Course Curriculum for

B Tech in Artificial Intelligence and Data Science

2023-2024 onwards

Computer Science and Engineering Department

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India.)

Table of Contents

NATIONAL INSTIUTE OF TECHNOLOGY DELHI

National Institute of Technology Delhi (NITD) is one of the thirty one NIT (s) established in the year 2010 by an Act of Parliament. The Institute has been declared as an Institute of National importance. NIT Delhi is an autonomous Institute which functions under the aegis of Ministry of Education, Government of India. It aims to provide instructions and research facilities in various disciplines of Engineering, Science and Technology, Management, Social Sciences and Humanities for advance learning and dissemination of knowledge.

NIT Delhi has started its academic session in 2010 with three undergraduate B.Tech degree programmes in Computer Science and Engineering, Electronics and Communication Engineering and Electrical and Electronics Engineering. The academic activities of NIT Delhi were initiated at NIT Warangal in year 2010 which later moved to a temporary campus at Dwarka, New Delhi in June 2012 and then shifted to IAMR Campus, Narela in February 2014. Currently, NIT Delhi is operating from its permanent campus at Plot No. FA7, Zone P1, GT Karnal Road, Delhi-110036, India

MISSION: Application of Knowledge through learning and inculcating Research Oriented mindset towards Design and Innovative Development for Realistic Societal Solutions.

VISION: Committed to holistic development of Lives and Society by imparting Knowledge of Science and Technology and Crystallizing the future.

Department of Computer Science and Engineering

The Computer Science and Engineering Department was started in 2010 along with the foundation of NIT Delhi. Initially, only the Bachelor of Technology Programme was offered with the intake 30 which presently has been increased to 60. Now, apart from B. Tech., the department also offers Master of Technology (CSE & Analytics), and Ph.D. program which cover a number of important areas of Computer Science and Engineering. The department provides the students with a broad undergraduate and graduate curriculum, based on the application and theoretical foundations of computer science. The departmental faculties and students participate in interdisciplinary research. The department envisions producing quality graduates, capable of leading the world in the technical realm. The department is equipped with the latest configuration and high computing system with hi-speed Internet facilities. The Computer Science Program at this institute are dedicated to educate students and to advance research in computer and information technology. The department has all the facilities to carry out the related teaching and research work.

Vision: To communicate quality Computer Science education for producing globally identifiable technocrats and entrepreneurs upholding sound ethics, profound knowledge, and innovative ideas to meet industrial and societal expectations.

Mission:

- To impart value-based technical knowledge and skill relevant to Computer Science and Engineering through effective pedagogies and hands-on experience on the latest tools and technologies to maximize employability.
- To strengthen multifaceted competence in allied areas of Computer Science in order to nurture creativity and innovations to adapt the ever-changing technological scenario requiring communally cognizant solutions.
- To create an appetite for research that leads to pursuing a research career or higher education in contemporary and emerging areas of computer science.
- To inculcate the moral, ethical, and social ideals essential for prosperous nation building.

Program: B.Tech. Artificial Intelligence and Data Science

Program Educational Objectives

PEO-1	Graduates will be capable of applying advanced tools and techniques to innovate ideas and create intelligent systems for a wide range of real-world problems while maintaining strong ethical standards.
PEO-2	Graduates will be prepared to pursue higher studies and continue to develop their professional knowledge.
PEO-3	Graduates will recognize the importance of research and professional development in the rapidly evolving fields of AI and Data Science. .
PEO-4	Graduates will be prepared with an entrepreneurial mindset, enabling them to identify business opportunities, create startups, exhibit leadership qualities with demonstrable attributes in lifelong learning

Program Articulation Matrix

PEO	PEO-1	PEO-2	PEO-3	PEO-4
Mission Statements	2	2	3	3

1 - Slightly 2 – Moderately 3 – Substantially

Program: B.Tech. Artificial Intelligence and Data Science

Program Outcomes

PO- 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, Engineering fundamentals, and Electrical Engineering to the solution of complex engineering problems
PO-2	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO-3	**Design/Development of solutions**: Design solutions for complex Electrical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO-4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex civil engineering activities with an understanding of the limitations.
PO-6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO-7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO-9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO-11	**Project management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO-12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO-1	Ability to analyze, build, and design new techniques and tools to produce innovative industrial solutions using mathematical and theoretical concepts of Artificial Intelligence and Data Science.
PSO-2	Ability to carry out research and education in trans-disciplinary fields to solve real world problems using state-of-art algorithms and techniques of Artificial Intelligence and Data Science.

CURRICULUM

B.Tech. Artificial Intelligence and Data Science

1st Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADLB 101	Mathematical Foundations for Data Science	3-0-0	3
2	ADLB 102	Discrete Mathematics	3-1-0	4
3	ADBB 103	Computer Programming-I	3-0-2	4
4	ADBB 104	Computer Fundamentals	3-0-2	4
5	PHLB 112	Quantum Physics	3-1-0	4
6	HMLB 102	Theory and Practices of Human Ethics	1-0-0	1
7	HSPB 150	Holistic Health & Sports	0-0-2	1
			Total Credits	20

2nd Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADLB 151	Probability and Statistics	3-0-0	3
2	ADBB 152	Computer Organization and Architecture	3-0-2	4
3	ADBB 153	Data Structures and Algorithms	3-0-2	4
4	ADBB 154	Programming using Python	1-0-2	2
5	ADLB 155	System Programming	3-0-0	3
6	CELB 101	Environmental Sciences	2-0-0	2
7	ADPB 156	Project I	0-0-4	2
			Total Credits	20

3rd Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADBB 201	Artificial Intelligence	3-0-2	4
2	ADBB 202	Database Management Systems	3-0-2	4
3	ADLB 203	Optimization Techniques	3-1-0	4
4	ADBB 204	Operating Systems	3-0-2	4
5	ADBB 205	Computer Graphics	3-0-2	4
			Total Credits	20

4th Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADBB 251	Data Science	3-0-2	4
2	ADBB 252	Data Warehousing and Mining	3-0-2	4
3	ADBB 253	Big Data Management	2-0-2	3
4	ADBB 254	Machine Learning	3-0-2	4
5	ADLB 255	Theory of Computation	3-0-2	4
6	ADPB 200	Project II	0-0-4	2
			Total Credits	20

5th Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADBB 301	Deep Learning	3-0-2	4
2	ADLB 302	Natural Language Processing	3-1-0	4
3	ADBB 303	Cloud Computing	3-0-2	4
4	ADBB 304	Image Processing and Computer Vision	3-0-2	4
5	ADLB 305	Internet of Things	3-1-0	4
			Total Credits	20

6th Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADLB 351	Social Network Analysis	3-1-0	4
2	ADBB 352	Big Data Analytics	3-0-2	4
3	ADBB 353	Soft Computing	3-0-2	4
4	ADLB XXX	Program Elective-I	3-0-0	3
5	ADLB XXX	Program Elective –I	3-0-0	3
6	ADPB 300	Project – III	0-0-4	2
7	ADPB 354	**Internship (during summer break)**	Credits will be given to the next Semester	
			Total Credits	20

7th Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADLB 401	Cyber Security	3-0-0	3
2	ADLBXXX	Program Elective-II	3-1-0	4
3	ADLBXXX	Program Elective-II	3-1-0	4
4	ADBBXXX	Program Elective-III	3-0-2	4
5	ADBBXXX	Program Elective-III	3-0-2	4
6	ADPB 354	Internship	0-0-2	1
			Total Credits	20

8th Semester

S.No	Course Code	Course Title	L-T-P	Credits
1	ADPB 400	B. Tech Project (Internship inside NIT Delhi /Outside NIT Delhi)		16
2	ADLB 451	Independent Study/ MOOC Course	3-0-0	3
3	ADPB 452	Seminar	0-0-2	1
			Total Credits	20

Professional Elective Courses

Professional Elective – I,II,III , IV and V

S.No	Course Code	Course Title
Professional Elective – I		
1	ADLB 355	Human Computer Interface
2	ADLB 357	Cognitive Networks
3	ADLB 359	Fundamentals of Robotics
4	ADLB 361	Biometrics Systems
5	ADLB 363	Statistical Methods for Data Science
6	ADLB 365	Multimedia Databases
7	ADLB 356	Nature Inspired Algorithms
8	ADLB 358	Blockchain Technology
9	ADLB 360	Sensor Networks
10	ADLB 362	Sentiment Analysis
11	ADLB 364	Reinforcement learning
12	ADLB 366	Information Storage and Retrieval
Professional Elective – II		
13	ADLB 402	Fuzzy Logic and Applications
14	ADLB 404	Foundations of Cryptography
15	ADLB 406	Drone Applications
16	ADLB 408	High performance Parallel Computing Architecture
17	ADLB 410	Game Theory
18	ADLB 412	Biometric Security
19	ADLB 403	Quantum Computing
20	ADLB 405	Digital Forensics
21	ADLB 407	GIS Applications
22	ADLB 409	Multi Agent Applications
23	ADLB 411	Graph Mining
24	ADLB 413	IoT and Multimedia Technology
Professional Elective – III		
25	ADBB 414	Augmented and Virtual reality
26	ADBB 416	Performance Modelling
27	ADBB 418	Motion Planning for Robotics
28	ADBB 420	Compiler Design
29	ADBB 422	Intelligent Data Management
30	ADBB 424	Forensics Biometric Analysis
31	ADBB 415	Social Computing
32	ADBB 417	Spatio – Temporal Data Analysis
33	ADBB 419	Convex Optimization
34	ADBB 421	Computational Biology
35	ADBB 423	Speech Recognition
36	ADBB 425	Time Series Analysis

Basic Science Courses

S.No	Course Code	Course Title	L-T-P	Credits
1	ADLB 101	Mathematical Foundations for Data Science	3-0-0	3
2	ADLB 102	Discrete Mathematics	3-1-0	4
3	ADLB 151	Probability and Statistics	3-0-0	3
4	PHLB 112	Quantum Physics	3-1-0	4

	Total Credits	**14**

Engineering Science Courses

S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	ADBB 103	Computer Programming-I	3-0-2	4
2	ADBB 104	Computer Fundamentals	3-0-2	4
3	ADBB 152	Computer Organization and Architecture	3-0-2	4
4	ADBB 153	Data Structures and Algorithms	3-0-2	4
5	ADLB 155	System Programming	3-0-0	3
6	CELB 101	Environmental Sciences	2-0-0	2
			Total Credits	21

Humanities and Social Science Courses

S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	HMLB 102	Theory and Practices of Human Ethics	1-0-0	1
2	HSPB 150	Holistic Health & Sports	0-0-2	1
			Total Credits	2

The Overall Credit Structure

Course Category	Credits
Basic Science	4
Engineering Science	2
Humanities and Social Sciences	1
Program Core	104
Professional Elective	22
Open Elective	27
Total Graded Credit Requirement	160

Minor in Electrical Engineering/CSE/ECE/ME/VLSI/CE/

S.No	Course Code	Course Title	L-T-P	Credits
1				
2				
3				
4				
5				
6				
7				
			Total Credits	

DETAILED SYLLABI

B.Tech. Artificial Intelligence and Data Science

Course Title: MATHEMATICAL FOUNDATIONS AND DATA SCIENCE

Course Code: ADLB 101

L-T-P: 3-0-0

Credits: 03

Pre-requisites: None

Course Outcomes:

CO-1	Represents the rudiments of Data Science (L2)
CO-2	Extend the use of linear systems of equations, matrices and determinants, and vector spaces in the science of data (L2)
CO-3	Demonstrate the rules of probability and statistics for understanding the nature of data (L3)
CO-4	Articulate the use of different optimization techniques for data analysis (L3)
CO-5	Illustrate analytical models for real-word scenarios (L4)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1														
CO-2														
CO-3														
CO-4														

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems.

Module-II (8 Hours)

Vectors; Matrices and their properties (determinants, traces, rank, nullity, etc.); Addition and Multiplication; Eigenvalues and eigenvectors; Matrix factorizations; Distances and Nearest Neighbors; Similarities; Projections; Notion of hyperplanes; half-planes.

Module-III (9 Hours)

Probability theory and axioms; Random variables; Probability distributions and density functions (univariate and multivariate); Conditional Probability, Bayes' Theorem, Continuous and discrete distributions, Transformation of random variables, estimating mean, variance, covariance, Expectations and moments; Covariance and correlation; Statistics and sampling distributions; Hypothesis testing; Confidence (statistical) intervals; Correlation functions; White-noise process; Exponential family of distributions (Bernoulli, Beta, Binomial, Dirichlet, Gamma, & Gaussian)

Module-IV (8 Hours)

Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization; Optimization view of machine learning.

