ST JOSEPH'S UNIVERSITY, BENGALURU

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by
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ST. JOSEPH'S INSTITUTE OF INFORMATION TECHNOLOGY

DEPARTMENT OF ADVANCED COMPUTING

SYLLABUS FOR UNDERGRADUATE PROGRAMME

SUMMARY OF CREDITS IN BCA (Data Analytics)

2026 -2029

Department of Advanced Computing (UG)						
Sem 1	**Code Number**	**Title**	**No. of Hrs of Instructions per semester**	**No. of Hours of teaching per week**	**No. of credits**	**Max marks for SE duration of examination**
Theory	BCADA1125	Fundamentals of Computing	45	03	03	60-2Hrs
Theory	BCADA1225	Exploratory Data Analysis	45	03	03	60-2Hrs
Theory	BCADA1325	Mathematics I	45	03	03	60-2Hrs
Theory	BCADA1425	C Programming	45	03	03	60-2Hrs
Theory		Language I	45	03	03	60-2Hrs
Theory		Language II	45	03	03	60-2Hrs
Practical	BCADA1P125	C Programming Lab	30	02	01	25- 2 Hrs
Practical	BCADA1P225	Data Analysis Lab (Excel)	30	02	01	25- 2 Hrs
Total Number of credits:			**20**			
Sem 2	**Code Number**	**Title**	**No. of Hrs of Instructions per semester**	**No. of Hours of teaching per week**	**No. of credits**	**Max marks for SE duration of examination**
Theory	BCADA2125	Principles and Practices of Data Science	45	03	03	60-2Hrs

Theory	BCADA 2225	Advanced Statistical Computing	45	03	03	60-2Hrs
Theory	BCADA 2325	Mathematics II	45	03	03	60-2Hrs
Theory	BCADA 2425	Python Programming	45	03	03	60-2Hrs
Theory		Language I	45	03	03	60-2Hrs
Theory		Language II	45	03	03	60-2Hrs
Practical	BCADA 2P125	Data Science Lab (Using R)	30	02	01	25- 2 Hrs
Practical	BCADA 2P225	Python Programming Lab	30	02	01	25- 2 Hrs
Total Number of credits:			**20**			

Sem 3	**Code Number**	**Title**	**No. of Hrs of Instructions per semester**	**No. of Hours of teaching per week**	**No. of credits**	**Max marks for SE duration of examination**
Theory	BCADA3125	Python for Data Analytics	45	03	03	60-2Hrs
Theory	BCADA3225	Operating Systems	45	03	03	60-2Hrs
Theory	BCADA3325	Mathematics - III	45	03	03	60-2Hrs
Theory	BCADA3425	Econometrics	45	03	03	60-2Hrs
Theory		Language I	45	03	03	60-2Hrs
Theory		Language II	45	03	03	60-2Hrs
Theory	DAMDE 3125	National Entrepreneurship Network – Ignite program	30	02	02	30-2Hrs
Practical	BCADA 3P125	Python for Data Analytics Lab	30	02	01	25- 2 Hrs
Practical	BCADA 3P225	Operating Systems Lab	30	02	01	25- 2 Hrs

Total Number of credits:			**22**			
Sem 4	**Code Number**	**Title**	**No. of Hrs of Instructions per semester**	**No. of Hours of teaching per week**	**No. of credits**	**Max marks for SE duration of examination**
Theory	BCADA 4125	Database Management Systems	45	03	03	60-2Hrs
Theory	BCADA 4225	Multivariate Statistics	45	03	03	60-2Hrs
Theory	BCADA 4325	Data Structures using Python	45	03	03	60-2Hrs
Theory	BCADA 4425	Computer Networks	45	03	03	60-2Hrs
Theory		Language I	45	03	03	60-2Hrs
Theory		Language II	45	03	03	60-2Hrs
Practical	BCADA 4P125	Database Management Systems Lab	40	02	01	25- 2 Hrs
Practical	BCADA 4P225	Data Structures using Python Lab	40	02	01	25- 2 Hrs
Total Number of credits:			**22**			
Theory	BCADA5 126	Machine Learning	45	03	03	60-2Hrs
Theory	BCADA5 226	Java Programming	45	03	03	60-2Hrs
Theory	BCADA5 326	Cloud Computing	45	03	03	60-2Hrs
Theory	BCADA5 426	Artificial Intelligence	45	03	03	60-2Hrs
Theory	BCADA5 526	Optimisation Techniques	45	03	03	60-2Hrs

Practical	BCADA5 P126	Machine Learning Lab	30	02	01	25- 2 Hrs
Practical	BCADA5 P226	Java Programming Lab	30	02	01	25- 2 Hrs
Theory	BCADA5 626	AWS	30	02	02	30-2Hrs
Theory	BCADA5 726	Research Methodology and Publication Ethics	30	02	02	30-2Hrs
Total Number of credits:			**21**			
Theory	BCADA6 126	Deep Learning	45	03	03	60-2Hrs
Theory	BCADA6 226	Enabling technologies for Data Science	45	03	03	60-2Hrs
Theory	BCADA6 326	Natural Language Processing	45	03	03	60-2Hrs
Theory	BCADA6 426	Digital Information Processing	45	03	03	60-2Hrs
Practical	BCADA6 P126	Deep Learning Lab	30	02	01	25- 2 Hrs
Practical	BCADA6 P226	Enabling technologies for Data Science Lab	30	02	01	25- 2 Hrs
Practical	BCADA6 P326	Project	60	06	03	50 - 3 Hrs
Theory	BCADA6 526	Design thinking	30	02	02	30 - 2Hrs
Total Number of credits:			**19**			

Program Outcomes (POs) for BCA(Data Analytics)

1. **PO1: Discipline Knowledge**
   Apply knowledge of computing fundamentals, algorithms, mathematical and statistical principles to solve problems relevant to the domain of data analytics.
2. **PO2: Problem Analysis and Decision Making**
   Identify, define, analyse complex problems to assist in decision making for data analytics using structured problem-solving techniques, visualizations, mathematical models, and modern tools.
3. **PO3: Design and Development of Real-world Solutions**
   Design and implement efficient solutions for data-centric problems based on real time using appropriate programming languages, tools, AI, and machine learning models.
4. **PO4: Modern Tool Usage**
   Apply current data mining analytics tools, programming environments, libraries, and computational frameworks for data processing and visualization.
5. **PO5: Data Interpretation and Statistical Reasoning**
   Interpret and analyse data using mathematical/statistical models and computing frameworks to draw meaningful inferences and support managerial decision-making.
6. **PO6: Ethics and Big Data Governance**
   Understand the legal, ethical, and societal responsibilities related to data ownership, privacy, and usage, and follow best practices in data governance and security.
7. **PO7: Effective Communication Skills**
   Communicate technical concepts, analytical findings, and interpretations clearly and effectively to diverse audiences.
8. **PO8: Teamwork and Project Management**
   Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary projects with the ability to manage projects related to software and data science.
9. **PO9: Lifelong Learning**
   Recognize the need for lifelong learning and adapt to emerging technologies and methods in the rapidly evolving field of data science and analytics.
10. **PO10: Research Aptitude**
    Develop aptitude for research by formulating hypotheses, experimenting, analysing, and interpreting data using scientific methods and tools.

