using suitable techniques.

CO4 Explain and implement interrupt handling mechanisms and DMA in microprocessor systems.

CO5 Demonstrate the ability to design microprocessor-based systems for real-world applications.

Course Contents:

UNIT I

Introduction to Microprocessors: Evolution of microprocessors, microprocessor vs. microcontroller, Overview of 8085 and 8086 architectures, Pin configuration and internal architecture, Instruction set classification and addressing modes

UNIT II

Assembly Language Programming: Instruction formats and types, Data transfer, arithmetic, logical, control flow instructions, Assembly language programming using 8085/8086, Stack and subroutines, Macros and procedures

UNIT III

Interfacing Concepts: Memory interfacing: RAM, ROM, EPROM, I/O interfacing: I/O mapped and memory-mapped I/O, Interfacing with keyboards, displays (LED, 7-segment, LCD), ADC and DAC interfacing

UNIT IV

Interrupts and DMA: Interrupt structure of 8085 and 8086, Hardware and software interrupts, Programmable interrupt controller (PIC) – 8259, Direct Memory Access (DMA), DMA controller – 8257

UNIT V

Peripheral Devices and System Design: Programmable Peripheral Interface (PPI) – 8255, USART – 8251, Programmable Timer/Counter – 8253/8254, Designing a microprocessor-based system

References:

1. Microprocessor Architecture, Programming and Applications with the 8085, 6e, by Ramesh Gaonkar, Penram International Publishing
2. Microprocessors And Interfacing, 3e, by Douglas V Hall, SSSP Rao, McGraw Hill Education
3. Advanced Microprocessor and Peripherals, 3e, by K Bhurchandi, A. K. Ray, McGraw Hill Education
4. The 8086 Microprocessor Programming & Interfacing The PC, by Kenneth J Ayala, Masood Books UP
5. Microprocessors and Microcontrollers Architecture, Programming and Interfacing Using 8085, 8086 and 8051, by Soumitra Mandal, McGraw Hill Education
6. The 8051 Microcontrollers & Embedded Systems, 2e, by Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, Pearson Education India

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Numerical Methods and Statistics	ML-5031(C)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Apply numerical techniques to solve algebraic and transcendental equations.

CO2 Utilize numerical methods for interpolation, differentiation, and integration.

CO3 Solve systems of linear and non-linear equations using iterative techniques.

CO4 Implement numerical solutions for ordinary differential equations (ODEs).

CO5 Analyze and interpret data using statistical measures and probability distributions.

Course Contents:

UNIT I

Numerical Solution of Algebraic and Transcendental Equations: Bisection Method, Regula Falsi Method, Newton-Raphson Method, Secant Method, Convergence criteria and error analysis

UNIT II

Interpolation and Extrapolation: Finite Differences, Newton's Forward and Backward Interpolation, Lagrange Interpolation, Newton's Divided Difference

Numerical Differentiation and Integration: Numerical Differentiation using finite differences, Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Error estimation

UNIT III

Solution of Systems of Equations: Gauss Elimination and Gauss-Jordan Method, LU Decomposition, Gauss-Seidel and Jacobi Iterative Methods

UNIT IV

Numerical Solution of Ordinary Differential Equations: Euler's Method, Modified Euler's Method, Runge-Kutta Methods (2nd and 4th order), Predictor-Corrector Methods (Milne's Method)

UNIT V

Introduction to Statistics: Measures of Central Tendency: Mean, Median, Mode, Measures of Dispersion: Range, Variance, Standard Deviation, Probability Concepts and Distributions: Binomial, Poisson, Normal, **Statistical Inference:** Sampling Distributions, Confidence Intervals, Hypothesis Testing (z-test, t-test, chi-square test), Correlation and Linear Regression Analysis

References:

1. Numerical Methods for Engineers, 8e, by Steven C. Chapra, Raymond P. Canale, McGraw-Hill Science Engineering
2. Numerical Methods: For Scientific and Engineering Computation, by Rk Jain Mk Jain,Srk Iyengar, New Age International Pvt. Ltd.
3. Introductory Methods of Numerical Analysis, 5e, by S.S. Sastry, PHI Learning Pvt. Ltd.
4. Numerical Methods in Engineering & Science with Programs in C, C++ and MATLAB, by Dr. B.S. Grewal, Khanna Publishers
5. Numerical Methods in Engineering with Python 3, by Jaan Kiusalaas, Cambridge University Press
6. Numerical Methods for Scientists and Engineers, by Richard W. Hamming, Dover Publications Inc.
7. Probability and Statistics for Engieers and Scientists 9e, by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Pearson Education
8. The Elements of Statistical Learning: Data Mining Inference and Prediction 2e, by Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer
9. Mining of Massive Datasets, 2e, by Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Dreamtech Press
10. An Introduction to Statistical Learning: with Applications in Python, by Gareth James, Daniela Witten, and Trevor Hastie, Springer

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Theory of Computation	ML-5041(A)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Demonstrate knowledge of basic mathematical models of computation and describe how they relate to formal languages

CO2 Understand that there are limitations on what computers can do, and learn examples of unsolvable problems.

CO3 Learn that certain problems do not admit efficient algorithms, and identify such problems

CO4 Apply knowledge of computing and mathematics appropriate to the discipline

CO5 Function effectively as a member of a team in order to accomplish a common goal.

Course Contents:

UNIT I

AUTOMATA

Introduction to formal proof – Additional forms of proof – Inductive proofs –Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Finite Automata with Epsilon transitions.

UNIT II

REGULAR EXPRESSIONS AND LANGUAGES

Regular Expression – FA and Regular Expressions – Proving languages not to be regular – Closure properties of regular languages – Equivalence and minimization of Automata.

UNIT III

CONTEXT-FREE GRAMMAR AND LANGUAGES

Context-Free Grammar (CFG) – Parse Trees – Ambiguity in grammars and languages – Definition of the Pushdown automata – Languages of a Pushdown Automata – Equivalence of Pushdown automata and CFG, Deterministic Pushdown Automata.

UNIT IV

PROPERTIES OF CONTEXT-FREE LANGUAGES

Normal forms for CFG – Pumping Lemma for CFL - Closure Properties of CFL – Turing Machines– Programming Techniques for TM.

UNIT V

UNDECIDABILITY

A language that is not Recursively Enumerable (RE) – An undecidable problem that is RE – Undecidable problems about Turing Machine – Post's Correspondence Problem - The classes P and NP.

References:

1. Introduction to Languages and the Theory of Computation 4e, by John C. Martin, McGraw Hill Education
2. Introduction to Automata Theory, Languages, and Computation, 3e by John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman, Pearson Education
3. Introduction to the Theory of Computation, 3e, by Michael Sipser, Cengage India Pvt. Ltd.
4. Theory of Computer Science: Automata, Languages and Computation 3e, by KLP Mishra and N. Chandrsekaran, PHI Learning Pvt. Ltd.
5. Theory of Computation Simplified, by Varsha H. Patil, Vaishali S. Pawar, Swati A. Bhvsar, Aboli H. Patil, BPB Publications
6. An Introduction to Formal Languages and Automata 7e, by Peter Linz, and Susan H. Rodge, Jones and Bartlett Publishers, Inc.
7. Elements of The theory of Computation 2e, HR Lewis and CH Papadimitriou, Pearson Education

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	E-Commerce and Governance	ML-5041(B)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the basic concepts and technologies used in the field of e-commerce and e-governance.

CO2 Understand the processes of developing and implementing information Systems.

CO3 Be aware of the ethical, social, and security issues of e-payment and information systems.

CO4 Understand the impact of e-business on different fields and industries.

CO5 Understand the implications for the management of e-commerce and governance.

Course Contents:

UNIT I

Introduction to E-Business and E-Commerce: Definition the e-Commerce and e-Business, e-commerce Types of EC transactions, e-Business Models. Internet Marketing and e-Tailing, Elements of e-Business Models. benefits and limitations of e-Commerce.

UNIT II

E-Marketplaces: Structures, Mechanisms, Economics & impacts: Define e-Marketplace and their Functions. e-Marketplace types and their features. various types of auctions and list their characteristics. benefits, limitations and impacts of auctions. E-Commerce in the wireless environment. Competition in the DE and impact on industry.

UNIT III

E-Business Applications, E-Procurement and E-Payment Systems: Integration and e-Business suits, ERP, e-SCM, CRM, E-Payment. E-Procurement definition, processes, methods and benefits. Discuss the categories and users of smart cards. Describe payment methods in B2B EC.

UNIT IV

The Impact of E-Business on Different Fields and Industries: E-Tourism, Employment and Job Market Online Online Real Estate, Online Publishing and e-Books, Banking and Personal Finance Online, On-Demand Delivery Systems and E-Grocers, Online Delivery of Digital Products.

UNIT V

E-Learning and Online Education: Electronic learning, benefits and drawbacks of e-Learning. The e-Learning Industry. e-Content development and tools. Major technologies used in e-Learning. Different approaches for e-Learning delivery. Evaluation of e-Learning

Text Book:

1. Electronic Commerce: A Managerial Perspective, Turban, E. et al., Prentice Hall-2008.
2. Frontiers of e-commerce, Ravi Kalakota, Pearson.
3. Electronic Business and Electronic Commerce Management, 2nd edition, Dave Chaffey, Prentice Hall, 2006
4. e-Learning Tools and Technologies, Horton and Horton, Wiley Publishing.

References:

1. Electronic Commerce 2002: A Managerial Perspective, by Efraim Turban, David King, Jae K. Lee, Merrill Warkentin, and H. Michael Chung, Pearson Education
2. Frontiers of E-Commerce, Ravi Kalakota and Andrew B Whinston, Pearson Education
3. E-Business and E-Commerce, by Dave Chaffey, Prentice Hall
4. E-learning Tools and Technologies, by William Horton and Katherine Horton, John Wiley & Sons
5. Essentials of E-Commerce Technology, by V. Rajaraman, PHI Learning Pvt. Ltd.
6. E-Commerce: Fundamentals and Applications, by Henry Chan, Raymond Lee, Tharam Dillon, and Elizabeth Chang, Wiley
7. E-Governance: Concepts and Case Studies, by C.S.R. Prabhu, PHI Learning Pvt. Ltd.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Java Programming	ML-5041(C)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the knowledge of the structure and model of the Java programming language.