Module-IV (6 Hours)

Linear regression as an exemplar function approximation problem; Linear classification problems.

Learning Resources:

Text Books:

1. Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, Sixth Edition, 2023
2. David G. Luenberger, Optimization by Vector Space Methods, John Wiley & Sons, 1969 (reprint 1997)

Reference Books:

1. Kenneth Hoffman, Ray Kunze, Linear Algebra, Pearson, Second Edition, 2018

Course Title: DISCRETE MATHEMATICS

Course Code: ADLB 102

L-T-P: 3-1-0

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Illustrate the basics of discrete mathematics and predicate calculus (L2).
CO-2	Explain set theory and relations (L2).
CO-3	Demonstrate the concepts of graph theory and experiment with trees to solve problems like minimum spanning tree and tree traversals (L3).
CO-4	Develop the concept of functions and recursive function theory (L3).
CO-5	Illustrate different algebraic structures (L2).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2											3
CO-2	3	3	3									2	3	2
CO-3	3	3	3	3	3								3	3
CO-4	3	2	3		2								3	3

CO-5	3	2	2									2		3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: (5 Hours)

Mathematical reasoning; propositions; negation disjunction and conjunction; implication and equivalence; truth tables; predicates; quantifiers; natural deduction; rules of Inference; methods of proofs; use in program proving; resolution principle.

Module-II: (10 Hours)

Set theory; Paradoxes in set theory; inductive definition of sets and proof by induction; Peono postulates; Relations; representation of relations by graphs; properties of relations; equivalence relations and partitions; Partial orderings; Posets; Linear and well- ordered sets.

Module-III: (7 Hours)

Graph Theory; elements of graph theory, Euler graph, Hamiltonian path, trees, tree traversals, spanning trees.

Module-IV: (7 Hours)

Functions; mappings; injection and surjections; composition of functions; inverse functions; special functions; Peono postulates; pigeonhole principle; recursive function theory.

Module-V: (7 Hours)

Definition and elementary properties of groups, semigroups, monoids, rings, fields, vector spaces and lattices. Elementary combinatorics; counting techniques; recurrence relation; generating functions.

Learning Resources:

Text Books:

1. K.H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, Fifth Edition, 2003

Reference Books:

1. C. L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book Company, Second Edition, 1985
2. J. L. Mott, A. Kandel, T. P. Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, Second Edition, 1986
3. W. K. Grassmann, J. P. Tremblay, Logic and Discrete Mathematics, Pearson, 1995

Course Title: COMPUTER PROGRAMMING-I

Course Code: ADBB 103

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Illustrate the steps involved in compiling, linking, and debugging any code written in a specific language (L2).
CO-2	Explain the basic concepts such as keyword, identifiers, header files, and the methods of iteration or looping and branching, etc. (L2).
CO-3	Apply the concepts of functions to understand modular programming (L3).
CO-4	Utilise the concept of pointers and arrays to structure data in a computer program (L3).
CO-5	Develop the basic applications in C programming using structures, union and file handling (L6).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2		3								2	3
CO-2	3	3	2									2	2	3
CO-3	3	3	3		3								3	3
CO-4	3	3	3		3								3	3
CO-5	3	3	3	2	3							2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Introduction to Computers: Hardware and Software. Basic Model of Computation, Notion of Algorithms, Flowcharts, Top down design, Bottom up approaches of problem solving, Number system.

Module-II (9 Hours)

Introduction to programming language, Basics of C, Basic Data types – int, float, double, char, Bool, Void. Arithmetic and logical operators: precedence and associativity. Flow of Control – Conditional statements – If-else, Switch-case constructs, Loops – While, do-while, for.

Module-III (7 Hours)

Function – User defined functions, library functions, Parameter passing – call by value, call by reference, recursion.

Module-IV (7 Hours)

Arrays – Advantages and drawbacks, One dimensional, Multi-Dimensional Arrays and strings: Declaration, Initialization, Accessing, Passing arrays and strings as parameters to functions. Pointers, Dynamic memory allocation, Dynamic arrays – One dimensional, Multidimensional dynamic arrays.

Module-V (8 Hours)

Structure: Declaration, Initialisation, passing structure to function, Use of pointers in structure. Preprocessors, Macros, File management in C I/O – Opening, closing and editing files. Correctness & Efficiency Issues in Programming, Time & Space measures.

Learning Resources:

Text Books:

1. E. Balagurusamy, *Programming in ANSI C*, TATA McGraw Hill, 6th edition, 2012.

Reference Books:

1. Yashavant Kanetkar, *Let Us C*, Infinity Science Press, 13th edition, 2012.
2. Brian Kernighan & Dennis Ritchie, *The C Programming Language*, Prentice Hall, 2nd Edition, 1988.
3. Byron S. Gottfried, *Schaum's Outline of Programming with C*, TATA McGraw Hill, 2nd edition, 1996.

List of Experiments:

1. Installation of C Development Environment.
2. Introduction to Programming Logic Building.
3. Basic Concepts of a Computer Programming Language.
4. Implementation of sequential constructs.
5. Implementation of selection constructs.
6. Implementation of Iterative constructs and their nested variants.
7. Implementation of arrays (One dimensional and multi-dimensional along with operations performed on arrays).
8. Implementation of functions (normal functions, recursive functions and parameter passing methods).
9. Implementation of Pointers with arrays, strings and functions.
10. Implementation of structures and Union.
11. Implementation of file handling in C.

Course Title: COMPUTER FUNDAMENTALS

Course Code: ADBB 104

L-T-P: 2-0-2

Credits: 03

Pre-requisites: None

Course Outcomes:

CO-1	Illustrate the binary system and its importance in computer architecture (L2).
CO-2	Identify where, when, and how enhancements of computer hardware and software have taken place (L3).
CO-3	Develop skills for problem-solving approaches (L3).
CO-4	Analyse different types of operating systems, network types, and topologies (L4).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2										2	2	2
CO-2	3	3	2		2							2	2	3
CO-3	3	3	3		3								3	3
CO-4	3	2	2	2									2	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: (3 Hours)

Computer hardware: Evolution of Computer Hardware, Moore's Law, Classification of Computers, Fundamental Units of Computer, Communication between various units, Processor speed, Multiprocessor system, Input/Output devices, Storage Devices.

Module-II: (5 Hours)

Number System: Introduction and types of number system, conversion between number systems, complements, arithmetic operations on number systems, signed and unsigned number system, fixed and floating point numbers.

Module-III: (5 Hours)

Logic development and algorithms: Various techniques to solve a problem, ways to specify an algorithm, flow charting techniques, types of computer languages.

Module-IV: (6 Hours)

Operating Systems and System Software: What is Operating System – Evolution of OS, types of operating system: batch, multiprogramming, multiprocessing, multi-user, time sharing, personal, parallel, real time; Single User System, Multi User Systems, Booting; Approaches to OS design and implementation: Microkernel, Layered, Kernel approach; Introduction to development tools: Editors, Translators, Compiler, Debugger, Assembler.

Module-V: (5 Hours)

Data communication, Computer network and Internet Basics: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Guided Transmission Media, Wireless Transmission, Introduction to Computer Network, Types of Networks: Broadcast and Point-to-point-LAN-MAN-WAN- Wireless networks.

Learning Resources:

Text Books:

1. Peter Nortan, Computer Fundamentals, TATA McGraw Hill, 5th edition, 2003

Reference Books:

1. Allen B. Tucker, Computer Science Handbook, CRC Press, 2nd edition, 2004
2. I. T. L. Education Solutions Limited (ITL ESL), Introduction to Computer Science, Pearson Education, 4th impression, 2009

List of Experiments:

1. Basic Unix commands.
2. Familiarisation with operating system; file management commands to create, copy, move, delete, and rename files/folders.
3. Prepare and print a bio-data with a covering letter using LaTeX.
4. Spreadsheet task: compute total marks and grades based on boundary conditions for n students.
5. Prepare a presentation with transitions, animations, and insertion of scanned images and web content.
6. Figure creation using draw.io.
7. Basics of programming.
8. Programs: average of three numbers; area of triangle; volume of cylinder; temperature conversion.
9. Programs: largest of three numbers; even/odd check; roots of a quadratic equation; print day name for a given code.
10. Programs: print natural numbers; factorial; multiplication table; sum of digits; sum of a set of numbers; grade calculation based on boundaries.
11. Programs: conversion between number systems (binary, octal, decimal, hexadecimal).

Course Title: QUANTUM PHYSICS

Course Code: PHLB 112

L-T-P: 3–1–0

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Basic understanding of key concepts and the principle of Quantum Physics and its applications; understanding the role of uncertainty in quantum physics (L1, L2).
CO-2	Interpret the wave function and apply operators to obtain information about a particle's physical properties such as position, momentum, and energy (L1–L5).
CO-3	Solve the Schrödinger equation to obtain wave functions for basic one-dimensional

	potentials, and estimate the shape of the wave function from the potential (L3, L4).
CO-4	Analyse and evaluate quantum-physics problems independently with key questions and appropriate methods (L4, L5).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	3	3	1	2	1	1	1	2	1	3	1	1
CO-2	3	2	3	3	1	2	1	1	1	2	1	3	1	1
CO-3	3	2	3	3	1	2	1	1	1	2	1	3	1	1
CO-4	3	2	3	3	1	2	1	1	1	2	1	3	1	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: (4 Hours)

Planck's radiation law, Photoelectric effect, Compton's experiment, The Bohr model, de Broglie's hypothesis.

Module-II: (10 Hours)

Probability amplitudes and quantum states, Operators and observables, Position and momentum representations, Time evolution in quantum mechanics.

Module-III: (10 Hours)

Wave mechanics: Free particle in one dimension, Infinite square well, Finite square well, Split infinite square well, Scattering of free particles, Resonant scattering.

Harmonic oscillators: Ground state of the quantum harmonic oscillator, Excited states of the quantum harmonic oscillator, What oscillates in the quantum harmonic oscillator? Quantum vs classical harmonic oscillator.

Module-IV: (10 Hours)

Transformations and symmetries; Translations: expectation values, wave functions, translational invariance and momentum as a "good quantum number"; Reflections (parity); Rotations; Heisenberg picture and Heisenberg equation of motion.

Module-V: (7 Hours)

Rotational invariance and angular momentum as a good quantum number, Eigenstates of L2 and □̂□.

Module-V: (7 Hours)

Operators, Position representation, Independent particles, Measurements; Product States vs entangled states; Entanglement Growth; EPR experiment and Bell inequalities

Learning Resources:

Text Books:

1. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill, 6th Edition, 2003.

Reference Books:

2. Richard P. Feynman, Robert Leighton, Mathew Sands, The Feynman Lectures on Physics, Pearson Education India, The New Millennium Edition, 2012.
3. R. Shankar, Principles of Quantum Mechanics, Plenum Press, 2nd Edition, 1994.
4. D. J. Griffiths, Introduction to Quantum Mechanics, Prentice-Hall, 2nd Edition, 2005.

Course Title: THEORY AND PRACTICES OF HUMAN ETHICS

Course Code: HHPB 150

L-T-P: 1–0–0

Credits: 01

Pre-requisites: None

Course Outcomes:

CO-1	Develop and understand the basic elements of human values and business ethics at the organizational level and get acquainted with the business world.
CO-2	Understand the possible engagement between Industry 5.0 and the human ethics and exploring the extent up to which the AI technology may replace or complement the core human values.
CO-3	Build better technology by taking into consideration all the possible rules, regulations and governance regimes of Artificial Intelligence (AI) based technology.
CO-4	Develop the balance between the internal values as engineers with respect to engineering technology keeping in line with moral sense of external values and wellbeing.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	2	2	1	1	3	2	3	3	3	3	3	3	3
CO-2	2	1	3	3	1	3	3	3	3	3	3	2	2	1
CO-3	1	1	3	3	1	3	3	3	3	3	3	1	3	2
CO-4	1	1	1	1	1	3	2	3	3	3	2	3	2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1:

Introduction: Organizational Systems and Resources Personality, Types of Personality, Determinants of Personality. Biographical and Personal factors. Environmental Factors. Psychological Factors. Big Five Personality traits.

Module-II:

Feelings, Classification of Feelings. Dimensions of Emotions. Emotions and External Constraints. Emotional Intelligence. Artificial Intelligence. Authority, Responsibility and Accountability: Meaning and Balance, Case Study: Surveillance technologies and Privacy at Work.

Module-III:

Human Resource Policies& Procedures, Big Data and Privacy Policies, e-Governance Regimes, Algorithm based Decision-making versus non-epistemic human values & Ethics

Module-IV:

Concept of moral Relativism and Moral Imperialism, Cognitive Moral Development, Approaches to Fostering Ethical Behavior, Artificial intelligence and Value alignment, Digital wellbeing.