Course Outcomes and Course Contents

SEMESTER I

Semester	I
Paper Code	BCADA1125
Paper Title	FUNDAMENTALS OF COMPUTING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

The objective of this course is to provide students with a solid grounding in the fundamental principles of computing and programming. By the end of the course, students will be equipped with the knowledge and skills necessary to solve problems.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Understand the Fundamentals in Computing

CO2: Understand Core Computing Concepts

CO3: Develop Problem-Solving Skills

CO4: Learn Software Development Principles

CO5: Apply Computing Concepts to Real-World Scenarios

UNIT 1: FUNDAMENTALS OF COMPUTERS 5 Hrs

Introduction to computers - Evolution of computer, Generation of computers, Classification of computer, Applications, Components of computers, Hardware (different types of hardware components), Software (System Software, Application Software, E-accessibility Software), (Open source, freeware and proprietary software), Peripherals (working of keyboard and laser printer), Computer Network – Basics, Categories, Protocols, Methods of data processing – Single

user programming, Multiprogramming, Real-time processing, On-line processing, Time sharing processing, Distributed processing, Computer Security - Types of threats and source of threats.

UNIT 2: BASICS OF COMPUTING AND PROGRAMMING 10 Hrs

Introduction to computing – building blocks for simple programs – problem to program – – problem analysis – programming style – documentation and testing – The Problem-Solving aspect – Steps in Problem Solving – Types of Problems – Types of Programming methodologies – Types of Computer Languages – Compiler – Interpreter

UNIT 3: PROBLEM SOLVING TECHNIQUES 10 Hrs

Programming life cycle phases – problem solving – implementation – maintenance – pseudo code representation – algorithmic efficiency – complexity of algorithms, Software Development Life Cycle.

Operating System Fundamentals: Operating Systems: Introduction, Functions of an operating System, Classification of Operating Systems, System programs, Application programs, Utilities,

UNIT 4: INTRODUCTION TO DIGITAL ELECTRONICS, NUMBER SYSTEMS, OPERATIONS AND CODES 8 Hrs

Introduction, Decimal numbers, Binary numbers, Number conversion, Binary Arithmetic, 1‟s and 2‟s Complements of Binary Numbers, signed numbers, Arithmetic operations with signed numbers, Hexadecimal Numbers, Octal numbers, Binary Coded Decimal(BCD), Digital Codes.

UNIT 5 LOGIC GATES, BOOLEAN ALGEBRA AND LOGIC SIMPLIFICATION 12 Hrs

The Inverter, the AND Gate, the OR gate, the NAND Gate, the NOR Gate, the Exclusive-OR and Exclusive-NOR Gates, Basics of Digital Integrated Circuits. Boolean Operations and Expressions, Laws and Rules of Boolean Algebra, De Morgan's Theorems, Boolean Analysis of Logic Circuits, Simplification Using Boolean Algebra, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables, The Karnaugh Map, Karnaugh Map SOP Minimization, POS Minimization. Flip-flops (SR, T, D, JK) and timing circuits (timer, delay) cover clocked memory elements

REFERENCES:

1. M. Morris Mano "Digital Logic and Computer Design", Pearson, 2013.

2. Thomos L. Floyd, "Digital Fundamentals", Tenth Edition, Pearson, 2015.

3. Cormen, Leiserson, Rivest, Stein "Introduction to algorithms", McGraw Hill publishers, 2002.

4. V. Anton Spraul, “Think Like a Programmer – An Introduction to Creative Problem Solving”, no starch press

Semester	I
Paper Code	BCADA1225
Paper Title	EXPLORATORY DATA ANALYSIS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

- To apply principles of study design and data collection
- Produce and Interpret graphical summaries of data
- Graphically and numerically describe the relation between two or more variables

COURSE OUTCOME:

Upon successful completion of this course student should be able to

CO1: Understand the basic concepts of data and its measure
CO2: Develop the basic understanding of probability and random variable
CO3: Understand the usage of different probability distributions
CO4: Evaluate relationship among variables and using the same for prediction
CO5: Develop analytical ability to solve real-world problems using these methodologies.

UNIT I: STATISTICS –AN OVERVIEW **9 Hrs.**

Need for data, types of data, principles of measurement, sources of data, classification, tabulation and graphical presentation of data, Measures of central tendency: objectives of Averaging, requisites of a measure of Central Tendency, Mathematical Averages: mean, median and mode and quartiles, Measures of dispersion: significance of Measuring Dispersion, different measures

of variation: range, variance, standard deviation, mean deviation, quartile deviation

UNIT II: FUNDAMENTALS OF PROBABILITY **9 Hrs.**

Concepts, the parallels between sets and events, Axioms of probability, Probability problems using permutations and combinations, The additive law, the idea of independence, Conditional probability, Bayes Theorem (simple problems. Problems involving conditional probability and dependence), theory of random variables, expectation and variance of random variables, idea of dependent random variables.

UNIT III: PROBABILITY DISTRIBUTIONS **9 Hrs.**

Discrete Probability Distributions: Binomial, Poisson, Negative Binomial Distribution, Hypergeometric Distribution, Continuous Probability Distribution: Normal, Exponential Chi square, t and F distributions, Central Limit Theorem, Fitting distributions to data

UNIT IV: CORRELATION ANALYSIS **9 Hrs.**

Significance of measuring correlation, types of correlation, methods of correlation analysis, partial and multiple correlation

UNIT V: REGRESSION **9 Hrs.**

Some important information about straight lines, the method of least squares, assessing the goodness of fit, assessing each individual predictor - Case Studies related to the above discussed topics using Excel

TEXTBOOKS:

1. Statistics for Managers Using Microsoft Excel, Eighth Edition, David M. Levine, David F. Stephan Kathryn A. Szabat, Pearson Publications

SUGGESTED BOOKS:

1. A First Course in Statistics, Eighth Edition, Ronald Ross. Pearson
2. Probability and Statistics, Second Edition Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, Schuam Outline Series, Mac Graw Hill
3. Business Statistics, Second Edition, Pearson Education India.

Semester	I
Paper Code	BCADA1325
Paper Title	MATHEMATICS I
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

Introduce the concepts of set theory, relations and functions, concepts of calculus in one variable and higher dimensions and its applications.

COURSE OUTCOME:

On successful completion of the course, students will be able to:

CO1: Acquaint the students with mathematical/logical fundamentals including numerical techniques.

CO2: Solve problems involving recurrence relations and generating functions.

CO3: Explain the relationship between the derivative and linear approximation.

CO4: Solving real life maximum and minimum problems.

UNIT I: SET, RELATION AND FUNCTION **12 Hrs.**

Sets and Subsets, Set Operations and the Laws of Set Theory, Cartesian Products and Relations, Function: One-to-One, Onto Functions, Function Composition and Inverse Functions, Countable and Uncountable Sets.

UNIT II: DIFFERENTIAL CALCULUS OF ONE VARIABLE **12 Hrs.**

Basic properties of Functions: Functions and Their Graphs, Shifting and Scaling Graphs, Limits and Continuity: Limit of a functions and Limit laws, One sided Limit continuity, Limits involving infinity, Asymptotes of Graphs, Derivatives - Tangent Lines and derivative at a Point, The

derivative as a function, Differentiation rules, The Chain Rule, Implicit Differentiation, Application of Derivatives: Extreme values of a functions on Closed Intervals, The Mean Value Theorem and related problems.

UNIT III: INTEGRAL CALCULUS **12 Hrs.**

Area and Estimating with Finite Sums, Limits of Finite, The Definite Integral, The Fundamental Theorem of calculus, Area sums, Indefinite Integral and Substitution Method, Area between curves, Arc Length, Area of Surface Revolution, Techniques of Integration , Geometric significance of integration.