CO2 Use the Java programming language for various programming tasks.

CO3 Develop software in the Java programming language.

CO4 Evaluate user requirements for software functionality required to decide whether the Java programming language can meet user requirements.

CO5 Propose the use of certain technologies by implementing them in the Java programming language

Course Contents:

UNIT I

The Java Environment: Java Development Kit (JDK) , Java virtual machine, Java programming environment (compiler, interpreter, applet viewer, debugger), Java Applications Programming Interface(API), Basic idea of application and applet. Java as an object oriented language: objects, classes, encapsulation, inheritance and software reuse, polymorphism, abstract classes and abstract methods,: defining an interface, implementing & applying interfaces, variables in interfaces, extending interfaces, Packages, scope and life-time; Access specifies; Constructors; Copy constructor; this pointer; finalize() method; arrays; Memory allocation and garbage collection

UNIT II

AWT: Containers and components, AWT classes, window fundamentals: Component, Container, Panel, Window, Frame, Canvas, AWT Controls, Layout Managers and Menus: adding and removing control, Labels, Button, Check Box, Radio Button, Choice, menu, Text area, Scroll list, Scrollbar; Frame; Layout managers flow layout, Grid layout, Border layout, Card layout. Java Event Handling Model: Java's event delegation model - Ignoring the event, Self-contained events, Delegating events; The event class hierarchy; The relationship between interface, methods called, parameters and event source; Adapter classes; Event classes action Event, Adjustment Event, Container Event, Focus Event, Item Event, Eye Event, Mouse Event, Text Event, Window Event. Applets: Applet security restrictions; the class hierarchy for applets; Life cycle of applet; HTML Tags for applet Introduction to Swing: swing library, Building applications using Swings.

UNIT III

Multithreading and Exception Handling: Overview of simple threads, Basic idea of multi-threaded programming, Thread synchronization: Locks, synchronized methods, synchronized block, Thread scheduling, Producer-consumer relationship, Daemon thread, Basic idea of exception handling, stack based execution and exception propagation, Exception types: Exception Handling: Try, Catch, Finally, Throw statement, Assertions

UNIT IV

Input/Output: Exploring Java I/O, Directories, stream classes The Byte stream: Input stream, output stream, file input stream, file output stream, print stream, Random access file, the character streams, Buffered reader, buffered writer, print writer, serialization. JDBC: JDBC-ODBC bridge; The connectivity model; The driver manager; Navigating the result set object contents; java.sql Package; The JDBC exception classes; Connecting to Remote database.

UNIT V

Java Networking: exploring java. Net package Networking Basics: Socket, Client server, reserved sockets, servers, Internet addressing, TCP sockets, UDP sockets. RMI: Client/Server architecture, RMI registry services; Steps of creating RMI Application and an example.

References:

1. Java The Complete Reference, by Herbert Schildt, Tata McGraw Hill
2. Java How to Program, by Deitel & Deitel, Pearson Education
3. Programming with Java by E. Balaguruswamy, Tata McGraw Hill
4. Head First Java: A Brain-Friendly Guide, 3e, by Kathy Sierra, Bert Bates, and Trisha Gee, O'Reilly Media Inc.
5. Let Us Java, by Yashvant Kanetkar and Anuj Kanetkar, BPL Publications
6. Java RMI: Designing & Building Distributed Applications, by William Grosso, O’Reilly Media

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Lab (Linux)	ML-5051	0L-0T-2P	2

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Explain the fundamental concepts of open-source operating system Linux

CO2 Understand the basic set of commands and editors in Linux operating system.

CO3 Discuss shell programming in Linux operating system

Course Contents:

UNIT I

Linux Utilities:

File handling utilities, Security by file permissions, Process utilities, Disk utilities, Networking commands, Filters, Text processing utilities, Backup utilities Sed - Scripts, Operations, Addresses, Commands, awk - Execution, Fields and Records, Scripts, Operations, Actions, Assocoative Array, Strings and Mathematical functions, System commands in awk, Applications. Shell programming with Bourne Again Shell (bash): Introduction, Shell responsibilities, Pipes and redirection, here documents, running a shell script, Shell as a programming language, Shell meta characters, File-name substitution, Shell variables, Command substitution, Shell commands, the environment, Quoting, test command, Control structures, Arithmetic in shell, Shell script examples, Interrupt processing functions, Debugging shell Scripts

UNIT II

Files and Directories:

File concepts, File types File system structure, file metadata - Inodes, kernel support for files, System calls for the file I/O operations- open, create, read, wrirte, close, lseek, dup2, file status information-stat family, file and record locking-fcntl function, file permissions- chmod, fchmod, file ownership-chown, lchown, fchown, links-soft links and hard links- symlink, link, unlink. Directories: Creating, removing and changing Directories-mkdir, rmdir, chdir, obtaining current working directory - getcwd, directory contents,scanning directories- opendir, readdir, rewin functions.

UNIT III

Process:

Process concept, Layout of a C program image in main memory, Process environment – environment list, environment variables, getenv, setenv, Kernel support for process, Process identification, Process

control - Process creation, replacing a process image, waiting for process, Process termination, Zombie process, Orphan process, ,system call interface for process management – fork, vfork, exit, wait, waitpid, exec family, process groups, sessions and controlling Terminal, differences between threads and processes. Signals: Introduction to signals, Signal generation, Signal handling, Kernel support for signals, signal function, Unreliable signals, Reliable signals, Signal functions: kill, raise, alarm, pause, abort, sleep.

UNIT IV

Interprocess Communication:

Introduction to IPC,IPC between processes on a single computer system, IPC between processes on different systems, Pipes - creationIPC between related processes using FIFOs(Named pipes), differences between unnamed and named pips, popen and pclose library functions. Message Queues: Kernel support for messages, APIs for message queues, Client/Server example Semaphores: Kernel support for semaphores, APIs for semaphores, file locking with semaphores.

UNIT V

Shared Memory:

Kernel support for Shared Memory, APIs for Shared Memory, Shared Memory example Sockets: Introduction to Berkley Sockets, IPC over a network, client – server model, Socket address structures (Unix domain and internet domain), Socket system calls for connection-oriented protocol and connectionless protocol, example- client/server programs- single server- client connection, multiple simultaneous clients, socket options - setsockopt and fcntl system calls, comparison of IPC mechanisms.

References:

1. Unix Shell Programming, by Yashavant Kanetkar, BPB Publications
2. Unix System Programming using C++, by T. Chan, PHI (Unit III to Unit VIII)
3. Unix Concepts and Applications, 4e, by Sumitabha Das, Tata McGraw Hill
4. Unix Network Programming, by W.R. Stevens, PHI
5. Beginning Linux Programming, 4e, by N. Matthew, R.Stones, Wrox, Wiley India Edition
6. Unix for Programmers 3e, by Graham Glass & King Ables, Pearson Education
7. System Programming with C and Unix, by A. Hoover, Pearson Education
8. Unix System Programming, Communication, Concurrency and Threads, by K.A. Robbins and S. Robbins, Pearson Education
9. Unix Shell Programming, by S.G. Kochan and P.Wood, 3rd edition, Pearson Education
10. Shell Scripting, by S. Parker, Wiley India Pvt. Ltd.
11. Advanced Programming in the Unix Environment, 2e, by W.R. Stevens, Pearson Education
12. Unix and Shell Programming, B.A. Forouzan & R.F. Gilberg, Cengage Learning
13. Linux System Programming, Robert Love, O'Reilly, SPD.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – V
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Lab (Python)	ML-5061	0L-0T-2P	2

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Write, Test and Debug Python Programs

CO2 Implement Conditionals and Loops for Python programs

CO3 Use functions and represent Compound data using Lists, Tuples and Dictionaries

Course Contents:

UNIT I

Introduction to Python Programming Language:
Introduction to Python Language, Strengths and Weaknesses, IDLE, Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators, Numeric Data Types, Conversions, Built In Functions

UNIT II

Data Collections and Language Component:
Introduction, Control Flow and Syntax, Indenting, the if Statement, Relational Operators, Logical, Operators, True or False, Bit Wise Operators, The while Loop, break and continue, The for Loop, Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections.

UNIT III

Object and Classes:
Classes in Python, Principles of Object Orientation, Creating Classes, Instance Methods, File Organization Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes

UNIT IV

Functions and Modules:
Introduction, Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda, Modules, Standard Modules – sys, Standard Modules – math, Standard Modules – time, The dir Function

UNIT V

I/O and Error Handling In Python:

Introduction, Data Streams, Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data from a File, Additional File Methods, Using Pipes as Data Streams, Handling IO Exceptions, Working with Directories, Metadata, Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions.

LIST OF EXPRIMENTS:

1. Running instructions in Interactive interpreter and a Python Script.
2. Write a program to purposefully raise Indentation Error and correct it.
3. Scientific problem-solving using decision making and looping.
4. Simple programming for one dimensional and two-dimensional arrays.
5. Python Programing to explore string functions.
6. Utilizing 'Functions' in Python
    a. Find mean, median, mode for the given set of numbers in a list.
    b. Write a function dups to find all duplicates in the list.
    c. Write a function unique to find all the unique elements of a list.
    d. Write function to compute gcd, lcm of two numbers
7. Demonstrate the use of Lists, Dictionaries.
8. Write a program to implement Turtle.
9. Building a Classical Data Structure using Python Programming.
10. Implement Searching Operations: Linear and Binary Search.
11. To sort the 'n' numbers using: Selection and Insertion Sort.
12. Find the most frequent words in a text read from a file.
13. Demonstrate Exceptions in Python.
14. Simulate elliptical orbits and bouncing ball using Pygame

References:

1. Python Programming Fundamentals 2e, Kent D. Lee, Springer
2. Automate the Boring Stuff with Python Paperback by Al Sweigart, No Starch Press
3. Intro to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and The Cloud Paperback by Paul J. Deitel, Harvey M. Deitel, Pearson Education
4. Think Python 3rd Edition, 3e, by Allen Downey, O'Reilly Media
5. Let Us Python, by Yashavant Kanetkar, BPL Publications
6. Python Adventures for Young Coders - Explore the World of Programming, by Alaa Tharwat, Apress
7. Learning Python: Powerful Object-Oriented Programming 6e, by Mark Lutz, O'Reilly Media
8. Python Cookbook, by David M. Baezly, O'Reilly Media

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Machine Learning	ML-6011	4L-0T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Provide an understanding of the theoretical concepts of machine learning.