Learning Resources:

Text Books:

1. Chitale, et.al. "Organizational Behaviour: Text and Cases", PHI Learning Private Limited
2. Matthew S. Liao "*Ethics of Artificial Intelligence",* Oxford University Press.

Reference Books:

1. Mike W. Martin & Roland Schinzinger "Ethics in Engineering" McGrow Hills.
2. Virginia Eubanks "Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor", St Martin's Press.

Other Suggested Readings:

Course Title: HOLISTIC HEATH & SPORTS

Course Code: HHPB 150

L-T-P: 0–0–2

Credits: 01

Pre-requisites: None

Course Outcomes:

CO-1	Students will be more aware about their overall health.
CO-2	Students will learn methods to keep them physically fit and to assess their physical fitness.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1														
CO-2														

CO-3													
CO-4													

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1
Physical fitness, components of physical fitness, methods to improve components of physical fitness, health, components of health, health-related fitness components, factors affecting overall health. Respiratory rate, Breathing rate, Body Mass Index. Physical Fitness Testing: Cooper's test, Push-up test, Squat test, Sit & Reach Test, Isometric Back strength test, Standing Broad jump test, Shuttle run test, 100 metre sprint test, one minute Sit-up test.

Module-II
Yoga & its Elements: Yoga, elements of Yoga, Asanas, Pranayama, Surya Namaskar.

Module-III
First Aid & Sports Injuries: First aid, aim of first aid, techniques of first aid, CPR technique, Recovery position, introduction to sports injuries.

Module-IV
Nutrition & Balanced Diet: Nutrition, components of nutrition, Balanced diet.

Module-V
Sports & Psychology: Psychology, Sports Psychology, Motivation, Anxiety, Leadership, The Big 5 personality test.

Learning Resources:

<u>Text Books:</u>

<u>Reference Books:</u>

<u>Other Suggested Readings:</u>

Course Title: PROBABILITY AND STATISTICS

Course Code: ADLB 151

L-T-P: 3-0-0

Credits: 03

Pre-requisites: None

Course Outcomes:

CO-1	Illustrate the principal concepts about probability (K2).
CO-2	Explain the concept of a random variable and the discrete probability distributions (K2).
CO-3	Explain continuous distributions and solve the distribution-related problems (K3).
CO-4	Apply the fundamentals of statistics to experiment with statistical inferences (K3).
CO-5	Utilise stochastic processes and Markov chains to solve real life problems (K3).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1														
CO-2														
CO-3														
CO-4														
CO-5														

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (7 Hours)

Events and outcomes. Probability rules Sample space and events, The axioms of probability. Conditional probability, Independence, Bayes' Rule, Law of Total Probability Elementary theorems of probability

Module-II (7 Hours)

Random variables, Joint and marginal distributions. Expectation and variance. Discrete distributions: Bernoulli, Binomial, Geometric, and Poisson.

Module-III (7 Hours)

Continuous distributions and densities: Uniform, Exponential, Gamma, Normal Central Limit Theorem and Normal approximations, Law of Large Numbers.

Module-IV (7 Hours)

Statistical Inference: Introduction of sampling, Sampling distributions of mean and variance, Point and interval estimation.

Module-V (8 Hours)

Stochastic processes: concepts and classifications. Bernoulli process. Poisson process. Markov chains. Transition probabilities. Steady-state distribution

Learning Resources:

Text Books:

3. Sheldon M Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Fifth Edition, Elsevier.

Reference Books:

1. K. Trivedi, *Probability and Statistics with Reliability, Queuing, and Computer Science Applications*, Second edition (2002), Wiley.
2. Athanasios Papoulis, S. Unnikrishna Pillai, *Probability, Random Variables, and Stochastic Processes*, Tata McGraw-Hill Education, 2002.
3. Robert V Hogg, Joseph McKean, Allen T Craig, *Introduction to Mathematical Statistics*, Seventh Edition, Pearson.

4. Michael Mitzenmacher, Eli Upfal, *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*, Cambridge University Press.

Course Title: COMPUTER ORGANIZATION & ARCHITECTURE

Course Code: ADBB 152

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Understand the fundamentals of computer organization and its relevance to classical and modern problems of computer design (K2).
CO-2	Apply knowledge of combinational and sequential logic circuits to mimic simple computer architecture to solve the given problem (K3).
CO-3	Analyze performance of various instruction set architecture, control unit, memories and various processor architectures (K4).
CO-4	Explain the basic concept of interrupts and their usage to implement I/O control and data transfers (K2).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2										2	2	2
CO-2	3	3	3		2								2	3
CO-3	3	3	3	2	2								3	3
CO-4	3	3	3	3	3								3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Introduction: Function and structure of a computer Functional components of a : Function and structure of a computer, Functional components of a computer, Interconnection of components, Performance of a computer.

Module-II (7 Hours)

Representation of Instructions Representation of Instructions: Machine instructions, Operands, Addressing : Machine instructions, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures.

Module-III (7 Hours)

Processing Unit: Organization of a processor - Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Microprogrammed control unit.

Module-IV (9 Hours)

Memory Subsystem: Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Error correction memories, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Hardware support for memory management.

Module-V: (8 Hours)

Input/Output Subsystem: Access of I/O devices, I/O ports, I/O control mechanisms - Program controlled I/O Interrupt controlled I/O and DMA controlled I/O I/O interfaces Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O interfaces - Serial port, Parallel port, PCI bus, SCSI bus, USB bus, I/O peripherals - Input devices, Output devices, Secondary storage devices.

Learning Resources:

Text Books:

1. D. A. Patterson, J. L. Hennessy, *Computer Organization and Design – The Hardware/Software Interface*, Morgan Kaufmann, 2014.

Reference Books:

1. M. Morris Mano, *Computer System Architecture*, Prentice Hall of India Pvt Ltd, Third edition, 2002.
2. W. Stallings, *Computer Organization and Architecture – Designing for Performance*, Prentice Hall of India, 2002.
3. C. Hamacher, Z. Vranesic, S. Zaky, *Computer Organization*, McGraw-Hill, 2002.
4. J. P. Hayes, *Computer Architecture and Organization*, McGraw-Hill, 1998.

List of Experiments:

1. To study and verify the truth table of logic gates.
2. Implement Half Adder and Full Adder using basic logic gates.
3. To simplify the given expression and to realize it using Basic gates and Universal gates
4. Implement Gray-to-Binary and Binary-to-Gray code conversion.
5. To implement 4 x 1 and 8 x 1 multiplexers
6. Verify the excitation table of various Flip Flops
7. To Design an 8-bit Arithmetic Logical Unit.
8. Design the control unit of a computer using either handwriting or microprogramming based on its register transfer language description.
9. To implement a simple instruction set computer with a control unit and a data path.

10. To design the data path of a computer from its register transfer language description.

Course Title: DATA STRUCTURES AND ALGORITHMS

Course Code: ADBB 153

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Recognize the need of different data structures and understand their characteristics (K2).
CO-2	Demonstrate the operations for maintaining common data structures and recognize the associated algorithms' complexity (K2).
CO-3	Apply different data structures including stacks, queues, hash tables, binary and general tree structures, search trees, and graphs for given problems (K3).
CO-4	Design, analyse and compare different algorithms for sorting and searching techniques (K5).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	3	2						1	2	2	3
CO-2	3	2	2	3	3						1	2	2	3
CO-3		3	3			2						2		3
CO-4	3			2							1	2		3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Introduction: Dynamic aspects of operations on data, characteristics of data structures, creation and manipulation of data structures, operations on data structures, types of data structures – linear and nonlinear. Introduction to algorithm: asymptotic notations, analysis of algorithms: time and space complexity.

Module-II (7 Hours)

Arrays: Dynamic memory allocation, one-dimensional arrays, multidimensional arrays, operations on arrays, storage – row major order, column major order. Linked lists: types of linked lists – singly, doubly and circularly linked lists, operations on linked lists.

Module-III (8 Hours)

Stacks: Implementation of stacks – array and linked list, operations on stacks, applications of stacks, notations – infix, prefix and postfix, conversion and evaluation of arithmetic expressions using stacks. Queues: Implementation of queues – array and linked list, operations on queues, types of queues – queue, double ended queue and priority queue.

Module-IV (8 Hours)

Trees: Binary tree, binary search tree, threaded binary tree, height balanced trees, tries, heaps, hash tables. Graph traversals: Breadth First Search, Depth First Search. Shortest path. Depth first search in directed and undirected graphs. Union-find data structure and applications. Directed acyclic graphs; topological sort.

Module-V (8 Hours)

Searching: Linear search, binary search and hashing. Algorithms and data structures for sorting: insertion sort, bubble sort, selection sort, merge sort, quick sort, heap sort, radix sort, bucket sort. Algorithm design techniques: divide and conquer, greedy approach, dynamic programming.

Learning Resources:

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, Fourth Edition, MIT Press, 2022.

Reference Books:

1. E. Horowitz, S. Sahni, *Fundamentals of Data Structures*, 2nd Edition, Computer Science Press, 2008.
2. E. Balagurusamy, *Data Structures Using C*, TATA McGraw Hill, 2013.
3. R. L. Kruse, *Data Structure and Program Design*, 2nd Edition, Prentice Hall, 1996.
4. A. M. Tanenbaum, Y. Langsam, M. J. Augenstein, *Data Structures Using C*, Pearson Education, 1990.

List of Experiments:

1. Write a Program in C to Implement Stacks Using Arrays and Linked Lists
2. Write a Program in C to Implement Queues Using Arrays and Linked Lists
3. Write a program that uses functions to perform the following operations on singly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal
4. Write a program that uses functions to perform the following operations on doubly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal.
5. Write a program that uses functions to perform the following operations on circular linked List i) Creation ii) Insertion iii) Deletion iv) Traversal
6. Write a program that uses both recursive and non recursive functions to perform the following searching operations for a Key value in a given list of integers: a) Linear search b) Binary search
7. Write a program that implements the following sorting i) Bubble sort ii) Selection sort iii) Quick sort.
8. Write a program that implements the following i) Insertion sort ii) Merge sort iii) Heap

sort.

9. Write a program to perform the following operations: a) Insert an element into a binary search tree. b) Delete an element from a binary search tree. c) Search for a key element in a binary search tree
10. Write a program to implement the tree traversal methods

Course Title: PROGRAMMING USING PYTHON

Course Code: ADBB 154

L-T-P: 1-0-2

Credits: 02

Pre-requisites: None

Course Outcomes:

CO-1	Explain the problem solving fundamentals (K2).
CO-2	Illustrate the syntax and semantics and looping structures in Python programming language (K2).
CO-3	Utilise string handling mechanisms for data handling (K3).
CO-4	Make use of lists, tuples and dictionaries in Python programming language (K3).
CO-5	Develop applications using file handling mechanisms, modules and packages of Python language (K6).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2		2							2	2	3
CO-2	3	3	2		3							2	3	3
CO-3	3	3	3		3								3	3
CO-4	3	3	3	2	3								3	3
CO-5	3	3	3	3	3								3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program. Algorithms – Characteristics – Flowcharts.

Module-II (7 Hours)

Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation.

Module-III (8 Hours)

Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers.

Module-IV (8 Hours)

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Module-V (8 Hours)

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments – Program structure and design – Recursive functions – Introduction to classes and OOP. Applications: Sample problems in engineering, data pre-processing, and plotting tools.

Learning Resources:

Text Books:

1. Kenneth A. Lambert, *Fundamentals of Python: First Programs*, Cengage Learning, Inc., 2nd Edition, 2018.

Reference Books:

1. Reema Thareja, *Python Programming using Problem Solving Approach*, Oxford University Press, 2nd Edition, 2023.
2. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist*, O'Reilly, 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
3. John V. Guttag, *Introduction to Computation and Programming Using Python*, MIT Press, Revised and Expanded Edition, 2013.

List of Experiments:

1

a) Write a program to perform different Arithmetic Operations on numbers in Python
b) Write a program to create, concatenate and print a string and accessing sub-string from a given string.
c) Write a python script to print the current date and time in the following format "Mon JUL 29 02:26:23 IST 2025"

2

a) Write a Python program that accepts a hexadecimal number as a string and converts it to decimal, binary, and octal formats.
b) Demonstrate slicing the string and counting the number of vowels in it

3

a) Write a program to create, append, and remove lists in python
b) Write a program to demonstrate working with tuples in python
c) Write a program to demonstrate working with dictionaries in python

4

a) Write a Python program to construct the stars(*) pattern shown on board, using a nested for loop
b) Write a Python script that prints prime numbers less than 20
c) Write a program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle

5 Write a Python program to multiply two matrices. The program should:

1. Accept the dimensions (rows and columns) of two matrices from the user.
2. Check whether matrix multiplication is possible (i.e., number of columns in Matrix A = number of rows in Matrix B).
3. Accept the elements of both matrices from the user.
4. Perform matrix multiplication and display the resulting matrix in a readable format.