UNIT IV: CALCULUS OF SEVERAL VARIABLES **9 Hrs.**

Functions of Several variables, Limit and Continuity in Higher Dimensions, Geometric significance of derivatives, Partial differentiations, The Chain Rule, Directional Derivatives and Gradient Vectors, Extremal Values and Saddle Point, Lagrange's Multipliers.

TEXT BOOKS:

1. "Thomas's Calculus" Pearson, 14th Edition by Joel Hass, Christopher Heil, Maurice D Weir
2. "Introduction to Real Analysis" by S K Mapa, Sarat Book Distributors, 2018,

SUGGESTED BOOKS:

1. Higher Engineering Mathematics by B.S.Grewal
2. "Principle of Real Analysis", 2nd Edition by S.C. Malik, New Academic Science, 2013

Semester	I
Paper Code	BCADA1425
Paper Title	C PROGRAMMING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

The course is oriented to those who want to learn the fundamental concepts associated with programming basics using C language as an implementation tool. The course will provide students with understanding of programming essentials, including algorithms, data types, elementary control structures and functions used within the framework of imperative and structural programming paradigms.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Describe the fundamental concepts and syntax of C programming.

CO2: Understand the logic of the program and output obtained using different sets of input.

CO3: Apply logical skills to design and develop algorithms/flow charts to solve real-world problems.

CO4: Gain the knowledge of Functions, Arrays, Structures, Unions and files.

CO5: Design and develop program using appropriate components in C language

UNIT I: BASIC BUILDING BLOCKS OF C PROGRAMMING 5 Hrs

Programming paradigm, Basic structure of C program, compiling and running a C program, Features of C, Character set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Preprocessor directives. Input output operations and Expressions. Formatted input/output functions, Unformatted input/output functions with programming examples using all functions.

Introduction to operator set, Arithmetic operators, Relational operators, Logical Operators, Assignment operators, Increment and Decrement operators, Conditional operators, Bit-wise operators, Special operators. Arithmetic expressions, evaluation of expressions, Precedence of arithmetic operators, Type conversion in expressions, Operator precedence and associativity.

UNIT II: DECISION MAKING, BRANCHING, ARRAYS AND STRINGS 10 Hrs

Decision making with ‘if’ statement, Simple ‘if’ statement, the ‘if…else’ statement, nesting of ‘if else’ statements, The ‘else if’ ladder, The ‘switch’ statement, The ‘?:’ operator, The ‘goto’ statement. Looping Statements - The ‘for’,’while’,’do-while’ statements with examples, jumps in loops - break and continue statements. Arrays and Strings. Introduction to Arrays, Types of arrays, Declaration arrays, Initializing one dimensional and multidimensional array. Introduction, Declaration and Initializing String Variables using arrays, String operations

UNIT III: FUNCTIONS AND RECURSION **10 Hrs**

Modular programming, need for functions, types of functions (User Defined and Built –In), working with functions, Definition, declaration and its scope, Category of functions Storage classes, (Automatic, Static, Extern, Register). Recursion – Recursive functions.

UNIT IV: POINTERS **10 Hrs**

Introduction, Benefits of using pointers, declaration and Initialization of pointers, obtaining a value of a variable, Pointer arithmetic - parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation with malloc/calloc, Example programs, pointers and arrays, pointers and strings, pointers and functions.

UNIT V: STRUCTURES, UNIONS AND FILES **10 Hrs**

Storage class, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, Union. file processing, file operations – read, write and seek

REFERENCE BOOKS:

1. Harry H. Chaudhary, “C Programming The ultimate way to learn the fundamentals of the C language”, MIT- Createspace Inc. O-D-Publishing, LLC USA, 2016
2. Yashavant P. Kanetkar, “Let us C”, Fifth edition, BPB Publications, 2006
3. Deitel and Deitel "C How to Program ", Sixth edition, Pearson, 2017

LABORATORY

Semester	I
Paper Code	BCADA1P125
Paper Title	C PROGRAMMING LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	30
Number of credits	1

1. Implementation of Basic Data types in C.
2. Programs using various operators
3. Implementation of Decision-making statement and Looping statement.
4. Execution of Break, Continue and Switch case statements.
5. Creation of functions in C.
6. Implementing array in C,
7. Sorting and searching elements using array.
8. Creation of Unions and Structures in C.
9. Creation of Pointers in C.
10. Various File Operations in C.

Semester	I
Paper Code	BCADA1P225
Paper Title	DATA ANALYSIS LAB(EXCEL)
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	30
Number of credits	1

1. Understanding Excel Interface for data Analysis : Getting Stated with Excel , Working with Data
2. Using the fill , series and column commands, Conditional Formatting in Excel
3. Using the visualization tools like charts and graphs in Excel for data comprehension
4. Using the summary statistics in Excel
5. Understanding the variations in data set using Excel commands
6. Creating random numbers in an Excel Spreadsheet

7. Generating probability distributions in Excel
8. Using Excel to understand relationship among Variables
9. Using regression as a prediction tool in Excel
10. Case Study 1
11. Case Study 2

SEMESTER II

Semester	II
Paper Code	BCADA 2124
Paper Title	PRINCIPLES AND PRACTICES OF DATA SCIENCE
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

To make the students learn the process of working with data in large scale. Make the student understand the existence of data with its wilderness and make use of it.

COURSE OUTCOME:

On successful completion of the course, students will be able to:

CO1: Understand the fundamental concepts of data.
CO2: Understand the fundamental concepts of data science process.
CO3: Understand the fundamental concepts of Machine Learning
CO4: Fundamental concepts of large data & Data Visualization
CO5: To gain knowledge about the recent trends of Data Science.

UNIT 1: PREPARING AND GATHERING DATA AND KNOWLEDGE **9 Hrs.**

Philosophies of data science - Data science in a big data world - Benefits and uses of data science and big data - facts of data- Overview of the data science process- Retrieving data –Data Preparation: Cleansing, integrating, and transforming data - Exploratory data analysis – Data Modeling: Model and variable selection, Model execution, Model diagnostic and model comparison - Presentation and automation: Presenting data, Automating data analysis

UNIT 2: BIG DATA **9 Hrs.**

Problems when handling large data – General techniques for handling large data – Case study – Steps in big data – Distributing data storage and processing with Frameworks – Case study.

UNIT 3: MACHINE LEARNING **9 Hrs.**

Application for machine learning in data science- Tools used in machine learning- Modeling Process – Training model – Validating model – Predicting new observations –Types of machine learning Algorithm : Supervised learning algorithms, Unsupervised learning algorithms.

UNIT 4: DATA VISUALIZATION **9 Hrs.**

Introduction to data visualization – Data visualization options – Filters – MapReduce – Dashboard development tools – Creating an interactive dashboard with dc.js-summary.

UNIT 5 : ETHICS AND RECENT TRENDS **9 Hrs.**

Data Science Ethics – Doing good data science – Owners of the data - Valuing different aspects of privacy - Getting informed consent - The Five Cs – Diversity – Inclusion – Future Trends.

TEXTBOOKS:

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman and Mohamed Ali, Manning Publications, 2016.
2. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013
3. Think Like a Data Scientist, Brian Godsey, Manning Publications, 2017.
4. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O’ Reilly, 1st edition, 2018.

SUGGESTED BOOKS:

1. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O’ Reilly, 1st edition, 2013.

2. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014
3. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013

Semester	II
Paper Code	BCADA 2224
Paper Title	ADVANCED STATISTICAL COMPUTING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

- To apply principles of sampling in data collection
- Learn the techniques of estimation
- Apply the regression techniques in solving real life problems

COURSE OUTCOME:

Upon successful completion of this course student should be able to -

CO1: Understand the basic concepts of sampling methods.
CO2: Understand the estimation procedures
CO3: Develop the skill to differentiate between parametric and non-parametric tests
CO4: Understand the use of multiple regression for prediction
CO5: Develop analytical ability to solve real-world problems using these methodologies

UNIT 1: SAMPLING AND SAMPLING DISTRIBUTIONS **9 Hrs.**

Principles of Sampling, Sampling methods, Sampling Distributions: mean, difference and proportions

UNIT 2: ESTIMATION AND CONFIDENCE INTERVALS **9 Hrs.**

Point Estimation, properties and drawback, Confidence Interval Estimation of population mean and proportions

UNIT 3: HYPOTHESIS TESTING **9 Hrs.**

General Procedure, Errors in Hypothesis Testing, testing related to parametric test like Z test, t – test, non-parametric statistics: advantages and limitations, the Chi-Square Distribution, applications of Chi-Square Test Statistic, Mann Whitney U-Test

UNIT 4: MULTIPLE REGRESSION ANALYSIS **9 Hrs.**

Assumptions, the basics, testing the accuracy of models, robust regression: bootstrapping, reporting the regression results, regression with categorical data, dummy coding

UNIT 5: ANALYSIS OF VARIANCE **9 Hrs.**

One Way and Two-Way Classification, assumptions, logic of F Ratio, post hoc procedures and violations of test assumptions - Case Study related to the above discussed topics using R

TEXTBOOK:

1. Statistical Inference: P. J. Bickel and K. A. Docksum, 2nd Edition, Prentice Hall.
2. Introduction to Linear Regression Analysis: Douglas C. Montgomery
3. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013

SUGGESTED BOOK:

1. Computer Age Statistical Inference by Bradley Efron and Trevor Hastie
2. Introduction to Statistical Learning by Gareth James

Semester	II
Paper Code	BCADA 2324
Paper Title	MATHEMATICS II
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45

Number of credits	3

COURSE OBJECTIVE:

This course will enable students to acquire further skills in the techniques of linear algebra, as well as understanding of the principles underlying the subject. This course will prepare students for further courses in mathematics and/or related disciplines.

COURSE OUTCOME:

On successful completion of the course, students will be able to:

CO1: Acquaint the students with mathematical/logical fundamentals including numerical techniques

CO2: Understanding the numerical techniques of interpolation in various intervals in real life situations.

CO3: Understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.

CO4: Able to define the various concepts of graphs and its implementations

CO5: Solve the real life problems using finite state machines

UNIT I: MATHEMATICAL LOGIC **10 Hrs.**

Basic Connectives and Truth Tables, Logic Equivalence – The Laws of Logic, Logical Implication – Rules of Inference, Fundamentals of Logic, the Use of Quantifiers, Quantifiers.

UNIT II: FORMAL LANGUAGES AND FINITE-STATE MACHINES **4 Hrs.**

Idea about formal languages, finite state machine.

Case studies

UNIT III: GRAPH THEORY **13 Hrs.**

Introduction to Graphs: Definition of Graph, Loop, Simple Graph, Graph as Models, Path and Cycle, Complete Graph, Bipartite Graph, Digraph, Tree, Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycle, shortest path algorithms. Case studies

UNIT IV: INTERPOLATION AND APPROXIMATION 9 Hrs.

Interpolation with unequal intervals – Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines – Difference operators and relations – Interpolation with equal intervals – Newton's forward and backward difference formulae.

UNIT V: NUMERICAL DIFFERENTIATION AND INTEGRATION 9 Hrs.

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

TEXT BOOKS:

1. "Introduction to Graph Theory" PHI Learning Pvt Ltd 2012, Douglas B West
2. "Introductory Method to Numerical Analysis", Prentice Hall India Learning Private Limited; Fifth edition (1 January 2012), S. S. Sastry.
3. "Introduction to Automata Theory, Languages and Computation ", Pearson Education, 1979, J. Hopcroft, J. Ullman

SUGGESTED BOOKS:

1. Discrete Mathematics with Applications by Thomas Koshy
2. Discrete Mathematics with Applications by Susanna S. Epp

Semester	II
Paper Code	BCADA2426
Paper Title	PYTHON PROGRAMMING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

This course provides a comprehensive introduction to Python programming, covering basic syntax, internal runtime structures, and essential data types like lists, tuples, dictionaries, and sets. Students will master control flow with loops and conditional statements while exploring functional programming, file I/O, and modular package management. The curriculum emphasises robust software development using exception handling and advanced Object-Oriented Programming principles, including inheritance and polymorphism. Grounded in industry-standard practices, the course utilises key references to bridge the gap between fundamental scripting and complex application design.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Analyse Python's runtime structure and internal execution flow while applying fundamental syntax and data type constraints.
CO2: Design and optimise data storage solutions utilising structured collections, including lists, tuples, dictionaries, and sets.
CO3. Construct complex algorithmic pathways through the systematic application of iterative loops and conditional control statements.
CO4: Develop modular software architectures by integrating user-defined functions, robust file I/O operations, and external library management.
CO5: Architect resilient, scalable applications through the implementation of comprehensive exception handling and sophisticated Object-Oriented Programming frameworks.

UNIT I: INTRODUCTION TO PYTHON INTERPRETER 9 Hrs.

Python - Introduction, Advantages and Disadvantages, History, Features, Applications, Python Internals, Runtime Structure, Basic Syntax, Python Identifiers, Reserved Keywords, Data Types.

UNIT II: DATA STRUCTURES 9 Hrs.

List, Tuple, Dictionary, Set

UNIT III: CONTROL STATEMENTS 10 Hrs.

Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation. Illustrative programs

UNIT IV: FUNCTIONS, I/O, FILE HANDLING, PACKAGES/LIBRARIES 10 Hrs.

Functions - Define, call, pass by reference, Function Arguments, Anonymous Function or Lambda Function, return statement.

I/O - Handling Files, Types of Files, Open(), close(), Different modes, Read & Write, file positions, File Seek, OS File/Directory Methods - Types and Methods

Packages/Libraries - Modules, import statement, packages.

UNIT V: EXCEPTION HANDLING, OO PROGRAMMING 7 Hrs.

Exception Handling - Exception Types, Handling Exceptions, Raising Exceptions

OO Programming - Classes, Objects, creating object, self-parameter, init function, destructors, privacy in Python, Inheritance and its types, Polymorphism - Method overloading, method overriding, constructor overriding, operator overloading.