CO2 Learn the most cost-effective approaches to automated knowledge acquisition in emerging data-rich disciplines.

CO3 Focus on the theoretical understanding of machine learning methods, as well as their computational implications.

CO4 Prepare the research and industry application of machine learning techniques.

Course Contents:

UNIT I

Introduction: Machine Learning (ML), Types of ML, (Supervised, Unsupervised, Semi-supervised, Reinforcement Learning), Applications of ML, Differences from AI, Deep Learning, and Statistics, hypothesis space and inductive bias, evaluation, cross-validation, Dimensionality Reduction: Subset Selection, Shrinkage Methods, Partial Least Squares.

UNIT II

Clustering in Machine Learning: Types of Clustering Method: Partitioning Clustering, Distribution Model-Based Clustering, Hierarchical Clustering, Fuzzy Clustering. Birch Algorithm, CURE Algorithm. Gaussian Mixture Models and Expectation Maximization. Parameters estimations – MLE, MAP. Applications of Clustering.

UNIT III

Classification algorithm: - Logistic Regression, Decision Tree Classification, Neural Network, K-Nearest Neighbors (K-NN), Support Vector Machine, Naive Bayes (Gaussian, Multinomial, Bernoulli). Performance Measures: Confusion Matrix, Classification Accuracy, Classification Report: Precisions, Recall, F1 score and Support.

UNIT IV

Ensemble Learning and Random Forest: Introduction to Ensemble Learning, Basic Ensemble Techniques (Max Voting, Averaging, Weighted Average), Voting Classifiers, Bagging and Pasting,

Out-of-Bag Evaluation, Random Patches and Random Subspaces, Random Forests (Extra-Trees, Feature Importance), Boosting (AdaBoost, Gradient Boosting), Stacking.

UNIT V

Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction (Projection, Manifold Learning) PCA: Preserving the Variance, Principal Components, Projecting Down to d Dimensions, Explained Variance Ratio, Choosing the Right Number of Dimensions, PCA for Compression, Randomized PCA, Incremental PCA. Kernel PCA: Selecting a Kernel and Tuning Hyper parameters. Learning Theory: PAC and VC model.

References:

1. Machine Learning, by Tom M. Mitchell, McGraw Hill Education
2. Hands-On Machine Learning with Scikit-Learn and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurelien Geon, O'Reilly Media
3. Machine Learning in Action, by Peter Harrington, Manning
4. Real-World Machine Learning Paperback by Henrik Brink, Joseph W. Richards, Mark-Fetherolf, and Beau Cronin, Manning
5. Simplified Machine Learning by Pooja Sharma, BPB Publications
6. Advanced Machine Learning: Fundamentals and Algorithms by Amit Tyagi, Avinash Sharma, and Khushboo Tripathi, BPB Publications
7. Introduction to Machine Learning with Python: A Guide for Data Scientists, by Andreas Muller, O'Reilly Media

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Compiler Design	ML-6021	3L-1T-2P	6

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the different phases of compiler.

CO2 Design lexical analyzer for a sample language.

CO3 Apply different parsing algorithms to develop the parsers for a given grammar.

CO4 Understand syntax-directed translation and run-time environment.

CO5 Learn to implement code optimization techniques and a simple code generator.

Course Contents:

UNIT I

INTRODUCTION TO COMPILERS: Structure of a compiler–Lexical Analysis–Role of Lexical Analyzer–Input Buffering–Specification of Tokens – Recognition of Tokens – Lex – Finite Automata – Regular Expressions to Automata–Minimizing DFA.

UNIT II

SYNTAX ANALYSIS: Role ofParser– Grammars– Error Handling– Context-free grammars – Writing a grammar–TopDown Parsing- General Strategies Recursive Descent Parser Predictive Parser-LL(1) Parser-Shift Reduce Parser-LRParser- LR(0) Item Construction of SLR Parsing Table-Introduction to LALR Parser-Error Handling and Recovery in Syntax Analyzer-YACC.

UNIT III

INTERMEDIATE CODE GENERATION: Syntax Directed Definitions, Evaluation Orders for Syntax Directed Definitions, Intermediate Languages: Syntax Tree, Three Address Code, Types and Declarations, Translation of Expressions, Type Checking.

UNIT IV

RUN-TIME ENVIRONMENT AND CODE GENERATION: Storage Organization, Stack Allocation Space, Access to Non-local Data on the Stack, Heap Management- Issues in Code Generation-Design of a simple Code Generator.

UNIT V

CODE OPTIMIZATION: Principal Sources of Optimization–Peep-hole optimization-DAG-Optimization of Basic Blocks- Global Data Flow Analysis- Efficient Data Flow Algorithm.

References:

1. Compilers: Principles, Techniques and Tools, 2e, by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman. Pearson Education
2. Principles of Compiler Design, by Alfred V Aho and Jeffrey D. Ullman, Narosa Publishing house
3. Compiler Design in C by Allen I. Holub, PHI Learning Pvt. Ltd.
4. Compiler Design by K. Muneeswaran, Oxford University Press
5. Compiler Design: Analysis and Transformation by Helmut Seidl, Reinhard Wilhelm, and Sebastian Hack, Springer
6. Compiler Design by Santanu Chattopadhyay, PHI Learning Pvt. Ltd.
7. Principles of Compiler Design‖, by V. Raghavan, Tata McGraw Hill Education
8. Optimizing Compilers for Modern Architectures: A Dependence based Approach, by Randy Allen and Ken Kennedy, Morgan Kaufmann Publishers
9. Advanced Compiler Design and Implementation, by Steven S. Muchnick, Morgan Kaufmann (Elsevier)
10. Engineering a Compiler, by Keith D Cooper and Linda Torczon, Morgan Kaufmann (Elsevier)

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Computer Graphics & Multimedia	ML-6031(A)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the basics of computer graphics, different graphics systems and applications of computer graphics.

CO2 Render projected objects to naturalize the scene in 2D view and use of illumination models for this.

CO3 Implement various algorithms to scan, convert the basic geometrical primitives, transformations, area filling, clipping.

CO4 Define the fundamentals of animation, virtual reality and its related technologies.

CO5 Design an application with the principles of virtual reality.

Course Contents:

UNIT I

OUTPUT PRIMITIVES: Introduction - Line - Curve and Ellipse Drawing Algorithms – Attributes – Two-imensional Geometric Transformations – Two-Dimensional Clipping and Viewing.

UNIT II

THREE-DIMENSIONAL CONCEPTS: Three-Dimensional Object Representations – Three-Dimensional Geometric and Modeling Transformations – Three-Dimensional Viewing – Color models – Animation.

UNIT III

MULTIMEDIA SYSTEMS DESIGN: An Introduction – Multimedia applications – Multimedia System Architecture – Evolving technologies for Multimedia – Defining objects for Multimedia systems – Multimedia Data interface standards – Multimedia Databases.

UNIT IV

MULTIMEDIA FILE HANDLING: Compression & Decompression – Data & File Format standards – Multimedia I/O technologies – Digital voice and audio – Video image and animation – Full motion video – Storage and retrieval Technologies.

UNIT V

HYPERMEDIA: Multimedia Authoring & User Interface – Hypermedia messaging - Mobile Messaging – Hypermedia message component – Creating Hypermedia message – Integrated multimedia message standards – Integrated Document management – Distributed Multimedia Systems.

References:

1. Computer Graphics C Version, by Donald Hearn and M. Pauline Baker, Pearson Education
2. Schaum's Outline of Computer Graphics 2e, by Zhigang Xiang, Roy A. Plastock, McGraw Hill Education
3. Computer Graphics from Scratch: A Programmer's Introduction to 3D Rendering by Gabriel Gambetta, No Starch Press
4. Computer Graphics by Samit Bhattacharya, Oxford University Press
5. Computer Graphics: A Programming Approach 2e, by Steven Harrington, McGraw Hill Education
6. Computer Graphics, by Apurva A Desai, PHI Learning Pvt Ltd.
7. Computer Graphics: Algorithms and Implementations, by DP Mukherjee and Debasish Jana, PHI Learning Pvt Ltd.
8. Computer Graphics & Multimedia, by GS Baluja, Dhanpat Rai & Co.
9. Multimedia Systems and Design, by Prabat K Andleigh and Kiran Thakrar, PHI Learning Pvt Ltd.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Deep Learning	ML-6031(B)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Explain the fundamentals of neural networks and deep learning architectures
CO2 Implement and train neural network models using backpropagation and optimization techniques
CO3 Analyze and evaluate the performance of various deep learning models on real-world datasets.
CO4 Apply convolutional and recurrent neural networks to solve tasks such as image classification and sequence modeling
CO5 Explore and critique recent advancements in deep learning, such as generative models and attention mechanisms

Course Contents:

UNIT I

Introduction to Neural Networks: Biological vs Artificial Neurons, Perceptron Model, Activation Functions (Sigmoid, Tanh, ReLU, etc.), Loss Functions, Training Neural Networks

UNIT II

Deep Neural Networks: Gradient Descent and Backpropagation, Vanishing/Exploding Gradients, Optimization Techniques: SGD, Momentum, Adam, RMSprop, Regularization: L1/L2, Dropout, Batch Normalization, Hyperparameter Tuning

UNIT III

Convolutional Neural Networks (CNNs): Convolution and Pooling Layers, CNN Architectures: LeNet, AlexNet, VGG, ResNet, Applications in Image Classification, Object Detection

UNIT IV

Recurrent Neural Networks (RNNs): Basic RNNs and their limitations, LSTM and GRU Networks, Sequence-to-Sequence Models, Applications in NLP and Time Series

UNIT V

Generative Models: Autoencoders, Variational Autoencoders (VAE), GANs, Transfer Learning and Fine-Tuning, Attention Mechanisms and Transformers (BERT, GPT), Explainability and Interpretability in Deep Learning

References:

1. Deep Learning, by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, The MIT Press
2. Neural Networks and Learning Machines, 3e, by Haykin, Pearson Education India
3. Deep Learning, by S. Sridhar, D. Narashiman, Pearson Education India
4. Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence, by Jon Krohn, Grant Beyleveld, Aglae Bassens, Pearson Education India
5. Neural Networks and Deep Learning: A Textbook, 2e, by Charu C. Aggarwal, Springer Nature
6. Fundamentals of Artificial Neural Networks, by Hassoun, PHI Learning Pvt. Ltd.
7. Deep Learning: Foundations and Concepts, by Christopher M. Bishop and Hugh Bishop, Springer Nature
8. Deep Learning, by John D. Kelleher, The MIT Press
9. Learning Deep Learning, by Magnus Ekman, Pearson Education
10. Dive into Deep Learning, by Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Cambridge University Press

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Embedded System	ML-6031(C)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Explain the embedded system concepts and architecture of embedded systems.