6 Implement the following Searching and Sorting techniques in python

i) Linear Search
ii) Binary Search
iii) Selection Sort
iv) Bubble Sort

7 Perform various file operations in python

a) Python program to perform read and write operations on a file.
b) Python program to copy the contents of a file to another file.
c) Python program to count frequency of characters in a given file.
d) Python program to print each line of a file in reverse order.
e) Python program to compute the number of characters, words and lines in a file.

8

a) Demonstrate the following kinds of Parameters used while writing functions in Python.
   i. Positional Parameters
   ii. Default Parameters
   iii. iKeyword Parameters
   iv. Variable length Parameters
b) Write a Python program to return multiple values at a time using a return statement.
c) Write a Python program to demonstrate Local and Global variables.
d) Demonstrate lambda functions in Python with suitable example programs

9 Write a python program to define a module to find Fibonacci Numbers and import the module to another program

10 Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order

11 Mini Project: Data Pre-processing and Visualization (Student may choose different data)

Sample Problem Statement:

Download a CSV file containing daily temperature data for a week.

Write a Python program that reads the file, filters out any missing or invalid entries,

Computes the average temperature, and plots a line chart using matplotlib.

Course Title: SYSTEM PROGRAMMING

Course Code: ADLB 155

L-T-P: 3-0-0

Credits: 03

Pre-requisites: None

Course Outcomes:

CO-1	Apply the knowledge of assembler and macro processors to convert assembly language into machine code.
CO-2	Analyze working phases of compiler to undertake meaningful language translation.
CO-3	Evaluate linkers, loaders, interpreters and debugging methods to manage system memory and provide a portable runtime environment.
CO-4	Analyze the working of an operating system and its components.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3											3	
CO-2	3	3	2	3									3	
CO-3	3	3		3									3	3
CO-4	2	2	3	3									2	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Introduction: Evolution of the components of a programming system, evolution of operating systems. Machine structure, machine language, and assembly language.

Module-II (7 Hours)

Assemblers: Design of assembler. Table processing: searching and sorting. Macro language and the macro processor: macro instructions, features of macro facility, implementation.

Module-III (8 Hours)

Loaders: Loader schemes, design of an absolute loader, design of a direct-linking loader.

Module-IV (8 Hours)

Compilers: Statement of problem, phases of the compiler, data structures, recursion, call and return statements, storage classes – use, implementation, block structure, nonlocal go to's, interrupts, pointers.

Module-V (8 Hours)

Operating systems: I/O programming, memory management, processor management, device management, information management.

Learning Resources:

Text Books:

1. John J. Donovan, *Systems Programming*, Tata McGraw Hill, 2014.

Reference Books:

1. L. L. Beck, *System Software – An Introduction to Systems Programming*, Addison-Wesley, 3rd Edition, 1996.

Course Title: Environmental Science

Course Code: CELB 101

L-T-P: 2–0–0

Credits: 02

Pre-requisites: None

Course Outcomes:

CO-1	
CO-2	

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1														
CO-2														
CO-3														
CO-4														

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1

Module-II

Module-III

Module-IV

Module-V

Learning Resources:

Text Books:

Reference Books:

Other Suggested Readings:

Course Title: ARTIFICIAL INTELLIGENCE

Course Code: ADBB 201

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Understand the basic concepts of AI. (L1, L2)
CO-2	Apply search strategies to solve AI problems. (L3)
CO-3	Apply knowledge representation and reasoning to solve real-world AI Problems. (L3)
CO-4	Explore machine learning concepts and algorithms for real-world applications. (L4)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2									2	3	3
CO-2	3	3	3	2	3							2	3	3
CO-3	3	3	3	3	3								3	3
CO-4	3	3	3	3	3	2	2	2		2		2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 (6 Hours)

Introduction, History, Possible Approaches in AI, Automated Problem Solving Agent: Intelligent Agent & Environment, Complex Problems and AI, Shannon number, Problem Representation in AI

Module-II (7 Hours)

Search Strategies: Search introduction, Uninformed Search, Informed/Heuristic Search, Beyond Classical Search, Local Search, Problem Reduction, Adversarial Search, Constraint Satisfaction Problems

Module-III (6 Hours)

Logic and Deduction: Logical Agents, Propositional logic and Predicate Logic, First Order Logic, inference in First order Logic, Inferencing By Resolution Refutation, Classical Planning

Module-IV (8 Hours)

Quantifying Uncertainty, Introduction of Probability, Probabilistic Reasoning, Bayes Net, Bayesian Network, Fuzzy Logic, Decisions Theory, Utility Function, Decision Network, Markov Decision Process, Probabilistic Reasoning over time, Hidden Markov Model, Kalman filter, Markov Chain Monte Carlo

Module-V (9 Hours)

Learning Agent, Introduction to Machine Learning, Types of Machine Learning, Learning from experience: Reinforcement Learning, Background, Model based and Model free learning, TD and Q Learning, RL Applications, Learning from Example, Supervised learning : Introduction, Naive Bayes, Decision Tree, Perceptrons, Neural Network, Introduction to Deep Learning. AI Applications and Ethics, Ethics of AI.

Learning Resources:

Text Books:

1. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Halls, Fourth Edition, 2020.

Reference Books:

1. Nils J. Nilsson Artificial Intelligence: A New Synthesis Morgan-Kaufmann, 1998.
2. Judea Pearl Heuristics: Intelligent Search Strategies for Computer Problem Solving Addison-Wesley Publishing Company 1984.

List of Experiments:

1. Introduction to Prolog programming
2. Python Frameworks Tutorial (with Jupyter and Colab) and it’s Data Structures
3. Searching in graph based problem space, exploring Uninformed search Techniques
4. Exploring Informed search Techniques (Vacuum world and Maze Problem)
5. Exploring Uninformed and Informed search Techniques (PACMAN Search Space)

6. Multi-agent in a search space
7. Introduction Logical Agent and Knowledge representation using Prolog
8. Reasoning Under Uncertainty using Bayesian Learning
9. Reinforcement Learning using Q-Learning
10. Introduction to Machine Learning and Python libraries for Data Analysis (Pandas, NumPy, Matplotlib)

Course Title: DATABASE MANAGEMENT SYSTEM

Course Code: ADBB 202

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Learn the basic concepts of Database Systems. (L2)
CO-2	Model the real-world systems using Entity Relationship Diagrams and convert the ER model into a relational logical schema using various mapping algorithms. (L3)
CO-3	Make use of SQL commands and relational algebraic expressions for query processing. (L4)
CO-4	Simplify databases using normalization process based on identified keys and functional dependencies and solve the atomicity, consistency, isolation, durability, transaction, and concurrency-related issues of databases. (L5)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2									2	2	3
CO-2	3	3	3	2	2						1	2	3	3
CO-3	3	3	3	3	3						1		3	3
CO-4	3	3	3	3	3	2		2			2	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (6 Hours)

Introduction - General introduction to database systems; Database - DBMS distinction, approaches to building a database, data models, database management system, three-schema architecture of a database, challenges in building a DBMS, various components of a DBMS

Module-II (8 Hours)

Database design and ER Model:- Overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain, and Normalization (1NF, 2NF, 3NF, BCNF).

Module-III (6 Hours)

Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.

Module-IV (8 Hours)

SQL - Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL - basic select-from-where block and its semantics, nested queries- correlated and uncorrelated, notion of aggregation, aggregation functions group by and having clauses, embedded SQL. Data Storage and Indexes - file organizations, primary, secondary index structures, various index structures - hash-based, dynamic hashing techniques, multi-level indexes, and B+ trees.

Module-V (8 Hours)

Transaction management and Concurrency control: Transaction processing and Error recovery - concepts of transaction processing, ACID properties, and serializability concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, and database recovery management. Error recovery and logging, undo, redo, undo-redo logging, and recovery methods.

Learning Resources:

Text Books:

1. R. Elmasri and S.B. Navathe Fundamentals of Database Systems Pearson 2016

Reference Books:

1. H.f.Korth and Silberschatz Database Systems Concepts McGraw Hill
2. C.J. Date Data Base Design Addison Wesley
3. Hansen and Hansen DBM and Design PHI
4. Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom Database System Pearson 2nd Edition

List of Experiments:

1. Library Management system (File Handling)

2. Introduction to SQL
    - Installation of SQL-Server
    - SQL data definition
    - Constraints in SQL
    - Schema change Statement
3. Basic SQL Queries
4. Complex SQL Queries-1
    - Correlated Nested Queries
    - Nested Queries
    - EXISTS Function in SQL
    - Aggregation Function
5. Complex SQL Queries-2
    - Joined Tables
    - Aggregate Functions
6. Complex SQL Queries-3
    - Grouping
    - EXISTS and UNIQUE functions
    - Aggregate Functions
7. Entity-Relationship Diagram from Case Study
8. Normalization of the Case Study
9. Webpage Connectivity with SQL Server Using XAMPP- 1
10. Webpage Connectivity with SQL Server Using XAMPP- 2
11. Mini DBMS Project
12. Mini DBMS Project

Course Title: OPTIMIZATION TECHNIQUES

Course Code: ADLB 203

L-T-P: 3-1-0

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	To understand the fundament of Linear Programming and Dynamic Programming. (L1, L3)
CO-2	Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas. (L1, L2)
CO-3	Identify appropriate optimization method to solve complex problems involved in

	various industries. (L1, L2, L4)
CO-4	To understand the graphical, simplex and analytical methods for making effective decision. (L2, L5)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2							2	3	2
CO-2	3	3	3	3	3						2	2	3	3
CO-3	3	3	3	3	3						2		3	3
CO-4	3	3	3	3	3						2	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 (12 Hours)

Preliminaries: Proofs, Vector Spaces and Matrices, Linear Transformations, Eigenvalues and Eigenvectors, Orthogonal Projections, Quadratic Forms, Matrix Norms, Concepts from Geometry, Elements of Calculus

Module-II (12 Hours)

Unconstrained Optimization: Basics of Set Constrained and Unconstrained Optimization, One Dimensional Search Methods, Golden Section Search, Fibonacci Search, Newton's Method, Secant Method, Solving Ax = b

Module-III (8 Hours)

Linear Programming: Introduction to Linear Programming, Simplex Method, Duality

Module-IV (8 Hours)

Nonlinear Constrained Optimization: Problems with Equality Constraints, Problems with Inequality Constraints, Karush Kuhn Tucker Condition, Convex Optimization Problems,

Module-V (8 Hours)

Algorithms for Constrained Optimization: Projections, Project gradient methods, Penalty methods

Learning Resources:

<u>Text Books:</u>

1. Edwin K.P. Chong, Stanislaw H. Zak, An Introduction to Optimization Wiley 4th Edition

Reference Books:

1. Stephen Boyd Convex Optimization LievenVandenberghe 3rd Edition
2. Paulo Cortez Modern Optimization with R (Use R) Springer2014

Course Title: OPERATING SYSTEM

Course Code: ADBB 204

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Understanding of the fundamental concepts, design principles, and implementation techniques of modern operating systems. (L2, L3)
CO-2	Ability to design, implement, and evaluate process management, memory management, file system management, and input/output management algorithms. (L5, L6)
CO-3	Ability to understand and implement distributed systems, such as client-server systems, distributed file systems, and distributed operating systems. (L2 , L4)
CO-4	Hands-on experience with the design and implementation of operating systems through programming projects and case studies. (L5, L6)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3												1	
CO-2	2	1	1										2	2
CO-3	3	2	2	2	2	1							2	2
CO-4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

Basics: Operating System Functionalities, Types of Operating Systems, Computer Architecture support to Operating Systems.

Module-II (8 Hours)

Process Management: Threads, Process Scheduling - Uniprocessor scheduling algorithms, Multiprocessor and Real-time scheduling algorithms, Process Synchronization - Peterson's Solution, Bakery. Algorithm, Hardware Support to Process Synchronization, Semaphores, Critical Regions, Monitors - Deadlock prevention, deadlock avoidance, and Detection and Recovery - Bankers Algorithm.

Module-III (7 Hours)

Memory Management: Segmentation and space allocation, Basics of linking and loading, Demand Paging, Page replacement algorithms, Analysis of page allocation policies, Thrashing- Working Set.

Module-IV (8 Hours)

File Systems: Contiguous, Sequential, and Indexed Allocation, File system interface, File System implementation; Case study of Unix File system, Mounting and Unmounting files systems; Network File systems.