TEXTBOOKS:

1. Python in easy steps - Mike McGrath, In Easy Steps Limited, Second Edition

2. “Hello World” - Computer Programming for Kids and other Beginners - Warren and Carter, Manning Publications, 2014

SUGGESSTED BOOKS:

1. Python3 Tutorial – Tutorialspoint
2. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010

LABORATORY

Semester	II
Paper Code	BCADA2P124
Paper Title	DATA SCIENCE LAB (USING R)
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

1. Creating and manipulating vector in R
2. Creating matrix and manipulating matrix in R
3. Operations on Data Frames in R
4. Operations on Lists in R.
5. Programs on If – else statements in R
6. Programs on For Loops in R.
7. Customizing and Saving to Graphs in R.
8. PLOT Function in R to customize graphs
9. 3D PLOT in R to customize graphs
10. Implement in R Programming the concept to find Sum, Mean and Product of a Vector, ignore element like NA or NaN.
11. Implement in R Programming the concept to find missing values.
12. Implement the concept to create a list of data frames and access each of those data frames from the list using R.
13. Implement the concept of matrix multiplication and addition using R.
14. Implement linear regression model and compare predicted value with actual value using Visualization.
15. Implement logistic regression model and compare predicted value with actual value using Visualization.
16. Implement k-means clustering.
17. Getting Started with R environment : downloading , installing , using scripts , R workspace, installing packages in R
18. Getting data into R workspace : creating variables, creating data frames , organizing data
19. Manipulating Data : selecting parts of a data frame , data frames and matrices
20. Exploring data with graphs in R
21. Exploring the assumptions of normality in R
22. Understanding Interval Estimation in R
23. Parametric and Non-Parametric Tests in R
24. Testing the Regression models for accuracy
25. Comparing means Using ANOVA

Semester	II
Paper Code	BCADA2P224
Paper Title	PYTHON PROGRAMMING LAB

Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	30
Number of credits	1

SEMESTER III

Semester	III
Paper Code	BCADA3125
Paper Title	PYTHON FOR DATA ANALYTICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE

The objective of this course is to equip students with a fundamental understanding of Big Data, including its characteristics, storage, and processing frameworks. Students will develop proficiency in using NumPy and Pandas for numerical computing and data manipulation, perform data wrangling techniques such as merging, reshaping, and transforming datasets, and apply data aggregation, grouping, and transformation operations. Additionally, students will learn to utilize visualization libraries like Matplotlib and Seaborn to create meaningful data representations for effective data analysis and decision-making.

COURSE OUTCOMES

CO 1: Understand the fundamentals of Big Data, its characteristics, storage mechanisms, and processing frameworks.

CO 2: Develop proficiency in using NumPy and Pandas for numerical computing and data manipulation.

CO 3: Perform data wrangling techniques, including merging, reshaping, transforming, and cleaning data.

CO 4: Apply data aggregation, grouping operations, and transformation techniques using Pandas.

CO 5: Utilize visualization libraries such as Matplotlib and Seaborn to create meaningful data visualizations.

UNIT I - INTRODUCTION TO BIG DATA **9 Hrs**

Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics -Validating – The Promotion of the Value of Big Data – Big Data Use Cases- Characteristics of Big Data Applications – Perception and Quantification of Value -Understanding Big Data Storage – A General Overview of High-Performance Architecture – HDFS – MapReduce and YARN – Map Reduce Programming Model

UNIT II - NUMPY AND PANDAS PACKAGES **9 Hrs**

NumPy ndarray - Vectorization Operation - Array Indexing and Slicing - Transposing Array and Swapping Axes - Saving and Loading Array - Universal Functions - Mathematical and Statistical Functions in NumPy .
Series and DataFrame data structures in pandas - Creation of Data Frames – Accessing the

columns in a DataFrame - Accessing the rows in a DataFrame - Panda's Index Objects - Reindexing Series and DataFrames - Dropping entries from Series and Data Frames - Indexing, Selection and Filtering in Series and Data Frames - Arithmetic Operations between Data Frames and Series - Function Application and Mapping.

UNIT III - DATA WRANGLING **9 Hrs**

Combining and Merging Data Sets – Reshaping and Pivoting – Data Transformation – String manipulations – Regular Expressions.

UNIT IV - DATA AGGREGATION AND GROUP OPERATIONS **9 Hrs**

Group By Mechanics – Data Aggregation – GroupWise Operations – Transformations – Pivot Tables – Cross Tabulations – Date and Time data types.

UNIT V - VISUALIZATION IN PYTHON **9 Hrs**

Matplotlib and Seaborn Packages – Plotting Graph - Controlling Graphs – Adding Text – More Graph Types – Getting and Setting Values – Patches.

REFERENCES:

1.Gowrishanker and Veena, "Introduction to Python Programming", CRC Press, 2019.
2.Python Crash Course, 2nd Edition, By Eric Matthes, May 2019

3.NumPy Essentials, By Leo Chin and Tanmay Dutta, April 2016
4.Joel Grus, “Data Science from scratch”, O'Reilly, 2015.
5.Wes Mc Kinney, “Python for Data Analysis”, O'Reilly Media, 2012.
6.Kenneth A. Lambert, (2011), “The Fundamentals of Python: First Programs”, Cengage Learning
7.Jake Vanderplas. Python Data Science Handbook: Essential Tools for Working with Data 1st Edition.

Semester	III
Paper Code	BCADA 3225
Paper Title	OPERATING SYSTEM
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. To analyze the various evolutions of operating systems.
2. To learn the basic concepts and roles of an operating system.
3. To study the various design issues in developing an operating system.
4. To familiarize with the important mechanisms in operating systems.
5. To appreciate the emerging trends in operating systems.

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1: Understand the evolution of Operating systems
CO2 Understand the Key concept of Operating Systems
CO3: Analyze the issues in designing Operating Systems
CO4: Analyze the usage and strengths of various algorithms of Operating Systems
CO5: Appreciate the role of various concepts and algorithms towards the performance of the system

UNIT I: OPERATING SYSTEMS OVERVIEW **10 Hrs.**

Introduction to operating systems – Computer system organization, architecture – Operating system structure, operations–Process, memory, storage management–Protection and security– Distributed systems – Computing Environments – Open-source operating systems – OS services – User operating-system interface – System calls – Types – System programs – OS structure – OS generation – System Boot – Process concept, scheduling – Operations on processes – Cooperating processes – Inter-process communication

UNIT II: PROCESS MANAGEMENT **10 Hrs.**

Basic concepts – Scheduling criteria – Scheduling algorithms – Thread scheduling – Multiple-processor scheduling, Synchronization hardware – Semaphores – Classic problems of synchronization – Critical regions – Monitors – Synchronization examples – Deadlocks – System model – Deadlock characterization – Methods for handling deadlocks – Deadlock Prevention – Deadlock Avoidance – Deadlock detection – Recovery from deadlock.

UNIT III: STORAGE MANAGEMENT **8 Hrs.**

Memory Management – Swapping – Contiguous memory allocation – Paging –Segmentation – Demand paging - Page replacement – Allocation of frames – Thrashing.

UNIT IV: I/OSYSTEMS **9 Hrs.**

File concept – Access methods – Directory structure – File-system mounting – Protection – Directory implementation – Allocation methods – Free-space management – Disk scheduling – Disk management – Swap-space management – Protection.

UNIT V: CASE STUDY **8 Hrs.**

The Linux System – History – Design Principles – Kernel Modules – Process Management – Scheduling – Memory management – File systems – Input and Output – Inter-process Communication

TEXT BOOK:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts Essentials", John Wiley & Sons Inc., 2010.

REFERENCES:

1. Andrew S.Tanenbaum, "Modern Operating Systems", Second Edition, Addison Wesley,2001.

2. D M Dhamdhere, "Operating Systems: A Concept-based Approach", Second Edition, Tata McGraw-Hill Education,2007.

3. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education‖,1996.

4. William Stallings, "Operating Systems: Internals and Design Principles", Seventh Edition, Prentice Hall,2011.

Semester	III
Paper Code	BCADA 3325
Paper Title	MATHEMATICS III
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

- To understand the basic concepts and techniques of solving algebraic equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.
- To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Understanding the basic concepts and techniques of solving algebraic equation and matrices techniques for solving systems of linear equations in the different areas of Linear Algebra.

CO2: Understanding the numerical techniques of interpolation in various intervals in real life situations.

CO3: Understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.

CO4: Knowledge of various techniques and methods of solving ordinary differential equations

CO5: Understanding database the knowledge of various techniques and methods of solving various types of partial differential equations.