CO2 Describe the architecture of 8051 microcontroller and write embedded program for it.

CO3 Select elements for an embedded systems tool

CO4 Understand the memory types used in embedded systems

CO5 Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Course Contents:

UNIT I

Introduction to Embedded Systems: Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, classification, major application areas, purpose of embedded systems, characteristics and quality attributes of embedded systems, common design metrics, and processor technology: general purpose processor, application specific processor, single purpose processor.

UNIT II

Embedded System Architecture: Von Neumann v/s Harvard architecture, instruction set architecture, CISC and RISC instructions set architecture, basic embedded processor, microcontroller architecture, CISC & RISC examples: 8051, ARM, DSP processors.

UNIT III

Input Output and Peripheral Devices Timers and counters, watchdog timers, interrupt controllers, PWM, keyboard controller, analog to digital converters, real time clock. Introduction to communication protocols: basic terminologies, concepts, serial protocol: I2C, CAN, firewire, USB. Parallel protocols: PCI bus, IrDA, bluetooth, IEEE 802.11, wireless protocols.

UNIT IV

Memory System Architecture Caches, virtual memory, MMU, address translation, memory and interfacing, memory write ability and storage performance. Memory types, composing memory –

advance RAM interfacing, microprocessor interfacing I/O addressing, interrupts, direct memory access, arbitration multilevel bus architecture.

UNIT V

Embedded System Supporting Technologies, Difference between normal OS and RTOS, scheduling algorithms. Case study: Tiny OS, VxWorks, QNX. Overview of VLSI technology, introduction to device drivers, Case studies: washing machine, air-conditioning, auto focus camera

References:

1. Embedded Systems Introduction, 4e, by Raj Kamal, McGraw Hill Education
2. Making Embedded Systems: Design Patterns for Great Software, 2e, by Elecia White, O'Reilly Media
3. Embedded Systems: A Contemporary Design Tool, 2e, by James K. Peckol, Wiley
4. Introduction to Embedded Systems, 2e, by K.V. Shibu, McGraw Hill Education
5. Introduction to Embedded Systems, 2e, by Ashford Lee Edward, PHI Learning Pvt. Ltd.
6. An Embedded Software Primer, by David E Simons, Pearson Education
7. Embedded System Design: A Unified Hardware/Software Introduction, by Frank Vahid and Tony Givargis, Wiley

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Spatial Data Analysis	ML-6041(A)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the fundamental concepts of spatial data, spatial relationships, and spatial processes
CO2 Collect, manage, and preprocess spatial data using appropriate data structures and formats (raster and vector)
CO3 Apply exploratory spatial data analysis (ESDA) techniques to identify spatial patterns and anomalies
CO4 Perform spatial statistical analyses including spatial autocorrelation and spatial regression
CO5 Use GIS and programming tools (e.g., QGIS, Python, R) to conduct real-world spatial analyses

Course Contents:

UNIT I

Introduction to Spatial Data: Definition and types of spatial data (raster, vector), Coordinate systems and map projections, Sources of spatial data (satellite imagery, GPS, open data portals), Spatial data formats: shapefiles, GeoJSON, GeoTIFF

UNIT II

Spatial Data Management and Preprocessing: Data cleaning and transformation, Georeferencing and digitization, Spatial joins, buffering, clipping, overlay, Data integration: combining spatial and non-spatial data

UNIT III

Exploratory Spatial Data Analysis (ESDA): Spatial distribution: center, dispersion, clustering, Visualization: thematic maps, choropleths, heat maps, Identifying outliers and hotspots, Point pattern analysis (e.g., Ripley's K-function)

UNIT IV

Spatial Statistics and Modeling: Spatial autocorrelation: Moran's I, Geary's C, Spatial interpolation: IDW, Kriging, Spatial regression models: spatial lag, spatial error, Geographically Weighted Regression (GWR)

UNIT V

Advanced Spatial Techniques: Network analysis (shortest path, accessibility), Terrain and surface analysis (DEM, slope, aspect), Space-time analysis and spatiotemporal data, Remote sensing

integration in spatial analysis, GIS tools: QGIS, ArcGIS basics, Python for spatial data (GeoPandas, Shapely, Folium), R for spatial statistics (sf, sp, raster, tmap)

References:

1. Geographical Data Science and Spatial Data Analysis, by Lex Comber, Chris Brunsdon, Sage Pubns Ltd.
2. Spatial Analysis Methods and Practice: Describe – Explore – Explain through GIS, by George Grekousis, Cambridge University Press
3. Spatial Statistics for Data Science: Theory and Practice With R, by Paula Moraga, CRC Press
4. An Introduction to Spatial Data Analysis: Remote Sensing and GIS With Open Source Software, by Martin Wegmann, Jakob Schwalb-willmann, Stefan Dech, Pelagic Pub Ltd.
5. Spatial Data Analysis: Models, Methods and Techniques, by Manfred M. Fischer, Jinfeng Wang, Springer
6. Python for Geospatial Data Analysis: Theory, Tools and Practice for Location Intelligence, by Bonny P. McClain, Shroff/O'Reilly

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B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Internet Of Things	ML-6041(B)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the vision of IoT from a global context.

CO2 Understand the application of IoT.

CO3 Determine the Market perspective of IoT.

CO4 Use of Devices, Gateways and Data Management in IoT.

CO5 Building state of the art architecture in IoT.

Course Contents:

UNIT I

IoT & Web Technology - The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

UNIT II

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies.

M2M to IoT - An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT III

IoT Architecture: State of the Art – Introduction, State of the art, Architecture Reference Model - Introduction, Reference Model and architecture, IoT reference Model,

IoT Reference Architecture - Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT IV

IoT Applications for Value Creations - Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to

Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

UNIT V

Internet of Things Privacy, Security and Governance: Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

References:

1. Internet of Things (IoT): Architecture and Design Principles 2e, by Raj Kamal, McGraw Hill Education
2. Internet of Things, by Jeeva Jose, Khanna Book Publishing
3. Internet of Things (IoT) & Its Applications, by Satish Jain and Shashi Singh, BPB Publications
4. Internet of Things: Architecture, Implementation and Security, by Mayur Ramgir, Pearson Education
5. Internet of Things by Srinivasa K. G., Siddesh G. M., Hanumantha Raju R., Cengage Learning Pvt. Ltd.
6. Internet of Things by Surya Durbha, Jyoti Joglekar, Oxford University Press
7. Internet of Things A Hands-on-Approach, by Vijay Madisetti and Arshdeep Bahga, University Press
8. Getting Started with the Internet of Things, by Cuno Pfister, O‟Reilly Media

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Cloud Computing	ML-6041(C)	4L-0T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the concepts, characteristics, delivery models and benefits of cloud computing.

CO2 Understand the key security and compliance challenges of cloud computing.

CO3 Understand the key technical and organisational challenges.

CO4 Understand the different characteristics of public, private and hybrid cloud deployment models.

Course Contents:

UNIT I

Introduction:
Historical development, Vision of Cloud Computing, Characteristics of cloud computing as per NIST, Cloud computing reference model, Cloud computing environments, Cloud services requirements, Cloud and dynamic infrastructure, Cloud Adoption and rudiments. Overview of cloud applications: ECG Analysis in the cloud, Protein structure prediction, Gene Expression Data Analysis, Satellite Image Processing, CRM and ERP, Social networking.

UNIT II

Cloud Computing Architecture:
Cloud Reference Model, Types of Clouds, Cloud Interoperability & Standards, Scalability and Fault Tolerance, Cloud Solutions: Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management. Cloud Offerings: Cloud Analytics, Testing Under Control, Virtual Desktop Infrastructure

UNIT III

Cloud Management & Virtualization Technology:
Resiliency, Provisioning, Asset management, Concepts of Map reduce, Cloud Governance, High Availability and Disaster Recovery. Virtualization: Fundamental concepts of compute, storage, networking, desktop and application virtualization. Virtualization benefits, server virtualization, Block and file level storage virtualization Hypervisor management software, Infrastructure Requirements, Virtual LAN (VLAN) and Virtual SAN (VSAN) and their benefits.

UNIT IV

Cloud Security:

Cloud Information security fundamentals, Cloud security services, Design principles, Secure Cloud Software Requirements, Policy Implementation, Cloud Computing Security Challenges, Virtualization security Management, Cloud Computing Security Architecture.