Module-V (8 Hours)

I/O System: Disk Scheduling, Device drivers - block and character devices, streams, Character and Block device switch tables. Protection and Security - Accessibility and Capability Lists.

Learning Resources:

Text Books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne Operating System concepts Addison-Wesley Eighth edition, 2017.

Reference Books:

1. Andrew Tanenbaum, Modern Operating Systems Prentice Hall.
2. William Stallings Operating Systems Prentice Hall.

List of Experiments:

1. Basics of Unix Commands
2. Implementation of Process Related System Calls (Fork).
3. Implementation of System Calls (Open, Read, Write, and Close) for File Management
4. Implementation of Process Synchronization
5. Implementation of Memory Management Using Address Translation
6. Implementation of FIFO Page Replacement Algorithms
7. Implementation of LRU Page Replacement Algorithms
8. Implementation of First Come First Serve and Shortest Job First Scheduling Algorithm
9. Implementation of Priority and Round Robin CPU Scheduling Algorithm
10. Implementation of Banker's Algorithm.
11. Implementation of Sleeping Barbar Problem in Process Synchronization
12. Implementation of Algorithm for Deadlock Detection

Course Title: Computer Graphics

Course Code: ADBB 205

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Demonstrate understanding of the basics of Computer Graphics (L2).
CO-2	Develop understanding and underlying techniques and algorithms of Graphics Primitives, Display Methods and Visible surface detection concepts (L3).
CO-3	Develop understanding of frequency domain processing techniques. (L3)
CO-4	Develop understanding of modelling techniques used to restore images (L3)
CO-5	Develop understanding of color image processing and compressing techniques (L3)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2									2	2	3
CO-2	3	3	3	2	3							2	3	3
CO-3	3	3	3	3	3								3	3
CO-4	3	3	3	3	3							2	3	3
CO-5	3	3	3	3	3								3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (5 Hours)

OVERVIEW OF GRAPHICS SYSTEM: Input devices, Output primitives, Video display devices, Raster and vector graphics, linecircle-ellipse generating algorithm, filled area primitives

Module-II (8 Hours)

TRANSFORMATIONS AND PROJECTIONS: 2D Transformation, 3D transformation, Parallel projection, Perspective projection.

Module-III (7 Hours)

LINE CLIPPING: Cohen-Sutherland, Liang Barsky, Polygon clipping: Sutherland Hodgeman &Weiler-Atherton polygon clipping.

Module-IV (8 Hours)

CURVES & SURFACES: Conics-Parametric forms for circle, ellipse, parabola; Bezier Curves, Bernstein polynomials, Convex Hull property, B-Spline Curves: Knot vectors uniform and open uniform curves, Periodic B-splines, Uniform B-splines, Non-uniform, rational B-splines, subdividing curves.

Module-V (8 Hours)

HIDDEN SURFACE REMOVAL: Hidden Surface Removal: Back face removal, Floating Horizon method for curved objects, Z-Buffer or depth buffer algorithm, Painter's algorithm(Depth sorting method), Binary space partitioning trees, Scan line algorithm, Warnock's algorithm (Area subdivision method).

Learning Resources:

Text Books:

1. Donald Hearn and M. Pauline Baker, Computer Graphics – C Version, 2nd Edition, Pearson, 2014.

Reference Books:

1. David F. Rogers, Procedural Elements of Computer Graphics, 2nd Edition, McGraw Hill, 1998.
2. J. D. Foley, A. Van Dam, S. K. Feiner, and J. F. Hughes, Computer Graphics: Principles and Practice, 2nd Edition, Pearson, 2003.
3. Steven Harrington, Computer Graphics: A Programming Approach, 2nd Edition, McGraw Hill, 1987.

List of Experiments:

1. Digital Differential Analyzer Algorithm
2. Bresenham's Line Drawing Algorithm
3. Midpoint Circle Generation Algorithm
4. Ellipse Generation Algorithm
5. Creating various types of texts and fonts
6. Creating two dimensional objects
7. Two Dimensional Transformations
8. Coloring the Pictures
9. Three Dimensional Transformations

10. Curve Generation
11. Simple Animations using transformations
12. Key Frame Animation

Course Title: DATA SCIENCE

Course Code: ADBB 251

L-T-P: 3-0-1

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Understand and apply data preprocessing techniques.(L2)
CO-2	Implement machine learning algorithms.. (L3)
CO-3	Utilize statistical methods for data interpretation. (L4)
CO-4	Design visualizations to effectively communicate findings (L6)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	3							2	3	3
CO-2	3	3	3	2	3							2	3	3
CO-3	3	3	3	3	3								3	3
CO-4	3	2	3	2	3					2	2	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (6 Hours)

Linear algebra; vectors; matrices; product of matrix & vector; rank; null space; solution of over-determined set of equations and pseudo-inverse; distance; projections; eigenvalue decomposition; statistical modeling/descriptive statistics, notion of probability (random variables), distributions, mean, variance, covariance, covariance matrix, introduction to hypothesis testing, One-Tailed and Two-Tailed Test, Type 1 and Type 2 errors, Test Statistic

Module-II (8 Hours)

Introduction to python; variables and datatypes; operators; sequence data; control structures and functions; reading data; most widely used library for python: Pandas, NumPy, SciPy, Matplotlib

Module-III (8 Hours)

Data analysis: types of data (Structured, unstructured, and semi-structured); Data preprocessing: Missing values, outliers, normalization, and standardization; Feature engineering: Encoding, scaling, and transformation, Singular value decomposition (SVD,)Principal component analysis(PCA)

Module-IV (7 Hours)

Predictive modeling; Linear regression, multiple linear regression; cross-validation; classification using logistic regression; classification using kNN and k-means clustering.

Module-V (7 Hours)

Typology of data science problems and a solution framework; optimization techniques like multivariate optimization – unconstraint, equality constraint, unequality constraint; Gradient descent and cost functions.

Learning Resources:

Text Books:

1. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali, Introducing Data Science, First Edition, Ebury Press, 2023.

Reference Books:

1. B. Uma Maheswari and R. Sujatha, Introduction to Data Science: Practical Approach with R and Python, First Edition, Wiley, 2021.
2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning, Second Edition, Springer, 2009.
3. Wes McKinney, Python for Data Analysis, Third Edition, Shroff/O'Reilly, 2022.

List of Experiments:

1. Learn to install and use of various libraries used for data handling in python
    a. Install Anaconda and Jupyter Notebook
    b. Install Numpy, Pandas, SciPy, Matplotlib packages and learn basis operations on datasets using these packages
    c. Load data from file stored in local computer and visualize it
2. Implement eigenvalue decomposition on provided data sets:
    a. Using Numpy library
    b. Using SciPy library
3. Implement Singular Value Decomposition (SVD) on given datasets.
4. Analyze the relationship between the given data series by calculating their Covariance and Correlation. Create scatter plots to visualize the data and include a title displaying the Covariance and Correlation values.
5. Verify if given dataset is normally distributed or not by following methods:

    a. Visual method: create Histogram, Create a Q-Q plot
    b. Shapiro-Wilk Test
    c. Kalmogorov-Smirnov Test
6. State hypothesis and Perform following T statistics tests on given datasets
    a. One sample T-test
    b. Independent sample T-test
    c. Paired sample T-test
7. State hypothesis and Perform following F statistics tests on given datasets
    a. One way ANOVA test
    b. Two way ANOVA test
8. Perform following data preprocessing techniques on the given dataset.
    a. Handling missing data, non-relevant, noisy and outlier data
    b. Handling Categorical variables in data
    c. Scaling and normalization
    d. Handling Unbalanced data
9. Perform Principal Component Analysis (PCA) on given dataset.
10. Model the given datasets using linear regression, logistic regression, log-linear regression, and multiple regressions.
11. Implement the Decision Tree Algorithm on the provided dataset.
12. Apply the KNN algorithm to a given dataset.

Course Title: DATA MINING AND WAREHOUSING

Course Code: ADBB 252

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Explain the concept and significance of Data Mining (L2).
CO-2	Explore Recent Trends in Data Mining such as Web Mining, Spatial-Temporal Mining (L2).
CO-3	Analyze different mining algorithms and clustering techniques for Data Analytics (L3).
CO-4	Design and Develop a Data Warehouse for an organization (L6).

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	3							2	3	3

CO-2	3	3	3	3	3							2	3	3
CO-3	3	3	3	3	3								3	3
CO-4	3	2	3	2	3					2	2	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (8 Hours)

Design Guidelines for Data Warehouse Implementation, Multidimensional Models, OLAP - Introduction, Characteristics, Architecture, Multidimensional view, Efficient Processing of OLAP Queries, OLAP Server Architecture, ROLAP versus MOLAP Versus HOLAP and Data Cube, Data Cube Operations, Data Cube Computation.

Motivation for data mining, Introduction to data mining system, Data mining functionalities, KDD, Data object and attribute types, Statistical description of data, Issues and Applications.

Module-II (6 Hours)

Supervised Learning Framework, Concepts & Hypothesis, Training & Learning, Boolean Functions and Formulae, Monomials, Disjunctive Normal Form & Conjunctive Normal Form, A Learning Algorithm for Monomials.

Module-III (8 Hours)

Data cleaning, Data integration and transformation, Data reduction, Data discretization and Concept Hierhy Generation, Data mining primitives Frequent patterns, Market basket analysis, Frequent itemsets, closed itemsets, association rules, Types of association rule (Single dimensional, multidimensional, multilevel, quantitative), Finding frequent itemset (Apriori algorithm, FP growth), Generating association rules from frequent itemset, Limitation and improving Apriori, From Association Mining to Correlation Analysis, Lift.

Module-IV (8 Hours)

Issues regarding Classification & Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back Propagation,

k-Nearest Neighbour Classifiers, Genetic Algorithms, Rough Set & Fuzzy
Set Approaches.

Module-V (6 Hours)

Types of Data in Clustering Analysis, Categorization of Major Clustering Methods, Hierarchical Methods, Density-based methods, Grid-based methods, Grid-based methods, Model-based Clustering Method..

Learning Resources:

Text Books:

1. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2011.

2. Eibe Frank and Ian H. Witten, Data Mining: Practical Machine Learning Tools and Techniques, Third Edition, Morgan Kaufmann, 2011.

3. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, Introduction to Data Mining, Global Edition, Pearson, 2019

Reference Books:

1. Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, Database System Concepts, Seventh Edition, McGraw Hill, 2019.

List of Experiments:

1. Load Data from heterogenous sources including text files into a predefined warehouse schema.
2. Design a data mart for a bank to store the credit history of customers in a bank, Use this credit profiling to process future loan applications.
3. Feature Selection and Variable Filtering (For very large data sets).
4. Association Mining in large data sets
5. Interactive Drill-Down, Roll up, Slice and Dice Operations.
6. Generalized EM and k-Means Cluster Analysis
7. Generalized Additive Models (GAM).
8. General Classification Regression Tress (GTrees)
9. General CHAID (Chi-square Automatic Interaction Detection) Models
10. Interactive Classification and Regression Trees.
11. Goodness of Fit Computations

Course Title: BIG DATA MANAGEMENT

Course Code: ADBB 253

L-T-P: 2-0-1

Credits: 03

Pre-requisites: None

Course Outcomes:

CO-1	Analyze and differentiate between traditional and Big Data technologies. (L4)
CO-2	Implement data processing pipelines using Big Data tools. (L3)
CO-3	Apply advanced storage and retrieval techniques for Big Data. (L3)
CO-4	Work with distributed systems and Big Data frameworks like Hadoop and Spark. (L3)

CO-5	Design and optimize Big Data solutions for real-world applications. (L6)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2							2	3	3
CO-2	3	3	3	3	3							2	3	3
CO-3	3	3	3	3	3								3	3
CO-4	3	3	3	2	3	2		2		2	2	2	3	3
CO-5	3	3	3	3	3	2		2		2	2	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (6 Hours)

Introducing to Big Data – Characteristics and evolution of Big Data (3Vs: Volume, Velocity, Variety); Applications of Big Data: Challenges in managing Big Data; Big Data vs Traditional data.

Module-II (8 Hours)

Big Data storage; Distributed File Systems: Introduction to HDFS (Hadoop Distributed File System); Key-value storage systems: NoSQL Databases (MongoDB); Comparison: SQL vs NoSQL; Data Models: Document, Columnar, Graph-Based Systems.

Module-III (4 Hours)

Big Data processing; Batch Processing: Introduction to Hadoop and MapReduce; working mechanism of MapReduce, YARN; real-time processing: introduction to Apache Spark: RDDs (Resilient Distributed Datasets), SparkSQL and DataFrames; Data Stream Processing: Kafka, Apache Flink (Overview).

Module-IV (4 Hours)

Big Data Analytics; basics of Big Data Analytics: data preprocessing for Big Data, visualization tools (Tableau, PowerBI, Python Libraries).