UNIT I: MATRICES **12 Hrs.**

System of linear equation, Row reduction and echelon forms, vector equation, Matrix equation, Solution sets of linear systems, Linear Independence, Introduction to Linear Transformation, The matrix of a Linear Transformation. Matrix Operations, The Inverse of a matrix, Characterization of Invertible Matrices, Subspaces of $R^n$and Dimension and rank.

UNIT II: SOLUTION OF EQUATIONS AND EIGENVALUE PROBLE **9 Hrs.**

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton-Raphson method – Solution of linear system of equations – Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT III: VECTOR SPACES **12 Hrs.**

Vector spaces, subspaces, Null spaces, Column Spaces and Linear Transformation, linearly independent set and Bases, Coordinate system, The dimension of a vector space, Rank, Change of Basis, Eigenvectors and Eigenvalues, The characteristic equation, Diagonalization.

UNIT IV: DIFFERENTIAL EQUATIONS **9 Hrs.**

Introduction to differential equations, Formation of differential equations, Equations of First Order and First Degree: Solving equations of second and higher order homogeneous equations with constant coefficients, solving equations of second and higher order non-homogeneous equations with constant coefficients by finding the complementary function particular integral.

SELF-STUDY **3 Hrs.**

TEXT BOOKS:

1. "An introduction to Differential Equation", New Central Book Agency, 2011, R K Ghosh and K C Maity.
2. "Introductory Method to Numerical Analysis", Prentice Hall India Learning Private Limited; Fifth edition (1 January 2012), S. S. Sastry
3. "Linear Algebra and its Applications," 3rd edition, Pearson Education (Asia) Pte. Ltd, 2005. David C. Lay

SUGGESTED BOOKS:

1. "Linear Algebra with Applications, 8th Edition By Steve Leon
2. "Linear Algebra," 2nd edition, Pearson Education (Asia) Pte. Ltd/2004. Kenneth Hoffman and Ray Kunze

Semester	III
Paper Code	BCADA 3425
Paper Title	ECONOMETRICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

To equip the students with the knowledge of the techniques of modern econometrics, required for applied research in data analytic industry.

COURSE OUTCOMES:

Upon successful completion of this course student should be able to

CO1: To get familiar with the concept of econometrics
CO2: To get insights into classical linear regression
CO3: To familiarize the concept of relaxation of assumptions of classical regression model

CO4: To get insights of Non-linear relationship
CO5: To solve the Simultaneous equations using different methods

UNIT I : INTRODUCTION TO ECONOMETRICS **8 Hrs.**

Nature and Scope of Econometrics - Meaning of Econometrics, Relationship Between Statistics, Mathematics and Economics, Economic and Econometric Models, the aims and methodology of Econometrics, statistical Vs deterministic relationship, regression Vs Causation, regression Vs correlation, terminology and notation, the nature and sources of data for Econometric analysis. Review of basic statistical concepts, Population and Sample, Random variables, Probability distribution function, Multivariate probability density functions, Expected value, Variance, Co variance, Correlation Co efficient.

UNIT II: CLASSICAL LINEAR REGRESSION **8 Hrs.**

Two Variable Regression Analyses - the basic two Variable Regression model: OLS Estimation, Hypothesis testing, Extensions of two variable regression model – Functional forms of regression model. Interpretation of multiple regression coefficients , properties of regression coefficients, multicollinearity, goodness of fit.

UNIT III: RELAXING THE ASSUMPTIONS OF THE CLASSICAL REGRESSION MODEL **10 Hrs.**

Multi-collinearity, Heteroscedasticity and Autocorrelation- Nature, Consequences, Detection and Remedial Measures

UNIT IV: UNDERSTANDING NON-LINEAR RELATIONSHIPS. **6 Hrs.**

Transformation of variables - Logarithmic transformations, Engel curve, semi- logarithmetic transformation, non linear regression, use of dummy variables in regression

UNIT V: SIMULTANEOUS EQUATIONS SYSTEM **8 Hrs.**

Identification problem, Least Squares estimation , Bias Problem

SELF STUDY **5 Hrs**

SUGGESTED BOOKS:

1. Cristopher Dougherty Introduction to Econometrics
2. Johnson , Econometric Methods
3. Damodar Gujrati , Econometrics

4. The Econometrics of Financial Markets : J. Campbell, A.Lo and C. Mackinlay Econometric Analysis : William H. G

Semester	III
Paper Code	DAMDE 3125
Paper Title	NATIONAL ENTREPRENEURSHIP NETWORK – IGNITE PROGRAM
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	30
Number of credits	2

COURSE OBJECTIVES:

Upon successful completion of this course, students should be able to:

- Understand entrepreneurial skillset and mindset
- Identify problems as catalyst for innovation
- Develop customer personas based on initial research
- Enhance customer personas based on market/other feedback
- Examine the core principles of lean startups/design thinking
- Acquire techniques for narrowing down solutions to the most viable options (map problem-JTBD-solution idea)
- Understand contemporary competition and market influences
- Understand solution: prototyping vs. MVPs

COURSE OUTCOMES:

After successful completion of this course, the students should:

- Commit to higher career possibilities enabled by entrepreneurial skills
- Scope a problem worth solving with user impact, and personal drivers
- Enhance customer personas based on market/other feedback
- Analyze responses to uncover insights on customer needs/JTBD/problems
- Pivot problem/customer segmentation based on customer insight

- Acquire techniques for narrowing down solutions to the most viable options (map problem-JTBD-solution idea)
- Apply learn method to estimate the Total Addressable Market (TAM)
- Develop & exhibit fundamental skills to prototype
- Apply market analysis in planning
- Craft an initial sales plans

UNIT I: Orientation **5 Hours**

Entrepreneurial leadership and its relevance of entrepreneurial mindset for students' career choices-Overview of global/Indian startup ecosystems-Introduction to design thinking/innovation.

Problem Identification: Develop macro industry-problem perspective - Assemble 'real-world' problems – Analyze problems.

UNIT II: Customer Identification **7 Hrs**

Identify customer segments. Assess 'Jobs-To-Be-Done' (JTBD) for a customer segment-Develop customer personal. **Customer Needs Validation:** Understand customer validation-Validate customer-problem fit-Pivot/refine customer-problem fit for feasibility. **Solution Idea Generation:** Examine ideation techniques-Generate solution ideas. **Opportunity and Competition Mapping:** Identify global competitors-Review industry trends-Estimate market size (TAM).

UNIT III: Prototype Development and MVP **6 Hrs**

Overview of prototypes & MVP - Build an initial prototype-Prototypes for early validation. **Opportunity (feasibility) assessment:** Map your relative position in the market-Estimate opportunity size. **Business Modelling:** Examine revenue models-Review and organize the lean canvas-Build the lean canvas for your startup.

UNIT IV: Marketing and Sales Strategy **7 Hrs**

Understand marketing and sales-Recommend a GTM approach-Map a sales process. **Financial management for profitability:** Understand startup costs-Get started with financial planning-Analyse the path to profitability-Understand bootstrapping strategies & explore funding options. **Team and talent requirements:** Finding co-founders and mentors-Building an initial team.

UNIT V: Venture Idea Pitch Readiness **5 Hrs**

Scale orientation - Persuasive story-telling for a feasible venture idea. Final Milestone - Venture Idea Feasibility Presentation - **Milestone 3:** Venture idea feasibility (extrnal) jury presentation

Text Books

[1] Dr. R. Paulmoni, "Entrepreneurship, Innovation And Creativity", AG Publishing House, First Edition, 2024.

[2] H. James Harrington, "Creativity, Innovation, and Entrepreneurship", Productivity Press; 1st edition (11 December 2018).