UNIT V

Market Based Management of Clouds, Federated Clouds/Inter Cloud: Characterization and Definition, Cloud Federation Stack, Third Party Cloud Services. Case study: Google App Engine, Microsoft Azure, Hadoop, Amazon, Aneka

References:

1. Mastering Cloud Computing 2e, by Rajkumar Buyya, Christian Vecciola, Thamarai Selvi, Shivananda Poojara and Satish N. Srirama, McGraw Hill Education
2. Cloud Computing, by Shailendra Singh, Oxford University Press
3. Cloud Computing for Everyone: Understanding Principles, Architecture, Security, Data, and Green Practices, by Rohit Agarwal, and Dilip K Prasad, BPB Publications
4. Cloud Computing: Concepts, Technology, Security & Architecture, 2e, by Thomas Erl and Eric Barceló Monroy, Pearson Education
5. Cloud Computing: A Practical Approach, by Toby Velte, Anthony Velte and Robert Elsenpeter, McGraw Hill Education
6. Cloud Computing: A Hands-On Approach, by Arshdeep Bahga and Vijay Madisetti, The Orient Blackswan
7. Cloud Computing Bible, by Barrie Sosinsky, Wiley
8. Cloud Computing: Architecting Next-Gen Transformation Paradigms, 4e, by Kumar Saurabh, Wiley

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Data Analytics Lab	ML-6051	0L-0T-2P	2

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the basics of software as a product.

CO2 List the components of Hadoop and Hadoop Eco-System.

CO3 Access and Process Data on Distributed File System.

CO4 Manage Job Execution in Hadoop Environment.

CO5 Develop Big Data Solutions using Hadoop Eco System.

Course Contents:

UNIT I

Basics of data analytic framework, data per-processing, Statistics, probability, Probability Distribution, Bayes' Theorem, Central Limit theorem, Data Exploration & preparation, Concepts of Correlation, Regression, Covariance, Outliers, Data visualization.

UNIT II

Introduction to R as a data analytics tool.

UNIT III

Introduction to MATLAB as a data analytics tool.

UNIT IV

Introduction to Python as a data analytics tool.

UNIT V

Case studies.

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
THIRD YEAR, Semester – VI
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	R Programming Lab	ML-6061	0L-0T-2P	2

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the fundamentals of R programming, including data types, control structures, and functions.

CO2 Import, clean, manipulate, and manage data using R and its packages.

CO3 Perform basic and advanced statistical analysis using R.

CO4 Create effective visualizations using base R and packages like ggplot2.

CO5 Develop and debug R scripts for solving real-world data problems.

Course Contents:

UNIT I

Introduction to R: Installation and setup (R, RStudio), R as a statistical programming language, RStudio interface and workflow, Basic syntax: variables, operators, expressions, Data Structures in R: Vectors, Lists, Matrices, Arrays, Data Frames and Tibbles, Factors and Dates, Indexing and Subsetting

UNIT II

Control Structures and Functions: Conditional statements: if, else, switch, Loops: for, while, repeat, user-defined functions, scope and environments, apply family of functions (apply, lapply, sapply, etc.)

UNIT III

Data Handling and Manipulation: Reading/writing data: CSV, Excel, JSON, etc., dplyr, tidyr, and data.table for data wrangling, Data cleaning: missing values, outliers, reshaping

UNIT IV

Data Visualization: Base R plotting, Grammar of Graphics and ggplot2, Plot types: histograms, boxplots, bar charts, line graphs, scatterplots, Customization and themes

UNIT V

Statistical Analysis in R: Descriptive statistics, Hypothesis testing: t-tests, chi-square, ANOVA, Correlation and regression, Basic time series analysis, Machine Learning with caret or mlr3, Text processing using tm or tidytext, R Markdown for dynamic reports, Shiny for interactive web applications

References:

1. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, 2e, by Hadley Wickham, Shroff/O'Reilly
2. The Art of R Programming, by Norman Matloff, No Starch Press
3. Statistical Programming in R, by K.G. Srinivasa, G.M. Siddesh, Chetan Shetty, and B.J. Sowmya, Oxford University Press
4. R for Everyone: Advanced Analytics and Graphics, 2e, by Jared P. Lander, Pearson Education
5. Hands on Programming With R: Write Your Own Functions and Simulations, by Garrett Grolemund, Shroff/O'Reilly
6. R Programming for Beginners, by Sandip Rakshit, McGraw Hill Education
7. Advanced R, by Hadley Wickham, CRC Press
8. Hands on Data Science with R: From basics to advanced, by Dr. Meenakshi, Mrs. Nandini S. R, Dr. C. Mahiba, and Dr. Nanditha B. R., Clever Fox Publishing

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Nature Inspired Computing	ML-7011	2L-1T-1P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the fundamental principles of nature-inspired algorithms and their biological motivations.
CO2 Analyze and compare various NIC techniques such as Genetic Algorithms, Swarm Intelligence, and Evolutionary Strategies.
CO3 Implement and apply NIC algorithms to optimization and problem-solving tasks.
CO4 Evaluate the performance of NIC algorithms in terms of convergence, robustness, and scalability.
CO5 Integrate multiple NIC techniques or hybridize with classical methods for enhanced problem solving.

Course Contents:

UNIT I

Introduction to Nature-Inspired Computing: Overview of bio-inspired computing, Characteristics of NIC techniques, Comparison with traditional algorithms, Search spaces and optimization basics

UNIT II

Evolutionary Computation: Genetic Algorithms (GA), Encoding, Selection, Crossover, Mutation, Elitism and Fitness Functions, Genetic Programming (GP), Evolution Strategies (ES), Applications in optimization

UNIT III

Swarm Intelligence: Ant Colony Optimization (ACO), Pheromone model, Evaporation, Path construction, Particle Swarm Optimization (PSO), Position and velocity updates, Convergence behaviour, Firefly Algorithm, Bee Algorithm (brief overview). Applications in combinatorial and continuous optimization

UNIT IV

Other Nature-Inspired Algorithms: Artificial Immune Systems, Differential Evolution (DE), Harmony Search, Bacterial Foraging Optimization, Cuckoo Search

UNIT V

Performance Analysis and Hybrid Systems: Performance metrics for nature-inspired computing algorithms, Convergence and stagnation issues, Parameter tuning and control, Hybridization with classical and other algorithms

References:

1. Nature-Inspired Optimization Algorithms, 2e, by Xin-She Yang, Academic Press
2. Nature-Inspired Optimization Algorithms, by A. Vasuki, CRC Press
3. Discrete Problems in Nature Inspired Algorithms, by Anupam Shukla, Ritu Tiwari, CRC Press
4. Evolutionary Computation – A Unified Approach, by Kenneth A. De Jong, The MIT Press
5. Natural Computing with Python, by Giancarlo Zaccone, BPB Publications
6. Swarm Intelligence, by James Kennedy, Russell C. Eberhart, and Yuhui Shi, Morgan Kaufmann Publishers Inc.
7. Swarm Intelligence: From Natural to Artificial Systems, by Eric Bonabeau, Marco Dorigo, and Guy Theraulaz, Oxford University Press
8. Metaheuristics - From Design to Implementation, by EG Talbi, John Wiley & Sons Inc.
9. Mathematical Foundations of Nature-Inspired Algorithms, by Xin-She Yang and Xing-Shi He, Springer

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Data Science	ML-7021(A)	3L-1T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.

CO2 Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.

CO3 Ability to understand and apply scaling up machine learning techniques and associated computing techniques and technologies.

CO4 Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.

Course Contents:

UNIT I

Conceptualization and summarization: Representation of data. Modeling of machine learning techniques. Application of big data computing technologies.

UNIT II

Trivial data versus Big data: Representation learning. Publicly available datasets. Scalability and Scaling up techniques. Report writing using Latex.

UNIT III

Big data computing environment: Modern data analytics technologies like Hadoop and MapReduce. Suitable programming languages like Python, Java and C, Big data friendly machine learning scikit-learn, NumPy, Pandas, Matplotlib libraries. Software platforms like MATLAB or R

UNIT IV

Machine learning techniques: Three phases of machine learning. types of learning, support vector machine, decision trees and random forests, deep learning

UNIT V

Scaling up machine learning: Dimensionality reduction techniques like principal component analysis and feature hashing, Online processing technique called stochastic gradient descent, Big data machine learning models.

References:

1. Data Science From Scratch: First Principles with Python, 2e, by Joel Grus, O'Reilly Media
2. Introduction to Statistical Learning: with Applications in Python, by Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, and Jonathan Taylor, Springer
3. Python Data Science Handbook: Essential Tools for Working with Data, 2e, by Jake VanderPlas, O'Reilly Media
4. Data Science and Machine Learning using Python, by Dr Reema Thareja, McGraw Hill Education
5. Introduction to Data Science: Practical Approach with R and Python, by B. Uma Maheswari and R. Sujatha, Wiley
6. Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, by Nathan Marz and James Warren, Manning
7. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools by Davy Cielen, Arno D.B. Meysman and Mohamed Ali, Manning
8. Big Data Analytics, by Raj Kamal, Preeti Saxena, McGraw Hill Education
9. Big Data Analytics 2e, by RadhaShankarmani, M. Vijaylakshmi, Wiley
10. Big Data with Hadoop MapReduce: A Classroom Approach, by Anand Paul, Ganeshkumar Pugalendhi and Rathinaraja Jeyaraj, CRC Press
11. Big Data and Analytics: The key concepts and practical applications of big data analytics, by Jugnesh Kumar, Anubhav Kumar and Rinku Kumar, BPB Publications
12. Big Data Analytics: Concepts, Techniques, Tools and Technologies, by G. Sudha, M. Thangaraj and S. Suguna, PHI Learning Pvt. Ltd.
13. Big Data and Analytics, 2e, by Seema Acharya and Subhashini Chellappan, Wiley
14. Big Data Big Analytics, by Michael Minelli, Michele Chambers and AmbigaDhiraj, Wiley

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Business Data Analysis	ML-7021(B)	3L-1T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand and apply basic concepts of data analysis in the context of business decision-making.
CO2 Perform descriptive and inferential statistical analysis on business data.
CO3 Use spreadsheet tools (e.g., Excel) and statistical software (e.g., R, Python, SPSS) for data analysis and visualization.
CO4 Analyze and interpret trends, patterns, and relationships in business data using exploratory and predictive methods.
CO5 Apply data analysis techniques to real-world business problems such as customer behavior, sales forecasting, and market segmentation.