Module-V (4 Hours)

Big Data security and privacy: Data Security in Distributed Systems; Privacy Challenges in Big Data; Data Governance and Compliance (GDPR, HIPAA, etc.); case studies and applications in Big Data applications (IoT, E-Commerce, etc.).

Learning Resources:

Text Books:

1. Seema Acharya and Subhashini Chellappan, Big Data and Analytics, Second Edition, Wiley, 2019.

Reference Books:

1. Tom White, Hadoop: The Definitive Guide, First Edition, O'Reilly, 2012.

2. James Warren and Nathan Marz, Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, First Edition, Manning Publications, 2015.

3. S. Bradshaw, E. Brazil, and K. Chodorow, MongoDB: The Definitive Guide, Third Edition, Shroff/O'Reilly, 2020.

List of Experiments:

1. To install and configure Hadoop (HDFS, MapReduce, YARN) on a local machine, VM or cluster, and understand the basic setup of the Hadoop ecosystem.
2. To perform basic HDFS operations such as uploading, retrieving, and managing large files stored in a distributed file system after the Hadoop installation.
3. To install Apache Hive on top of the Hadoop ecosystem and configure it for SQL-like query execution on big data.
4. To write and execute a basic MapReduce job that processes a large dataset on the Hadoop cluster, showcasing parallel processing.
5. To install and configure Apache Spark for distributed data processing, and integrate it with Hadoop.
6. To perform data processing tasks using Apache Spark, such as RDD operations, transformations, and aggregations on large datasets.
7. To install and configure Apache HBase, a NoSQL database, for handling large-scale real- time data storage and retrieval.
8. To perform data storage and retrieval operations in HBase, and analyze the use of HBase for real- time, large-scale data processing.
9. To install and configure Apache Impala for fast SQL querying on large datasets stored in Hadoop.
10. To execute complex SQL queries on large datasets using Apache Impala, and apply query optimization techniques for improved performance

Course Title: Machine Learning

Course Code: ADBB 254

L-T-P: 3-0-2

Credits: 04

Pre-requisites: None

Course Outcomes:

CO-1	Understanding popular ML algorithms with their associated mathematical foundations. (L1, L2)
CO-2	Explore role of data in the future of computing, and also in solving real-world problems using machine learning algorithms. (L3)
CO-3	Apply knowledge representation and reasoning to solve real world Machine Learning Problems. (L3)
CO-4	Explore machine learning concepts and algorithms for real world applications. (L4)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2								2	3	3
CO-2	3	3	3	3	3							2	3	3
CO-3	3	3	3	3	3								3	3
CO-4	3	3	3	3	3					2	2	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (8 Hours)

Introduction: machine learning, Types of machine learning– supervised, unsupervised, semi- supervised and reinforcement learning, machine learning activities, applications of machine learning.

Module-II (8 Hours)

Types of data in machine learning, Exploring structure of data, Data pre-processing, Model selection and training, Evaluating machine learning algorithms and performance enhancement of models. What is feature engineering?, Feature transformation, Feature subset selection. Principal component analysis

Module-III (8 Hours)

Introduction of regression, Regression algorithms: Simple linear regression, Multiple linear regression, Polynomial regression model, Logistic regression, Maximum likelihood estimation. Introduction of supervised learning, Classification model and learning steps, Classification algorithms: Naïve Bayes classifier, k-Nearest Neighbour (kNN), Decision tree, Support vector machines, Random Forest.

Module-IV (8 Hours)

Unsupervised Learning: Introduction of unsupervised learning, Unsupervised vs supervised learning, Application of unsupervised learning, Clustering and its types, Partitioning method: k- Means and K-Medoids, Hierarchical clustering, Density-based methods – DBSCAN.

Module-V (6 Hours)

Introduction to deep learning, overview of reinforcement learning, Case-study of ML applications: Image recognition, speech recognition, Email spam filtering, Online fraud detection and other.

Learning Resources:

Text Books:

1. Tom M. Mitchell, Machine Learning, Fourth Edition, Prentice Hall, 2020..

Reference Books:

1. Saikat Dutt, S. Chandramouli, and Das, Machine Learning, Pearson..

2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Second Edition, O'Reilly Media.

List of Experiments:

1. Write a python program to import and export data using Pandas library functions.
2. Demonstrate various data pre-processing techniques for a given dataset.
3. Write a Python program to demonstrate various Data Visualization Techniques.
4. Implement Simple and Multiple Linear Regression Models.
5. Develop Logistic Regression Model for a given dataset.
6. Develop Decision Tree Classification model for a given dataset and use it to classify a new sample.
7. Implement Naïve Bayes Classification in Python.
8. Build KNN Classification model for a given dataset.
9. Write a python program to implement K-Means clustering Algorithm.
10. Implement Random forest ensemble method on a given dataset.

Course Title: THEORY OF COMPUTATION

Course Code: ADLB 255

L-T-P: 3-0-0

Credits: 03

Pre-requisites: None

Course Outcomes:

CO-1	To use basic concepts of formal languages of finite automata techniques (L2)
CO-2	To Design Finite Automata's for different Regular Expressions and Languages. (L3)
CO-3	To Construct context free grammar for various languages. (L3)

CO-4	To solve various problems of applying normal form techniques, push down automata and Turing Machines. (L4)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2									2	2
CO-2	3	3	3	2									2	3
CO-3	3	3	3	3										3
CO-4	3	3	3	3									2	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1 (10 Hours)

Introduction to Computing, Mathematical model of computing, decision problems, set membership problems, Notion of a formal language, DFAs and notion for their acceptance, informal and then formal definitions, Class of regular languages, Closure of the class under complementation, union and intersection, Strategy for designing DFAs, Pumping lemma for regular languages, NFAs, conversion of equivalent DFAs of NFAs. NFAs with epsilon transitions, Regular expressions, Closure properties of and decision problems for regular languages, Mealy Machine and Moore Machines.

Module-II (6 Hours)

Notion of grammars and languages generated by grammars. Equivalence of regular grammars and finite automata. Context free grammars and their parse trees. Pushdown automata (PDAs): deterministic and nondeterministic. Language acceptance by final states and by empty stack. PDAs and CFGs, epsilon productions, unit productions from CFGs. Chomsky hierarchy. Pumping lemma for CFLs and its use. Closure properties of CFLs. Decision problems for CFLs.

Module-III (8 Hours)

Turing machines (TMs), their instantaneous descriptions. Language acceptance by TMs. Hennie convention for TM transition diagrams. Church-Turing hypothesis and its foundational implications. recursive languages. non-recursive enumerable languages.

Module-IV (6 Hours)

Notion of undecidable problems. Universal language and universal TM. Separation of recursive and r.e. classes. Notion of reduction. Some undecidable problems of TMs. Rice's theorem. Undecidability of Post's correspondence problem (PCP), some simple applications of undecidability of PCP

Module-V (6 Hours)

Notion of tractability/feasibility. The classes NP and co-NP, their importance. Polynomial time many-one reduction. Completeness under this reduction. Cook-Levin theorem: NP- completeness of propositional satisfiability, other variants of satisfiability. NP-complete problems from other domains.

Learning Resources:

Text Books:

1. J. E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edition, Addison Wesley, 2006

Reference Books:

1. M. Sipser, Introduction to the Theory of Computation, Thomson, 2001..

2. C. H. Papadimitriou and H. Lewis, Elements of the Theory of Computation, Prentice Hall, 1981.

Course Title: Deep Learning

Course Code: ADBB 301

L-T-P: 3-0-2

Credits: 4

Pre-requisites: ADBB 254 **(**Machine Learning)

Course Outcomes:

CO-1	Understand the fundamental concepts of deep learning, including artificial neural networks, activation functions, loss functions, and optimization techniques.
CO-2	Apply convolutional and recurrent neural network architectures to solve real-world tasks such as image classification, object detection, and natural language processing.
CO-3	Analyze the working of advanced models like Transformers, Vision Transformers (ViT), and Swin Transformers for both vision and language-related applications.
CO-4	Design generative and time series models using autoencoders, GANs, diffusion models, and deep learning-based forecasting techniques for domain-specific applications.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2			2							1	3	2
CO-2	3	3	3	2	3							1	3	3
CO-3	3	3	3	2	3							1	3	3
CO-4	3	3	3	3	3							2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Introduction to Deep Learning (10 Hours)

Overview of Deep Learning and its comparison with Machine Learning, Artificial Neural Networks (ANNs): Structure, perceptrons, limitations, forward propagation, backpropagation, activation functions (e.g., ReLU, Softmax), loss functions, optimization techniques (e.g., SGD, Adam), Regularization techniques: L1/L2 regularization, Dropout, Batch Normalization, Hyperparameter tuning, Commonly used frameworks (e.g., TensorFlow, PyTorch).

Module-II: Convolutional Neural Networks (CNNs) (9 Hours)

Key concepts: convolution, padding, pooling, CNN layers, Architectures: AlexNet, VGG, ResNet, MobileNet, and others, Applications: Image classification, transfer learning, object detection (e.g., YOLO, R-CNN), encoder-decoder models, Image segmentation: semantic, instance, and panoptic segmentation using U-Net and its variants, Regularization methods, Data augmentation techniques.

Module-III: Recurrent Neural Networks (RNNs) (6 Hours)

RNN architecture and working principles, Variants: LSTM, GRU, Advantages in handling sequential data, Challenges: vanishing and exploding gradients, Applications: NLP tasks such as sentiment analysis, text generation, sequence prediction.

Module-IV: Transformers (6 Hours)

Transformer architecture: encoder-decoder model, self-attention, multi-head attention, Applications: NLP tasks such as translation, summarization, sentiment analysis, Vision Transformers (ViTs), Swin Transformer and its hierarchical representation learning, Large Language Models (LLMs): BERT, GPT and their applications.

Module-V: Advanced Topics (5 Hours)

Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs): architecture and applications, Diffusion models in generative AI, Time Series Forecasting: ARIMA, SARIMA, deep learning approaches (LSTM, GRU), Federated Learning: privacy-preserving distributed training, Real-world implementations in speech and gesture recognition.

Learning Resources:

Text Books:

1. Christopher M. Bishop & Hugh Bishop "Deep Learning: Foundations and Concepts", Springer, 2023.
2. Ian Goodfellow and Yoshua Bengio and Aaron Courville "Deep Learning", MIT Press, 2016.

Reference Books:

1. Stephen Marsland "Machine Learning: An Algorithmic Perspective, Second Edition", Chapman and Hall/CRC.
2. Stanley H. Chan "Introduction to Probability For Data Science", Michigan Publishing

List of Experiments:

1. MNIST Digit Classification: Train a simple feedforward neural network on the MNIST dataset using forward and backpropagation.
2. Image Classification with CNN: Develop and evaluate a CNN model on datasets like CIFAR-10 or Fashion-MNIST.
3. Transfer Learning with Pre-trained CNN: Fine-tune models like VGG16, ResNet, or MobileNet on a custom image dataset.
4. Object Detection using YOLO: Implement YOLOv5 or YOLOv8 for real-time object detection on images or video frames.
5. Semantic Segmentation with U-Net: Use the U-Net architecture for medical or satellite image segmentation.
6. Instance Segmentation with Mask R-CNN: Apply Mask R-CNN for pixel-wise object segmentation on COCO or similar datasets.
7. Image Classification using ViT and Swin Transformer: Train Vision Transformer (ViT) and Swin Transformer models, and compare their performance with CNNs on image classification tasks.
8. Diffusion Model for Image Generation: Use a pretrained or simplified diffusion model (e.g., Stable Diffusion) to generate high-quality synthetic images.
9. Autoencoder and Variational Autoencoder (VAE): Build autoencoders for image denoising and extend to VAEs for generative modeling.
10. Generative Adversarial Networks (GANs): Implement a basic GAN or DCGAN to generate synthetic image data.
11. Time Series Forecasting with LSTM and SARIMA: Compare LSTM-based forecasting with classical SARIMA for time series prediction tasks.

12. Sentiment Analysis using LSTM and BERT: Perform sentiment classification using LSTM and fine-tuned BERT on datasets like IMDB or Twitter.