Reference Books:

[1] Peter F. Drucker, Innovation and Entrepreneurship, Harper Business; Reprint edition (9 May 2006)

[2] Michael Michalko, "Creative Thinkering", New World Library; Original edition (6 September 2011)

LABORATORY

Semester	II
Paper Code	BCADA3P125
Paper Title	PYTHON FOR DATA ANALYTICS LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

Semester	II
Paper Code	BCADA3P225
Paper Title	OPERATING SYSTEM LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

COURSE OBJECTIVES:

This course aims to provide hands-on exposure to the Linux operating system environment, focusing on command-line operations, file management, shell scripting, and process control. It enables students to develop the practical skills necessary to navigate, configure, and automate tasks in Linux, thereby reinforcing theoretical concepts of operating systems through real-world implementation.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

- **CO1:** Install, configure, and navigate the Linux operating system using appropriate system commands.
- **CO2:** Apply essential Linux commands for file, directory, and process management in a multi-user environment.
- **CO3:** Create and edit text and program files using Linux-based editors and utilities.
- **CO4:** Develop shell scripts incorporating variables, expressions, and control structures for task automation.
- **CO5:** Demonstrate problem-solving and logical reasoning through efficient use of Linux commands and scripting techniques.

SEMESTER IV

Semester	IV
Paper Code	BCADA 4125
Paper Title	DATABASE MANAGEMENT SYSTEM
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE DESCRIPTION:

To provide strong foundation for databases, tables, database management system and application area related to it and understand the underlying core concepts.

COURSE OBJECTIVES:

This course concentrates on introduction, principles, design and implementation of DBMS. It introduces about the distributed system and brief about data mining and data warehouse. To provide strong foundation of database concepts and develop skills for the design and implementation of a database application with a brief exposure to advanced database concepts.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Understand the fundamental concepts of Database Management systems
CO2: Understand the concepts of Database models.
CO3: Understand the core terms, concepts, and tools of relational database management systems.
CO4:Understand database design and logic development for database programming.

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UNIT I: DATABASE MANAGEMENT SYSTEM INTRODUCTION 10 Hrs.

Data- Database- Database management system- Characteristics of the database approach- Role of Database administrators- Role of Database Designers- End Users- Advantages of Using a DBMS-

Data models, Schema and Instances –Database design - Database Engine – 1 tier architecture – 2 tier architecture- 3 tier architecture – History of Database Management systems- Types of Databases.

UNIT II: DATABASE MODELS AND IMPLEMENTATION 10 Hrs.

Data Model and Types of Data Model- Relational Data Model- Hierarchical Model- Network Data Model- Object/Relational Model- Object-Oriented Model- Entity-Relationship Model- Modeling using E-R Diagrams- Notation used in E-R Model- Relationships and Relationship Types- Cardinalities. Subclasses, Super classes and Inheritance – Specialization and Generalization – Characteristics of Specialization and Generalization – Modeling of UNION types with categories- An example University EER Schema.

UNIT II: RELATIONAL DATABASES 10 Hrs.

Structure of relational databases- Properties of relational databases and Tables –Structure of relational databases – Database Schema – Armstrong Axioms – Functional Dependency- Anomalies in a Database- Properties of Normalized Relations- First Normalization- Second Normal Form Relation- Third Normal Form- Boyce-Codd Normal Form (BCNF).

UNIT IV: SQL AND ADDITIONAL CONCEPTS 10 Hrs.

Categories of SQL Commands; Data Definition; Data Manipulation Statements, SELECT - The Basic Form, Subqueries, Functions, GROUP BY Feature, Updating the Database, Data Definition Facilities. MongoDB Overview- MongoDB Data modeling.

SELF STUDY 5 Hrs.

REFERENCE BOOKS:

1. Elmasri Ramez and Navathe Shamkant B, Fundamentals of Database Systems, Addison-Wesley, 6th Edition, 2010.
2. Silberschatz, Korth, Sudarshan, Database System Concepts, 5 Edition, McGraw Hill, 2006.
3. O`neil Patricand, O`neil Elizabeth, Database Principles, Programming and Performance, 2nd Edition, Margon Kaufmann Publishers Inc, 2008.

Semester	IV
Paper Code	BCADA 4225
Paper Title	MULTIVARIATE STATISTICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE: The aim of this course is to appraise the students about the concepts and methods of multivariate analysis

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: To get an insight into the application of multivariate analysis
CO2: To familiarize the students with the concept of multivariate normal distribution
CO3: To familiarize the students with multiple regression
CO4: To get insights into the concepts of data reduction using principal component analysis
CO5: To get insights into factor analysis

UNIT I: ASPECTS OF MULTIVARIATE ANALYSIS **5 Hrs.**

Application of Multivariate Techniques, the organization of data , data displays and pictorial representations , matrix algebra and random vectors

UNIT II: THE MULTIVARIATE NORMAL DISTRIBUTION **10 Hrs.**

The Multivariate Normal Density and its properties, mean vector , Covariance Matrix , Correlation Matrix , Relationship between Correlation and covariance matrix , Multivariate Normal Distribution – Geometric interpretation , Examining data for multivariate Normal Distribution , Multivariate Inferential Statistics : Hotelling's T^2, Confidence Region , Hypothesis Testing for Equality of two population mean Vectors

UNIT III: MULTIPLE LINEAR REGRESSION **10 Hrs.**

Assumptions and Estimation of Model Parameters , Sampling distribution of parameter estimates , Model Adequacy Test, Tests of assumptions , Remedy against violations of assumptions, multivariate Linear Regression ,

UNIT IV: PRINCIPAL COMPONENT ANALYSIS **10 Hrs.**

Conceptual Model , Extraction of Principal Components , Model Adequacy and Interpretation

UNIT V: FACTOR ANALYSIS **10 Hrs.**

Factor Analysis : Basic and Orthogonal Models , Types of Models , parameter estimation , Model Adequacy Tests and Factor Rotation

SUGGESTED BOOKS:

1. 1. Applied Multivariate Statistical Analysis by R A Johnson and D W Wichern, Sixth Edition, PHI, 2012.
2. 2. Multivariate data analysis by Joseph F. Hair Jr, Rolph E. Anderson, Ronald L Tatham, and William C. Black, Fifth Edition, Pearson Education, 1998.
3. 4. Analysing multivariate data by J Lattin, J D Carroll and P E Green, Cengage Learning, 2010.
4. 5. Applied multivariate analysis by N H Timm, Springer, 2002.
5. 6. An Introduction to multivariate Statistical Analysis , T.W Anderson , Third Edition , Wiley Student Edition

Semester	IV
Paper Code	BCADA 4325
Paper Title	DATA STRUCTURES USING PYTHON
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

To equip students with a comprehensive understanding of Object-Oriented Programming (OOP) concepts, Python-specific data structures, and fundamental algorithms, enabling them to design, implement, and analyze efficient solutions using linear and non-linear data structures for real-world computational problems.

LEARNING OUTCOMES:

Upon completion of the course, students will be able to design and implement efficient programs using OOP principles, utilize Python data structures and algorithms effectively, and apply linear and non-linear data structures to solve complex computational problems, demonstrating proficiency in problem-solving and software development.

CO1: Understand and apply Object-Oriented Programming (OOP) concepts to design and implement efficient and reusable code.
CO2: Demonstrate proficiency in Python-specific data structures to manipulate and process data effectively.
CO3: Analyze and implement fundamental array operations, and apply various algorithms to solve computational problems.
CO4: Implement and evaluate linear data structures and apply them to real-world problems.
CO5: Explore and implement non-linear data structures to solve complex problems.