Course Contents:

UNIT I

Introduction to Business Data Analysis: Role of data in business decision-making, Types and sources of business data (internal, external, structured, unstructured), Data life cycle: collection, cleaning, analysis, reporting

UNIT II

Descriptive Statistics: Measures of central tendency (mean, median, mode), Measures of dispersion (variance, standard deviation, range), Data visualization: charts, histograms, box plots, pivot tables, Business use cases: KPI dashboards, performance metrics, Basic probability theory, Common distributions: Normal, Binomial, Poisson, Expected value and risk assessment, Applications in finance and operations

UNIT III

Inferential Statistics: Sampling methods and sampling distributions, Confidence intervals and hypothesis testing, t-tests, chi-square tests, ANOVA, Business applications: A/B testing, market research analysis

UNIT IV

Correlation and Regression Analysis: Correlation and causation, Simple and multiple linear regression, Model interpretation and diagnostics, Forecasting business outcomes (e.g., sales, profit). **Time Series and Forecasting:** Time series components: trend, seasonality, cyclicity, Smoothing

techniques: moving averages, exponential smoothing, ARIMA models (introductory level), Business demand forecasting, inventory planning.

UNIT V

Business Analytics Tools and Reporting: Excel for business analytics (Solver, Data Analysis Toolpak), R/Python for business data, Dashboards and reports (Excel, Power BI, Tableau), Data storytelling and effective communication of insights.

References:

1. Business Analytics: Data Analysis & Decision Making, by Wayne Winston and S. Albright, South-Western College Publishing
2. Data Science for Business, by Foster Provost, Shroff
3. Statistics for Business and Economics, 9e, by Paul Newbold, William Carlson, and Betty Thorne, Pearson Education
4. Business Analytics: An Application Focus, by Purba Halady Rao, PHI Learning Pvt. Ltd.
5. Data Mining for Business Analytics: Concepts, Techniques and Applications in Python, by Galit Shmueli, Peter C. Bruce, Peter Gedeck, Nitin R. Patel, and O.P. Wali, Wiley
6. Business Analytics :The Science of Data-Driven Decision Making, 2e, by U. Dinesh Kumar, Wiley
7. Business Analytics: Communicating with numbers, 2e, by Sanjiv Jaggia, Kevin Lertwachara, Alison Kelly, Leida Chen, and Apratim Guha, McGraw Hill Education

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (CSE)	Social Network Analysis	CS-7021(C)	3L-1T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the foundational concepts and theories of social networks and network science.
CO2 Model real-world systems as graphs and analyze their structural properties.
CO3 Apply key metrics such as centrality, density, and clustering to interpret network roles and relationships.
CO4 Use tools and programming libraries (Gephi, NetworkX, igraph) to visualize and analyze network data.
CO5 Explore and analyze dynamic, weighted, and directed networks in various domains (e.g., social media, organizational networks, citation networks).

Course Contents:

UNIT I

Introduction to Social Network Analysis: Network, Basic graph theory, History and applications of social network analysis, Types of networks: social, biological, communication, economic, Directed vs. undirected, weighted vs. unweighted networks

UNIT II

Representing and Visualizing Networks: Adjacency matrices and edge lists, Bipartite and multiplex networks, Network visualization principles, Tools: Gephi, Cytoscape, NetworkX (Python), igraph (R)
Network Structure and Metrics: Degree, closeness, and betweenness centrality, Eigenvector centrality and PageRank, Network density, diameter, and average path length, Clustering coefficient and transitivity

UNIT III

Network Components and Subgroups: Connected components (strong/weak), Cliques, k-cores, and cohesive subgroups, Community detection algorithms: modularity, Girvan–Newman, Louvain

UNIT IV

Dynamic and Temporal Networks: Network evolution over time, Models of network growth: Preferential Attachment (Barabási–Albert), Diffusion and influence in networks (e.g., information, innovation, disease)

UNIT V

Advanced Topics and Applications: Homophily and assortativity, Structural holes and social capital (Granovetter, Burt), Applications: Social media and influencer detection, Fraud detection in financial networks, Epidemiology (disease spread), Organizational networks and collaboration.

References:

1. Social Network Analysis: Methods and Applications, by Stanley Wasserman and Katherine Faust, Cambridge University Press
2. Social Network Analysis, by Tanmoy Chakraborty, Wiley
3. Social Network Analysis, 4e, by John Scott, Sage Pubns Ltd.
4. Analyzing Social Networks, by Stephen P. Borgatti, Martin G. Everett, Jeffrey C. Johnson, and Filip Agneessens, Sage Pubns Ltd
5. Understanding Social Networks, by Charles Kadushin, Oxford University Press

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Generative AI and Large Language Model	ML-7031(A)	3L-0T-0P	3

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand the foundational concepts behind Generative AI and Large Language Models (LLMs), including neural network architectures like transformers.

CO2 Explain the training, fine-tuning, and inference processes used in building large-scale models like GPT, BERT, and their variants.

CO3 Evaluate the capabilities and limitations of LLMs across various NLP tasks, including text generation, summarization, translation, and question answering.

CO4 Implement and fine-tune pre-trained LLMs using popular frameworks like Hugging Face Transformers, OpenAI API, or similar tools.

CO5 Critically analyze ethical, societal, and safety implications of deploying LLMs in real-world applications.

Course Contents:

UNIT I

Introduction to Generative AI: History and evolution of AI & NLP, Definition of Generative AI, Overview of generative models (GANs, VAEs, autoregressive models), Applications and use cases

UNIT II

Foundations of Large Language Models: Word embeddings and tokenization (Word2Vec, BPE), Attention mechanisms and the Transformer architecture, Training LLMs: objectives, datasets, and hardware considerations, Generative Pre-trained Transformer, Examples: ChatGPT, DeepSeek, Grok AI, BERT, T5, Meta's Llama, Microsoft's Turing-NLG, Claude, Google's Gemini, Midjourney, and Modern GenAI

UNIT III

Practical Usage of Pretrained LLMs: Introduction to Hugging Face Transformers and OpenAI APIs, Text generation, classification, summarization, Prompt engineering basics, Fine-tuning vs. instruction tuning vs. retrieval-augmented generation (RAG)

UNIT IV

Building a chatbot using LLMs: Summarization and Q&A systems in chatbot, Turing test in chatbot, **Scaling laws and model optimization:** Alignment and Reinforcement Learning from Human Feedback (RLHF), Multimodal models, Open-source vs paid models

UNIT V

Ethics, Safety, and Responsible AI: Bias, fairness, and toxicity in LLMs, Data privacy and misuse risks, Explainability and interpretability, Governance and regulation (AI and IT Act in India, OpenAI usage policies)

References:

1. Learn Generative AI with PyTorch, by Mark Liu, Manning Publications
2. Build a Large Language Model from Scratch, by Sebastian Raschka, Manning Publications
3. Generative AI 360°: Practical Guide to ChatGPT, Midjourney & AI Tools to Boost Productivity & Creativity, by Hitesh Motwani, ZebraLearn
4. Generative AI for Everyone: Deep learning, NLP, and LLMs for creative and practical applications, by Karthikeyan Sabesan, Sivagamisundari, and Nilip Dutta, BPL Publications
5. Generative AI with Python and PyTorch, 2e, by Joseph Babcock and Raghav Bali, Packt Publishing
6. Introduction to Large Language Models Generative AI for Text, by Tanmoy Chakraborty, Wiley
7. Prompt Engineering: Hands-on guide to prompt engineering for AI interactions, by Eric C. Richardson, BPB Publications
8. Prompt Engineering for Generative AI: Future-Proof Inputs for Reliable AI Outputs, by James Phoenix and Mike Taylor, Shroff/O'Reilly Media

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Digital Image Processing	ML-7031(B)	2L-1T-1P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Explain basic concepts of image processing.

CO2 Have knowledge of techniques employed for the enhancement of images.

CO3 Interpret image segmentation and representation techniques.

CO4 Explain the concepts of morphology in image processing.

Course Contents:

UNIT I

Introduction and Digital Image Fundamentals: The origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing, Elements of Digital Image Processing Systems, Image Sampling and Quantization, Some basic relationships like Neighbours, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations

UNIT II

Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Methods

UNIT III

Image Enhancement in the Frequency Domain: Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering. Image Restoration A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations

UNIT IV

Image Compression: Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Elements of Information Theory, Error free comparison, Lossy compression, Image compression standards. Image Segmentation Detection of Discontinuities, Edge linking and boundary detection, Threshold, Region Oriented Segmentation, Motion based segmentation

UNIT V

Representation and Description: Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Introduction to Morphology, Some basic Morphological Algorithms. Object Recognition Patterns and Pattern Classes, Decision-Theoretic Methods, Structural Methods.

References:

1. Digital Image Processing, 4e, by Rafael C. Gonzalez and Richard E. Woods, Pearson Education
2. Fundamentals of Digital Image Processing, by Anil K. Jain, Pearson Education
3. A Computational Introduction to Digital Image Processing, by Alasdair McAndrew, CRC Press
4. Digital Image Processing, 2e, by S. Jayaraman, S. Esakkirajan and T. Veerakumar, McGraw Hill Education
5. Digital Image Processing Using Python, by Manish Kashyap, BPL Publications
6. Digital Image Processing 2e, by S. Sridhar, Oxford University Press
7. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Thomson Learning
8. Fundamentals of Digital Image Processing, by S. Annadurai and R. Shanmugalakshmi, Pearson Education
9. Digital Image Processing, by Kenneth R. Castleman, Pearson Education
10. Digital Image Processing and Analysis, by B. Chanda and D. Dutta Majumder, PHI Learning Pvt. Ltd.
11. Image Processing Masterclass with Python, by Sandipan Dey, BPB Publications
12. Digital Image Processing: An Algorithmic Introduction, by Wilhelm Burger and Mark J. Burge, Springer
13. Digital Image Processing, 6e, by Bernd Jahne, Springer

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Component Based Technology	ML-7031(C)	3L-0T-0P	3

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Familiarization with Component Based Systems, their Purpose and Scope.