Course Title: Natural Language Processing

Course Code: ADLB 302

L-T-P: 3-1-0

Credits: 04

Pre-requisites: ADBB 254 (Machine Learning)

Course Outcomes:

CO-1	Understand the fundamental concepts of natural language processing, including models, ambiguity, processing paradigms, and phases of NLP along with text representation in computers.
CO-2	Apply linguistic resources and tools such as corpus, WordNet, TreeBank, and Finite State Automata to analyze morphology and word recognition using probabilistic models like N-grams and HMM.
CO-3	Demonstrate the ability to perform Part-of-Speech tagging, statistical and probabilistic parsing, and handle challenges like unknown words and multi-word expressions.
CO-4	Design semantic analysis techniques, Word Sense Disambiguation methods, and NLP applications such as sentiment analysis, summarization, and machine translation.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2			2							1	3	2
CO-2	3	3	2	2	3							1	3	2
CO-3	3	3	2	2	3							1	3	3
CO-4	3	3	2	3	3							2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Introduction to Natural Language Processing (8 Hours)

Human and Natural Language, Features of Language, Ambiguity in Language, NLP Applications, Rule-Based NLP, Statistical NLP, Machine Learning Approaches, Morphological Analysis, Syntactic Analysis, Semantic Analysis, Text Representation in Computers, ASCII, Unicode, Bag of Words, TF-IDF, Word Embeddings, NLP Tools and Libraries (NLTK, SpaCy).

Module-II: Linguistic Resources and Statistical Foundations (9 Hours)

Corpus, Balanced Corpus, TreeBank, PropBank, FrameNet, WordNet, VerbNet, Regular Expressions, Finite State Automata, Tokenization, Lexical Analysis, Morphology, Inflection, Derivation, Finite State Transducer, n-gram Language Models, Smoothing Techniques, Entropy, Perplexity, Hidden Markov Models (HMM), Maximum Entropy Models.

Module-III: POS Tagging and Parsing Techniques (9 Hours)

Part-of-Speech Tagging, Rule-Based Tagging, Stochastic Tagging, HMM Tagging, Transformation-Based Learning (TBL), Unknown Words, Named Entities, Multiword Expressions, Syntax Trees, Dependency Parsing, CYK Algorithm, Earley Parser, CKY Parser, Transition-Based Parsing, Statistical Parsing, Probabilistic Parsing.

Module-IV: Semantics and Text Analysis (5 Hours)

Lexical Semantics, Synonymy, Polysemy, WordNet, Word Sense Disambiguation, Dictionary-Based WSD, Supervised WSD, Unsupervised WSD, Predicate Logic, Semantic Role Labelling, Text Classification, Text Clustering, Sentiment Analysis, Subjectivity Detection.

Module-V: NLP Applications (5 Hours)

Spell Checking, Text Normalization, Text Summarization, Extractive Summarization, Abstractive Summarization, Machine Translation, Rule-Based MT, Statistical MT, Neural MT, Chatbots, Dialogue Systems, Question Answering, Information Retrieval, Text Generation, Named Entity Recognition, Speech Recognition, Text-to-Speech (TTS), Topic Modelling, Latent Dirichlet Allocation (LDA).

Learning Resources:

Text Books:

1. Daniel Jurafsky and James H Martin "Speech and Language Processing", Pearson Education, 2009
2. Siddiqui T., Tiwary U. S. "Natural language processing and Information retrieval", Oxford University Press, 2008.

Reference Books:

1. James A "Natural language Understanding", Pearson Education, 1994.

2. Bharati A., Sangal R., Chaitanya V. "Natural language processing: a Paninian perspective", PHI, 2000.

Course Title: Cloud Computing

Course Code: ADBB 303

L-T-P: 3-0-2

Credits: 04

Pre-requisites: NIL

Course Outcomes:

CO-1	Understand the fundamental concepts, service models, and deployment strategies of cloud computing and evaluate its benefits and challenges in real-world applications.
CO-2	Analyze the architecture of cloud systems and apply knowledge of virtualization and data center technologies to design scalable and efficient cloud solutions.
CO-3	Implement and evaluate basic cloud-based programs using distributed programming frameworks.
CO-4	Develop and demonstrate the ability to use modern cloud platforms and services for application development and deployment.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2											2	3
CO-2	3	3	2										3	2
CO-3	2	2	3		2								3	2
CO-4	2	2	3	1	3								3	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Fundamentals of Cloud Computing (6 Hours)

Introduction to Cloud Computing: Definition, Evolution, and History. Characteristics and Benefits of Cloud Computing. Cloud Service Models: IaaS, PaaS, SaaS. Deployment Models: Public, Private, Hybrid, Community. Challenges and Risks in Cloud Migration.

Module-II: Cloud Architecture and Technologies (7 Hours)

Cloud Reference Architecture and Components, Cloud Layers: Infrastructure, Platform, and Application, Data Center Design and Interconnection Networks, Cloud Infrastructure: Compute, Storage, and Networking, Networking Support and Role of the Internet in Cloud.

Module-III: Virtualization in Cloud (7 Hours)

Concept and Types of Virtualizations, Virtualization Tools and Technologies: Hypervisors (VMware, KVM, Xen). Virtualization of CPU, Memory, I/O Devices. Virtual Machines vs Containers, Resource Management in Virtual Environments, Data Center Virtualization and Orchestration.

Module-IV: Cloud Programming and Distributed Frameworks (8 Hours)

Features of Cloud Programming, Parallel and Distributed Programming Paradigms, Introduction to MapReduce Programming Model, Google File System (GFS), Hadoop Distributed File System (HDFS), Hadoop Ecosystem: Architecture and Applications, Overview of Cloud Development Platforms (e.g., AWS Lambda, Azure Functions).

Module-V: Cloud Platforms and Services (8 Hours)

Overview of Popular Cloud Providers: AWS, Microsoft Azure, Google Cloud, Cloud Storage Services: Amazon S3, Google Cloud Storage. SaaS, PaaS, and IaaS in Practice, Case Studies on Cloud-Based Solutions. Cloud Security Basics: IAM, Data Protection, Compliance.

Learning Resources:

Text Books:

1. Raj Kumar Buyya, James Broberg, A.Goscinski "Cloud Computing, Principal and Paradigms", Wiley, 2011.
2. Anthony Velte and Robert C. Elsenpete "Cloud Computing: A Practical Approach", McGraw Hill, 2018.
3. Barrie Sosinsky "Cloud Computing: Bible", Wiley, 2018

Reference Books:

1. Robert Gibbons "Cloud Computing: Web Based Applications That Change the Way You Work and Collaborate Online", Que Publishing, 2008.
2. Kumar Saurabh "Cloud Computing – Insights into New Era Infrastructure", Wiley, 2011.
3. Haley Beard "Cloud Computing Best Practices for Managing and Measuring Processes for On demand Computing", Emereo Pty Limited, 2008.

List of Experiments:

1. Install hypervisor with linux or windows OS on top of host OS.
2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
3. Install Google App Engine (GAE). Create hello world app and other simple web applications using python/java.
4. Use Google App Engine (GAE) launcher to launch the web applications.
5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
6. Implement a procedure to transfer the files from one virtual machine to another virtual machine.
7. Install Hadoop node cluster and run basic applications.

Course Title: Image Processing and Computer Vision

Course Code: ADBB 304

L-T-P: 3-0-2

Credits: 04

Pre-requisites: NIL

Course Outcomes:

CO-1	Learn the basics and mathematical background of Image Processing
CO-2	Analysis and study of methods used for image sampling and quantization, image transforms, image enhancement and restoration, image encoding, image analysis and pattern recognition.
CO-3	Utility of image compression techniques for storage and transmission purpose
CO-4	To learn about color imaging, color models, and color image processing.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2			2							1	3	2
CO-2	3	3	3	2	3							1	3	3
CO-3	3	2	3	2	3							2	3	3
CO-4	2	2	2	2	2							1	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Digital Image Fundamentals (9 Hours)

Introduction: Digital image representation, Fundamental steps in image processing, Components of Digital Image processing systems, Elements of visual perception, Image Formation model, Image Sampling and quantization, Relationship between pixels-neighbourhood, adjacency connectivity, regions, boundaries and distance measures.

Module-II: Image Enhancement Techniques (9 Hours)

Image Enhancement: Enhancement by point processing, Sample intensity transformation, Histogram processing, Image subtraction, Image averaging, Spatial Filtering-Smoothing Spatial filters, Sharpening Spatial filters, Frequency domain-Fourier Transform, Low-Pass, High-Pass, Laplacian, Homomorphic filtering.

Module-III: Image Segmentation Methods (9 Hours)

Image Segmentation: Detection of discontinuities – point, line and edge detection, Edge linking and boundary detection, Thresholding, Region-based segmentation – region growing, region splitting and merging, Use of motion in segmentation- Spatial techniques and Frequency domain techniques**.**

Module-IV: Image Compression Principles (5 Hours)

Image Compression: Coding redundancy, Interpixel redundancy, fidelity criteria, Image compression models, Error-free compression, Variable length coding, Bit-plane coding, Lossless predictive coding, Lossy compression, Image compression standards, Real-Time image transmission, JPEG and MPEG.

Module-V: Color Image Processing (4 Hours)

Color Image Processing: Color Models, Pseudo color Image Processing, Color Transformations, Smoothing and sharpening, Image Segmentation based on color.

Learning Resources:

Text Books:

1. R.C. Gonzalez, R.E Woods "Digital Image Processing", Pearson Education, 2008

Reference Books:

1. R.C. Gonzalez, R.E Woods, S. L. Eddins "Digital Image Processing Using MATLAB", PHI, 2003

2. M. Sonka, V. Hlavac, R. Boyle "Image Processing, Analysis, and Machine Vision", Brooks/Cole, 2007.
3. W.K. Pratt "Digital Image Processing", Wiley-Interscience, 2007.

List of Experiments:

1. Image Acquisition and Display: Read and display grayscale and color images using MATLAB or Python.
2. Gray-Level Transformations: Apply negative, log, and gamma correction transformations.
3. Histogram Equalization: Enhance contrast using histogram equalization.
4. Noise Removal Using Filters: Apply mean and median filters to remove salt-and-pepper noise.
5. Edge Detection: Detects edges using Sobel, Canny, and Laplacian operators.
6. Fourier Transform and Filtering: Perform FFT, apply low-pass and high-pass filtering, and reconstruct the image.
7. Image Restoration: Simulate degradation and restore using Wiener filtering.
8. Color Image Processing: Convert RGB to HSI and display individual components.
9. Morphological Operations: Perform dilation, erosion, opening, and closing on binary images.
10. Image Segmentation: Apply thresholding, edge-based, and watershed segmentation.

Course Title: Internet of Things

Course Code: ADLB 305

L-T-P: 3-1-0

Credits: 04

Pre-requisites: NIL

Course Outcomes:

CO-1	Understand the fundamentals of the Internet of Things, including its architecture, characteristics, enabling technologies, and real-world applications such as smart homes, healthcare, and smart cities.
CO-2	Identify and utilize appropriate IoT hardware components, microcontrollers, and communication protocols to design basic IoT systems.
CO-3	Analyze the integration of IoT systems with cloud platforms and apply concepts of cloud storage, edge, and fog computing for IoT data processing and analytics.

CO-4	Evaluate and implement basic security and privacy measures in IoT systems and develop small-scale IoT applications using Python and open-source platforms like Arduino or Raspberry Pi.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2			2							1	2	2
CO-2	3	2	3		3							1	3	3
CO-3	3	3	3	3	3							2	3	3
CO-4	3	3	3	3	3							2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Introduction to IoT (6 Hours)

Definition, Characteristics, and Evolution of IoT, IoT Ecosystem & Architecture, Physical design and Logical design of IoT, Enabling Technologies: RFID, Bluetooth, Zigbee, GPS, Wi-Fi, 4G/5G, Challenges and Applications of IoT (Smart Home, Smart City, Healthcare, etc).

Module-II: IoT Hardware and Communication (8 Hours)

IoT Devices: Sensors, Actuators, Microcontrollers (e.g., Arduino, Raspberry Pi), Embedded systems overview, Communication Models and APIs, IoT Communication Protocols: MQTT, CoAP, AMQP, HTTP, XMPP, M2M Communication.

Module-III: IoT Platforms and Cloud Integration (7 Hours)

IoT and Cloud Computing, Introduction to IoT Platforms: Google Cloud IoT, AWS IoT, Azure IoT, Cloud Storage Models for IoT Data, Data Analytics in IoT, Edge and Fog Computing in IoT.

Module-IV: Security and Privacy in IoT (7 Hours)

IoT Security Challenges, Authentication and Authorization in IoT, IoT Security Architecture, Common Attacks in IoT and their Mitigation, Privacy Preservation in IoT.

Module-V: IoT Application Development (8 Hours)

IoT System Design Methodology, Developing IoT Applications using Python, Hands-on with Arduino/Raspberry Pi, Case Studies: Smart Agriculture, Smart Healthcare, Smart Energy, etc, Mini Project / Lab Implementation.

Learning Resources:

Text Books:

1. Arshdeep Bahga, Vijay Madisetti "Introducing Internet of Things", Pearson, 2015.

Reference Books:

1. Raj Kamal "Introducing Internet of Things", McGraw Hill Education, 2017.
2. Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", Wiley, 2014
3. Olivier Hersent, David Boswarthick, Omar Elloumi "Internet of Things: a Modern Approach", Wiley, 2016.

List of Experiments:

1. Introduction to Arduino and Raspberry Pi: LED Blinking using GPIO
2. Sensor Data Acquisition: Reading Temperature and Humidity Using Sensor
3. Actuator Control: Automating Fan/LED based on Sensor Input
4. IoT Communication: Publishing Sensor Data using MQTT Protocol
5. Remote Monitoring: Sending Sensor Data using HTTP Requests
6. Cloud Integration: Real-time Data Logging on IoT Platforms (ThingSpeak/AWS IoT)
7. IoT Security: User Authentication and Data Encryption in IoT Applications
8. Smart Home Simulation: Controlling Devices via Smartphone App
9. Smart Agriculture System: Automated Irrigation using Soil Moisture Sensor

Course Title: Social Network Analysis

Course Code: ADLB 352

L-T-P: 3-1-0

Credits: 04

Pre-requisites: NIL

Course Outcomes:

CO-1	Understand the basic structure of social networks, their types, graph-based representations, and foundational graph theory concepts.
CO-2	Analyze and apply network models and centrality/structural measures to characterize and evaluate social networks.
CO-3	Apply and evaluate community detection and link prediction algorithms in social networks, using appropriate evaluation metrics.

CO-4	Design and implement solutions for analyzing influence propagation, mining and visualizing social media data, while addressing privacy and ethical concerns.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2			2							1	2	2
CO-2	3	3	3	2	3							1	3	3
CO-3	3	3	3	3	3							2	3	3
CO-4	3	3	3	3	3							2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Introduction to Social Networks Analytics (6 Hours)

Definition and types of social networks (online, offline, ego networks), Real-life applications: Facebook, Twitter, LinkedIn, citation networks, Structure of social networks: Nodes, edges, adjacency matrices, Basic concepts in graph theory: Paths, connectivity, degree, clustering coefficient.

Module-II: Social Network Analytics Models and Measures (8 Hours)

Random network models: Erdős–Rényi model, Small-world networks: Watts-Strogatz model, Scale-free networks: Barabási–Albert model, Centrality measures: Degree, Closeness, Betweenness, Eigenvector, Network density, Diameter, Reciprocity, Assortativity.

Module-III: Social Network Community Detection and Link Prediction (8 Hours)

Communities and modularity, Algorithms: Girvan-Newman, Louvain Method, Label Propagation, Link prediction methods: Similarity-based, probabilistic models, Evaluation metrics: Precision, recall, AUC.

Module-IV: Social Network Information Diffusion and Influence Analysis (7 Hours)

Diffusion models: Independent Cascade Model, Linear Threshold Model, Influence maximization: Greedy algorithms, Contagion models: Viral marketing, epidemic modeling, Case study: Twitter hashtag propagation.

Module-V: Mining and Visualization of Social Media Data (7 Hours)

Text mining from social networks, Sentiment analysis and opinion mining, Social media APIs (Twitter, Facebook Graph API), Visualization tools: Gephi, NetworkX, Cytoscape, Ethics, privacy, and challenges in social media analytics.

Learning Resources:

Text Books:

1. Matthew A. Russell "Introducing Social Network Analytics", O'Reilly Media, 2018.

Reference Books:

1. Stanley Wasserman & Katherine Faust "Introducing Social Network Analysis", Cambridge University Press, 1994.
2. David Easley & Jon Kleinberg "Networks, Crowds, and Markets", Cambridge University Press, 2010.
3. Maksim Tsvetovat & Alexander Kouznetsov "Social Network Analysis for Startups", O'Reilly Media, 2011.

Course Title: Big Data Analytics

Course Code: ADBB 352

L-T-P: 3-0-2

Credits: 04

Pre-requisites: NIL

Course Outcomes:

CO-1	Explain the concept and significance of Big Data and its analysis.
CO-2	Apply and Analyze regression and classification algorithms for Big Data analytics.
CO-3	Analyze different mining algorithms and clustering techniques for Big Data Analytics.
CO-4	Design and develop big data-based analytics for real-word ubiquitous computing scenarios.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	3	1	1			3					1	2
CO-2	2	3	3	3	1							3	3	2
CO-3	2	3	3	3	1							3	3	2
CO-4	2	2	3	3	1			3				3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Introduction to Big Data (7 Hours)

Evolution of big data, best practices for big data analytics, big data characteristics; Validating, Promotion of the value of big data, big data use cases. Characteristics of big data applications, Perception and quantification of value. Big Data Tools and Techniques: Understanding big data storage, General overview of high-performance architecture, HDFS, Map Reduce and YARN; Map Reduce programming model; Review of basic data analytic methods using R.

Module-II: Regression and Classification (7 Hours)

Advanced analytical theory and methods, Regression: Linear regression, Logistic regression; Classification: Decision trees, Overview of a decision tree, Decision tree algorithms, Evaluating a decision tree, Decision trees in R, Naïve Bayes, Bayes 'theorem, Naïve Bayes classifier in R.

Module-III: Data Stream Analysis (7 Hours)

Introduction to streams concepts: Stream data model and architecture, Stream computing, Sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting oneness in a window, Decaying window; Real Time Analytics Platform (RTAP) applications, Case studies: Real time sentiment analysis, Stock market predictions.

Module-IV: Frequent Itemset and Clustering (7 Hours)

Mining frequent itemset: Market based model, Apriori algorithm, handling large datasets in main memory, Limited Pass algorithm, counting frequent itemset in a stream, Clustering techniques: Hierarchical, k-Means, Clustering high dimensional data.

Module-V: NoSQL Data Management for Big Data (8 Hours)

NoSQL databases: Schema-less models, increasing flexibility for data manipulation, Key value stores, Document stores, Tabular stores, Object data stores, Graph databases; Hive; Sharding; HBase; Case Study: Analyzing big data with twitter, big data for E-Commerce Big data for blogs.

Learning Resources:

Text Books:

1. David Loshin "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph" Morgan Kaufmann/Elsevier Publishers, 2013.
2. Anand Rajaraman and Jeffrey David Ullman "Mining of Massive Datasets", Cambridge University Press, 2012.

Reference Books:

1. EMC Education Services "Data Science and Big Data Analytics: Discovering, Analyzing Visualizing and Presenting Data", Wiley, 2015.
2. Beasan Bart "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, 2015.

List of Experiments:

1. Study and Configuration Hadoop-based distributed architecture for Big Data Analytics.
2. Map Reduce Programming Examples Word Count. Union, Intersection and Difference. Matrix Multiplication.
3. Installation and Creation of MongoDB for Schema-less database.
4. Study and Implementation of Regression-based algorithms for Big Data Analytics.
5. Study and Implementation of Clustering-based algorithms for Big Data Analytics.
6. Implement and Perform Streaming Data Analysis for X data (formerly twitter), chat data, weblog analysis.
7. Implementation of Visualization techniques for Interpreting Big Data and its Analytics.

Course Title: Soft Computing

Course Code: ADBB 353

L-T-P: 3-0-2

Credits: 04

Pre-requisites: NIL

Course Outcomes:

CO-1	Understand the fundamentals of artificial neural networks, including early models like ADALINE and MADALINE, and different neural network architectures such as feedforward and recurrent networks.
CO-2	Apply supervised and unsupervised learning techniques to build and analyze different neural network models, including associative memory networks and Hopfield networks.
CO-3	Analyze fuzzy logic concepts such as fuzzy sets, fuzzy arithmetic, fuzzy rule-based systems, and defuzzification techniques to develop fuzzy inference systems.
CO-4	Evaluate the role of genetic algorithms and hybrid intelligent systems (e.g., neuro-fuzzy, genetic-fuzzy, and genetic-neural hybrids) in solving optimization and learning problems.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2			2							1	3	2
CO-2	3	3	3	2	3							1	3	3
CO-3	3	3	3	2	3							1	3	3
CO-4	3	3	3	3	3							2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-1: Introduction to Artificial Neural Networks (7 Hours)

Artificial Neural Networks: Basic concepts of artificial neural networks, earlier neural networks: ADALINE, MADALINE. Neural Network Architectures: Single layer feedforward network, Multi-layer feedforward network, Recurrent network.

Module-II: Learning Networks and Associative Memory (11 Hours)

Supervised Learning Network: Perceptron network, Back propagation network, Radial basis function network. Unsupervised Learning Network: Fixed weight competitive nets, Kohonen self-organizing feature maps, Counter propagation network, Adaptive reasoning theory. Associative memory: Auto-associative memory network, Hetero Associative memory network, Bidirectional associative memory, Hopfield networks.

Module-III: Fuzzy Logic and Fuzzy Systems (10 Hours)

Fuzzy Logic: Crisp set and Fuzzy set, Basic concepts of fuzzy sets, Fuzzy set operations, Fuzzy Arithmetic-fuzzy numbers, Fuzzy ordering, Fuzzy vectors. Fuzzy measures-belief and plausibility measure. Probability measure: Measure of fuzziness, Fuzzy integrals. Membership functions: Features of membership function, Fuzzification. Fuzzy Rule Based Systems: Fuzzy proposition, Formation and decomposition of rules, Fuzzy reasoning, Fuzzy inference systems, Fuzzy expert system. Defuzzification: Max-membership, Centroid method, Weighted average, Mean max.

Module-IV: Genetic Algorithms and Search Techniques (8 Hours)

Genetic Algorithms: Traditional optimization and search techniques, Genetic algorithms. Operators: Encoding, Selection, Crossover, Mutation. Classification: Adaptive genetic algorithms, Hybrid genetic algorithms, Parallel genetic algorithms, Real coded genetic algorithms.

Learning Resources:

Text Books:

1. Simon Haykin "A comprehensive foundation. Neural Networks", Pearson Education, 2001.

Reference Books:

1. Timothy J. Ross "Fuzzy logic with engineering applications", John Wiley & Sons, 2009.
2. Melanie Mitchell "An Introduction to Genetic Algorithms", Prentice-Hall, 1998.
3. D. E. Goldberg "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison-Wesley, 1989.

List of Experiments:

1. Train a single-layer perceptron to classify linearly separable data.
2. Demonstrate learning and convergence for simple classification tasks.
3. Train a neural network for XOR or digit classification problems using backpropagation.
4. Design and test an RBF network on a small dataset.
5. Implement SOM for clustering or dimensionality reduction.
6. Use a Hopfield network to store and recall binary patterns.
7. Perform fuzzy union, intersection, and complement operations.
8. Create a Mamdani-type or Sugeno-type FIS for a real-world problem (e.g., temperature control).
9. Compare different defuzzification methods (centroid, mean of maxima, etc.) for a fuzzy output.
10. Solve a mathematical optimization problem using a basic GA with crossover and mutation.

Course Title:	**Environmental Sciences**
Course Code:	**CELB 101**
L-T-P:	**2-0-0**
Credits:	**2**
Pre-requisites:	NIL

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To gain knowledge about environment and ecosystem.	Understanding (Level-II)
CO-2	To gain knowledge about the conservation of biodiversity and its importance.	Applying (Level-III)
CO-3	To aware students about problems of environmental pollution, its impact on human, ecosystem and control measures and understand the issues related to Solid waste.	Analyzing (Level-IV)
CO-4	To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.	Evaluating (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	2	3	2					2	1	1	1
CO-2	2	2	2	2	1	3	3					2	1	1	1
CO-3	3	2	2	2	2	3	3					2	3	2	2
CO-4	3	2	1	1		2	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.	04
Module-II	Ecosystem: Ecosystems - Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Biogeochemical cycles.	08
Module-III	Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. Inida as a mega- diversity nation, Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of	08

	India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
Module-IV	Environmental Pollution: Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Noise pollution Solid waste, Green House Effect, Global Warming, Climate Change, Ozone Layer Depletion and Photochemical Smog	**12**

Learning Resources: To expose the students to the basics of environmental sciences through multidisciplinary nature of environmental studies, ecosystem, biodiversity and its conservation, environmental pollution, social Issues and the environment.

.

Text Books:	1. Anubha Kaushik and C. P. Kaushik's —Perspectives in Environmental Studies, 6th Age International Publishers, 2018. 2. Benny Joseph, Environmental Science and Engineering ',McGraw Hill Education, 2017. 3. Gilbert M. Masters, Introduction to Environmental Engineering and Science ', 2nd edition, Pearson Education, 2004. 4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall, 2011. 5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering; International edition, 2015.
Reference Books:	1. Environment Impact Assessment Guidelines, Notification of Government of India, 2006. 2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
Other Suggested Readings:	