CO2 Analyse Software Engineering Practices related to CBD.

CO3 Apply design of Software Component Infrastructures.

CO4 Design real-life component-based software engineering

Course Contents:

UNIT I

Component Definition: Definition of Software Component and its Elements. Component Models and Component Services: Concepts and Principles, COTS Myths and Other Lessons Learned in Component-Based Software Development, Roles for Component-Based Development, Common High Risk Mistakes in Component-Based Software Engineering, CBSE Success Factors: Integrating Architecture, Process, and Organization, Software Engineering Practices: The Practice of Software Engineering, From Subroutines to Subsystems: Component-Based Software Development

UNIT II

The Design of Software Component Infrastructures: Software Components and the UML, Component Infrastructures: Placing Software Components in Context, Business Components, Components and Connectors: Catalysis Techniques for Defining Component Infrastructures, An Open Process for Component-Based Development, Designing Models of Modularity and Integration

UNIT III

The Management of Component-Based Software Systems: Measurement and Metrics for Software Components, The Practical Reuse of Software Components, Selecting the Right COTS Software: Why Requirements are Important, Software Component Project Management Processes, The Trouble with Testing Software Components, configuration Management and Component Libraries, The Evolution, Maintenance and Management of Component-Based Systems

UNIT IV

Component Technologies: Overview of the CORBA Component Model, Transactional COM+: Designing Scalable Applications, The Enterprise JavaBeans Component Model, Choosing Between COM+, EJB, and CCM, Software Agents as Next Generation Software Components

UNIT V

Legal and Regulatory: Component-based Software Engineering (CBSE) as a Unique Engineering Discipline, The Future of Software Components: Standards and Certification, Commercial Law Applicable to Component-Based Software, The Effects of UCITA on Software Component Development and Marketing, Future of CBSE

References:

1. Component-Based Development: Principles and Planning for Business Systems, by Katharine Whitehead, Addison Wilsey
2. Essential COM, by Don Box, Addison Wilsey
3. Component-Based Systems: Estimating Efforts Using Soft Computing Techniques, by Kirti Seth, Ashish Seth, and Aprna Tripathi, CRC Press

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Deep Reinforcement Learning	ML-8011	2L-1T-1P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Describe in-depth about theories, models and algorithms in machine learning.

CO2 Compare and contrast different learning algorithms with parameters.

CO3 Examine the nature of a problem at hand and find the appropriate learning algorithms and it's parameters that can solve it efficiently enough.

CO4 Design and implement of deep and reinforcement learning approaches for solving real-life problems.

Course Contents:

UNIT I

History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Activation functions, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalue Decomposition. Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention over images.

UNIT II

Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Batch Normalization, Instance Normalization, Group Normalization.

UNIT III

Greedy Layer-wise Pre-training, Better activation functions, Better weight initialization methods, Learning Vectorial Representations Of Words, Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Recent Trends in Deep Learning Architectures.

UNIT IV

Introduction to reinforcement learning (RL), Bandit algorithms – UCB, PAC, Median Elimination, Policy Gradient, Full RL & MDPs, Bellman Optimality, Dynamic Programming - Value iteration,

Policy iteration, and Q-learning & Temporal Difference Methods, Temporal-Difference Learning, Eligibility Traces, Function Approximation, Least Squares Methods

UNIT V

Fitted Q, Deep Q-Learning, Advanced Q-learning algorithms, learning policies by imitating optimal controllers, DQN & Policy Gradient, Policy Gradient Algorithms for Full RL, Hierarchical RL, POMDPs, Actor-Critic Method, Inverse reinforcement learning, Maximum Entropy Deep Inverse Reinforcement Learning, Generative Adversarial Imitation Learning, Recent Trends in RL Architectures.

References:

1. Deep Reinforcement Learning in Action, by Alexander Zai and Brandon Brown, Manning
2. Grokking Deep Reinforcement Learning, by Miguel Morales, Manning
3. Deep Reinforcement Learning Hands-On, by Maxim Lapan, Packt Publishing Ltd.
4. Practical Deep Reinforcement Learning with Python, by Ivan Gridin, BPB Publication
5. Deep Reinforcement Learning, by Aske Plaat. Springer
6. Reinforcement Learning, by Richard S. Sutton, Penguin Random House
7. An Introduction to Reinforcement Learning, by Soumyadip Sarkar, Notion Press
8. Reinforcement Learning: Industrial Applications of Intelligent Agents, by Phil Winder, O'Reilly Media
9. Mastering Reinforcement Learning with Python, by Enes Bilgin, Packt Publishing Ltd.
10. Algorithms for Reinforcement Learning, by Csaba Grossi, Springer
11. Foundations of Deep Reinforcement Learning: Theory and Practice in Python, by Laura Graesser and Wah Loon Keng, Pearson Education
12. Reinforcement Learning, by Richard S. Sutton, Andrew G. Barto, Bradford Books

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Engineering Economics and Management	ML-8021(A)	3L-1T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.

CO2 To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.

CO3 Foster interdisciplinary thinking by integrating engineering economic analysis with management strategies to solve complex, real-world engineering problems.

CO4 Encourage consideration of ethical, social, and environmental factors in engineering and economic decision-making.

Course Contents:

UNIT I

Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics and Macroeconomics Theory of Demand and Supply; meaning, determinants, law of demand, law of supply, equilibrium between demand & supply Elasticity; elasticity of demand, price elasticity, income elasticity, cross elasticity

UNIT II

Theory of production; production function, meaning, factors of production (meaning and characteristics of Land, Labour, capital and entrepreneur), Law of variable proportions & law of returns to scale Cost; meaning, short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost. Break even analysis; meaning, explanation, numerical

UNIT III

Markets; meaning, types of markets and their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly) National Income; meaning, stock and flow concept, NI at current price, NI at constant price, GNP, GDP, NNP, NDP, Personal income, disposal income

UNIT IV

Basic economic problems; Poverty - meaning, absolute and relative poverty, causes, measures to reduce Unemployment: meaning, types, causes, remedies Inflation; meaning, types, causes, measures to control

UNIT V

Introduction to Management; Definitions, Nature, scope Management and administration, skill, types and roles of managers Management Principles; Scientific principles, Administrative principles, Maslow's Hierarchy of needs theory

References:

1. Engineering Economics, 2e, by R. Paneerselvam, PHI Learning Pvt. Ltd.
2. Fundamentals of Management: Essential Concepts and Applications, by Stephen P. Robbins, David A. De Cenzo, and Mary A. Coulter, Pearson Education
3. Principles of Economics, 6e, by N. Gregory Mankiw, South-Western Pub.
4. Principles and Practices of Management by L.M. Prasad, Sultan Chand and Sons
5. Principles of Management, 6e, by P.C. Tripathy and P.N. Reddy, McGraw Hill Education
6. The Economic Theory of Modern Society, by Michio Morishima, Cambridge University Press
7. Modern Economic Theory, by K.K. Dewett and M.H. Navalur, S. Chand

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Big Data	ML-8021(B)	3L-1T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Students should be able to understand the concept and challenges of big data.

CO2 Students should be able to demonstrate knowledge of big data analytics.

CO3 Students should be able to develop Big Data Solutions using Hadoop Eco System.

CO4 Students should be able to gain hands-on experience on large-scale analytics tools.

Course Contents:

UNIT I

Introduction to Big data, Big data characteristics, Types of big data, Traditional versus Big data, Evolution of Big data, challenges with Big Data, Technologies available for Big Data, Infrastructure for Big data, Use of Data Analytics, Desired properties of Big Data system.

UNIT II

Introduction to Hadoop, Core Hadoop components, Hadoop Eco system, Hive Physical Architecture, Hadoop limitations, RDBMS Versus Hadoop, Hadoop Distributed File system, Processing Data with Hadoop, Managing Resources and Application with Hadoop YARN, MapReduce programming.

UNIT III

Introduction to Hive Hive Architecture, Hive Data types, Hive Query Language, Introduction to Pig, Anatomy of Pig, Pig on Hadoop, Use Case for Pig, ETL Processing, Data types in Pig running Pig, Execution model of Pig, Operators, functions, Data types of Pig.

UNIT IV

Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data architectural patterns, Variations of NOSQL architectural patterns using NoSQL to Manage Big Data, Introduction to MangoDB.

UNIT V

Mining social Network Graphs: Introduction Applications of social Network mining, Social Networks as a Graph, Types of social Networks, Clustering of social Graphs Direct Discovery of communities in a social graph, Introduction to recommender system.

References:

1. Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, by Nathan Marz and James Warren, Manning
2. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools by Davy Cielen, Arno D.B. Meysman and Mohamed Ali, Manning
3. Big Data Analytics, by Raj Kamal, Preeti Saxena, McGraw Hill Education
4. Big Data Analytics 2e, by RadhaShankarmani, M. Vijaylakshmi, Wiley
5. Big Data with Hadoop MapReduce: A Classroom Approach, by Anand Paul, Ganeshkumar Pugalendhi and Rathinaraja Jeyaraj, CRC Press
6. Big Data and Analytics: The key concepts and practical applications of big data analytics, by Jugnesh Kumar, Anubhav Kumar and Rinku Kumar, BPB Publications
7. Big Data Analytics: Concepts, Techniques, Tools and Technologies, by G. Sudha, M. Thangaraj and S. Suguna, PHI Learning Pvt. Ltd.
8. Big Data and Analytics, 2e, by Seema Acharya and Subhashini Chellappan, Wiley
9. Big Data Big Analytics, by Michael Minelli, Michele Chambers and AmbigaDhiraj, Wiley

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Robotics	ML-8021(C)	3L-1T-0P	4

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand robot mechanism.

CO2 Perform kinematic and dynamic analyses with simulation.

CO3 Design control laws for a robot.

CO4 Understand robot mechanism Integrate mechanical and electrical hardware for a real prototype of robotic device.

Course Contents:

UNIT I

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open-loop control systems; Kinematics systems: Definition of mechanisms and manipulators, Social issues and safety

UNIT II

Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH (Denavit-Hartenberg) parameters, Jacobian, Singularity, and Statics; Dynamic Modelling: Equations of motion: Euler-Lagrange formulation

UNIT III

Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/ Similarity/ Affine/ Projective transformations, Vision applications in robotics.

UNIT IV

Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID, Non-linear and advanced controls Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

UNIT V

Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

References:

1. Introduction to Robotics, 3e, by S.K. Saha, McGraw Hill Higher Education
2. Robotics: Fundamental Concepts and Analysis, by Ashitava Ghosal, Oxford University Press
3. Introduction to Robotics: Analysis, Systems, Applications, by Saeed B. Niku, Pearson Education
4. Robotics and Control, by R.K. Mittal and I.J. Nagrath, McGraw Hill Education
5. Introduction to Robotics: Mechanics and Control, by John Craig, Pearson Education
6. Robot Modelling and Control, by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, John Wiley and Sons Inc,
7. Intelligent Mechatronic System: Modeling, Control and Diagnosis, by R. Merzouki, A.K. Samantaray, P.M. Phathak, and B. Ould Bouamama, Springer
8. Embedded System Design, 2e, by Steve Heath, Newnes
9. Elements of Robotics, by Mordechai Ben-Ari and Francesco Mondada, Springer

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Natural Language Processing	ML-8031(A)	3L-0T-0P	3

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Understand fundamental concepts and techniques used in natural language processing.
CO2 Apply text preprocessing and feature extraction methods such as tokenization, stemming, lemmatization, and vectorization (TF-IDF, word embeddings).
CO3 Build and evaluate NLP models for tasks like text classification, sentiment analysis, language modeling, and named entity recognition.
CO4 Implement NLP applications using tools like NLTK, spaCy, scikit-learn, and Hugging Face Transformers.
CO5 Explore deep learning approaches in NLP, including RNNs, LSTMs, GRUs, and transformers.

Course Contents:

UNIT I

Introduction to Natural Language Processing: History and evolution of NLP, Applications of NLP: chatbots, search engines, sentiment analysis, etc. Challenges in NLP: ambiguity, context, structure

UNIT II

Text Processing and Representation: Text normalization: tokenization, stemming, lemmatization, Stopword removal, lowercasing, punctuation handling, N-grams and collocations, Bag-of-Words and TF-IDF representations

UNIT III

Linguistic Fundamentals: Morphology, syntax, semantics, pragmatics, Part-of-Speech (POS) tagging, Parsing: dependency and constituency parsing, Named Entity Recognition (NER)
Statistical and Machine Learning Approaches in NLP: Text classification (Naïve Bayes, SVM, Logistic Regression), Topic modeling (LDA), Clustering and dimensionality reduction (PCA, t-SNE), Evaluation metrics: accuracy, F1-score, precision, recall

UNIT IV

Word Embeddings and Semantic Representations: Word2Vec, GloVe, FastText, Contextual embeddings: ELMo, BERT, Sentence embeddings (SBERT, Universal Sentence Encoder),
Deep Learning for NLP: RNNs, LSTMs, GRUs for sequential data, Attention mechanism, Transformer architecture, Pretrained models: BERT, RoBERTa, GPT, T5

UNIT V

Advanced Topics and Applications: Question Answering (QA) system, Summarization, Machine Translation, Conversational AI (chatbots, virtual assistants), Retrieval-augmented generation (RAG) **Ethics and Fairness in NLP:** Bias in language models, Hate speech and toxicity detection, Privacy concerns in text data, Ethical data collection and model usage

References:

1. Natural Language Processing in Action, by Hobson Lane and Maria Dyshel, Manning Publications
2. Natural Language Processing, by Sini Raj Pulari, Umadevi Maramreddy, and Shriram K. Vasudevan, Oxford University Press
3. Understanding Natural Language Processing, by T.V. Geetha, Pearson Education
4. Natural Language Processing Cookbook, by Alessio Ligios and Rosario Moscato, BPB Publications
5. Natural Language Processing and Information Retrieval, by Tanveer Siddiqui and U.S. Tiwary, Oxford University Press
6. Natural Language Processing with Python, by Steven Bird, Ewan Klein, and Edward Loper, Shroff/O'Reilly Media
7. Natural Language Processing with Transformers, by Lewis Tunstall, Leandro Von Werra, Thomas Wolf and Aurelien Geron, O'Reilly Media
8. Multilingual Natural Language Processing Applications, by Bikel, Pearson Education

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Game Theory with Engineering Applications	ML-8031(B)	3L-0T-0P	3

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Formulate and analyze strategic interactions using game-theoretic models.

CO2 Apply solution concepts like Nash Equilibrium.

CO3 Apply Subgame Perfect Equilibrium, and Bayesian Equilibrium in engineering.

CO4 Evaluate applications in auctions, negotiation, market competition, and engineering.

Course Contents:

UNIT I

Introduction: Game Theory, Strategic form (normal form) games, Dominant strategies, dominated strategies, Nash Equilibrium (pure strategies), Applications: Market entry, coordination games

UNIT II

Mixed Strategies: Dynamic Games of Perfect Information, Mixed Strategy Nash Equilibrium, Expected utility and randomization, Extensive form games, Subgame Perfect Equilibrium (SPE), Backward induction, Applications: Sequential games, trust games

UNIT III

Repeated and Evolutionary Games: Repeated games (finite and infinite horizon), Grim trigger and tit-for-tat strategies, Folk Theorem and strategic enforcement, Evolutionary game theory basics, Applications: Cooperation, collusion

UNIT IV

Bayesian Games: Static games with incomplete information, Bayesian Nash Equilibrium, Auctions: First-price, second-price, common vs private value, Signaling and Screening models, Applications: Job market signaling, insurance, political games

UNIT V

Cooperative Games and Mechanism Design: Cooperative games: Core, Shapley value, Bargaining models (Nash bargaining solution), Mechanism design: Incentive compatibility, Revelation Principle, Vickrey–Clarke–Groves (VCG) mechanisms, Social choice and voting mechanisms

References:

1. An Introduction to Game Theory, by Martin J. Osborne, Oxford University Press,
2. Mathematical Game Theory, by Ulrich Faigle, World Scientific Publishing
3. A Course in Game Theory, by Thomas S Ferguson, World Scientific Publishing
4. Mathematical Game Theory and Applications, by Mazalov, Wiley
5. Game Theory An Introduction, by Steven Tadelis, Princeton University Press
6. Introduction to Game Theory, by Stef Tijs, Eurospan
7. Game Theory: A Modeling Approach, by Richard Alan Gillman and David Housman, CRC Press
8. Game Theory: Understanding the Mathematics of Life, by Brian Clegg, Icon Books
9. Insights into Game Theory: An Alternative Mathematical Experience, by Ein-Ya Gura and Michael Maschler, Cambridge University Press
10. Game Theory: A Beginner's Guide to Game Theory Mathematics, Strategy & Decision-Making, by John Cummings, Ingram Publishing
11. An Introductory Course on Mathematical Game Theory and Applications, by Julio Gonzalez-Diaz and Ignacio Garcia-Jurado, American Mathematical Society
12. Algorithmic Game Theory, by Noam Nisan, Tim Roughgarden, Eva Tardos and Vijay V. Vazirani, Cambridge University Press

R.K.D.F. UNIVERSITY, BHOPAL
B.TECH (Artificial Intelligence and Machine Learning)
FOURTH YEAR, Semester – VII
Course Content

Branch	Subject Title	Subject Code	Contact Hours per Week	Total Credits
B.TECH (AIML)	Blockchain Technologies	ML-8031(C)	3L-0T-0P	3

Course Outcomes:

After completing this course satisfactorily, a student will be able to:

CO1 Explain cryptographic building blocks and reason about their security.

CO2 Learn how the individual components of the Bitcoin protocol make the whole system works transactions, script, blocks, and the peer-to-peer network.

CO3 Define how Bitcoin mining works.

CO4 Exploit applications of Blockchain in real world sceneries.

Course Contents:

UNIT I

Introduction: Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Blockchain, Understanding Cryptocurrency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain; Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.

UNIT II

Understanding Blockchain with Cryptocurrency: Bitcoin and Blockchain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hash Cash PoW, Bit coin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

UNIT III

Understanding Blockchain for Enterprises: Permissioned Blockchain: Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, State machine replication, Overview of Consensus models for permissioned blockchain - Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

UNIT IV

Enterprise Application of Blockchain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, and Identity on Blockchain.

UNIT V

Blockchain Application Development: Hyperledger Fabric - Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

References:

1. Blockchain Technology: From Theory to Practice, by Sudeep Tanwar, Springer
2. Blockchain Technology, by Kumar Saurabh and Ashutosh Saxena, Wiley
3. Blockchain in Action, by Bina Ramamurthy, Manning
4. Mastering Blockchain: Inner Workings of Blockchain, from Cryptography and Decentralized Identities, to DeFi, NFTs and Web3, by Imran Bashir, Packt Publishing Ltd.
5. Blockchain Technology: Algorithms and Applications, by S. Asharaf, Neelima Sivadas, S. Adarsh, John Franklin, Wiley
6. Blockchain Essentials You Always Wanted to Know, by Kancharla, Vibrant Publishers
7. Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, by Lorne Lantz and Daniel Cawrey, O'Reilly Media
8. Blockchain Essentials: Core Concepts and Implementations, by Ramchandra Sharad Mangrulkar and Pallavi Vijay Chavan, Apress
9. Grokking Bitcoin, by Kalle Rosenbaum and David A. Harding, Manning
10. Mastering Bitcoin: Programming the Open Blockchain, 2e, by Andreas M. Antonopoulos, O'Reilly Media
11. Blockchain: Blueprint for a New Economy, by Melanie Swan, O'Reilly Media
12. Blockchain Basics: A Non-Technical Introduction in 25 Steps, by Daniel Drescher, Apress