UNIT I : Oops Concepts **9 Hrs**

Oops Concepts- class, object, constructors, types of variables, types of methods. Inheritance: single, multiple, multi-level, hierarchical, hybrid; Polymorphism: with functions and objects, with class methods, with inheritance. Abstraction: abstract classes.

UNIT II: Data Structures **7 Hrs**

Data Structures – Definition, Linear Data Structures, Non-Linear Data Structures Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, and slicing.

UNIT III : Arrays **9 Hrs**

Arrays - Overview, Types of Arrays, Operations on Arrays, Arrays vs List. Searching -Linear Search and Binary Search. Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort.

UNIT IV: Linked Lists **9 Hrs**

Linked Lists – Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists. Stacks - Overview of Stack, Implementation of Stack (List & Linked list), Applications of Stack Queues: Overview of Queue, Implementation of Queue(List & Linked list), Applications of Queues, Priority Queues.

UNIT V: Graphs **11 Hrs**

Graphs -Introduction, Directed vs Undirected Graphs, Weighted vs Unweighted Graphs, Representations, Breadth First Search, Depth First Search. Trees - Overview of Trees, Tree Terminology, Binary Trees: Introduction, Implementation, Applications. Tree Traversals, Binary Search Trees: Introduction, Implementation, AVL Trees: Introduction, Rotations, Implementation.

TEXTBOOKS:

1. Data structures and algorithms in Python by Michael T. Goodrich

2. Data Structures and Algorithmic Thinking with Python by Narasimha Karumanchi

REFERENCE BOOKS:

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka. 2. Data Structures and Algorithms with Python by Kent D. Lee and Steve Hubbard.

3. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L. Ranum.

4. Core Python Programming -Second Edition, R. Nageswara Rao, Dreamtech Press

Semester	IV
Paper Code	BCADA4425
Paper Title	COMPUTER NETWORKS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45

Number of credits	3

COURSE OBJECTIVES:

- To understand the protocol layering and physical level communication
- To analyse the performance of a network
- To understand the various components required to build different networks
- To learn the functions of network layer and the various routing protocols
- To familiarize the functions and protocols of the Transport, Network and application layer

COURSE OUTCOMES:

On successful completion of this course, the student will able to

CO1: Comprehend the basic layers and its functions in computer networks.
CO2: Understand the basics of how data flows from one node to another.
CO3: Analyse and design routing algorithms.
CO4: Design protocols for various functions in the network.
CO5: Understand the working of various application layer protocols.

UNIT I: INTRODUCTION AND PHYSICAL LAYER 9 Hrs.

Networks – Network Types – Protocol Layering – TCP/IP Protocol suite – OSI Model – Physical Layer: Performance – Transmission media – Switching – Circuit-switched Networks – Packet Switching.

UNIT II: DATA-LINK LAYER & MEDIA ACCESS 9 Hrs.

Introduction – Link-Layer Addressing – DLC Services – Data-Link Layer Protocols – HDLC – PPP – Media Access Control – Wired LANs: Ethernet – Wireless LANs – Introduction – IEEE 802.11, Bluetooth – Connecting Devices.

UNIT III: NETWORK LAYER 9 Hrs

Network Layer Services – Packet switching – Performance – IPV4 Addresses – Forwarding of IP Packets – Network Layer Protocols: IP, ICMP v4 – Unicast Routing Algorithms – Protocols – Multicasting Basics – IPV6 Addressing – IPV6 Protocol.

UNIT IV: TRANSPORT LAYER **9 Hrs.**

Introduction – Transport Layer Protocols – Services – Port Numbers – User Datagram Protocol – Transmission Control Protocol – SCTP.

UNIT V: APPLICATION LAYER **9 Hrs.**

WWW and HTTP – FTP – Email –Telnet –SSH – DNS – SNMP.

TEXT BOOKS

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2013.

2. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.

REFERENCE BOOKS

1. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", Seventh Edition, Pearson Education, 2017.

2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013.

3. Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.

4. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, Computer Networks: An Open Source Approach, McGraw Hill Publisher, 2011.

LABORATORY

Semester	IV
Paper Code	BCADA4P125
Paper Title	DATABASE MANAGEMENT SYSTEMS LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

Semester	IV
Paper Code	BCADA4P225
Paper Title	DATA STRUCTURE USING PYTHON LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

SEMESTER V

Semester	V
Paper Code	BCADA5126
Paper Title	MACHINE LEARNING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

This course will provide the students with an understanding of the concepts of Machine Learning, supervised learning and their applications, the concepts and algorithms of unsupervised learning, and the concepts and algorithms of advanced learning.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Describe the foundational concepts of Machine Learning, differentiate between types of learning, and apply appropriate techniques for data representation and visualisation.

CO2: Implement supervised and unsupervised learning algorithms such as regression, classification, decision trees, and neural networks, and analyse their performance in solving practical problems.

CO3: Design and construct machine learning pipelines using open-source toolkits, tune model parameters, and evaluate performance metrics to optimise solutions.

CO4: Analyse datasets using information-based, similarity-based, and probability-based learning methods, and evaluate their effectiveness in predictive analytics tasks.

CO5: Apply machine learning techniques to real-world domains such as image recognition, speech recognition, and fraud detection, and design domain-specific solutions to address challenges.

UNIT I: MACHINE LEARNING BASICS 9 Hrs

Introduction to Machine Learning (ML) - Essential concepts of ML – Types of learning – Machine learning methods based on Time – Dimensionality – Linearity and Nonlinearity – Early trends in Machine learning – Data Understanding, Representation, and visualisation.

UNIT II: MACHINE LEARNING METHODS 9 Hrs

Linear methods – Regression -Classification –Perceptron and Neural networks – Decision trees – Support vector machines – Probabilistic models–Unsupervised learning – Featurization

UNIT III: MACHINE LEARNING IN PRACTICE 9 Hrs

Ranking – Recommendation System - Designing and Tuning model pipelines- Performance measurement – Open-source Machine Learning libraries - Machine Learning Tool Kit: Orange, Weka, RapidMiner

UNIT IV: MACHINE LEARNING AND DATA ANALYTICS 9 Hrs

Machine Learning for Predictive Data Analytics – Data to Insights to Decisions – Data Exploration – Information-based Learning – Similarity-based learning – Probability-based learning – Error-based learning – Evaluation – The Art of Machine learning to Predictive Data Analytics.

UNIT V: APPLICATIONS OF MACHINE LEARNING 9 Hrs

Image Recognition – Speech Recognition – Email spam and Malware Filtering – Online fraud detection – Medical Diagnosis.

SUGGESTED BOOKS:

1. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.

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

3. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall, CRC Press, Second Edition, 2014.

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

5. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.

Semester	V
Paper Code	BCADA5226
Paper Title	JAVA PROGRAMMING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

By the end of this course, students will be able to identify and describe fundamental concepts of Java programming and object-oriented principles such as encapsulation, inheritance, and polymorphism. They will apply control structures and arrays to develop structured programs. Learners will analyze program requirements to implement inheritance, interfaces, packages, and exception handling. They will construct concurrent applications using multithreading, perform file handling with Java I/O streams, and integrate generics for type-safe programming.Students will design and develop interactive graphical user interfaces using Swing components to create efficient and reusable software solutions

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Identify Java features and apply OOP principles to develop basic programs using fundamental syntax elements

CO2: Construct Java programs by applying class and object fundamentals and implement method and constructor overloading, recursion, and nested/inner classes

CO3: Implement inheritance hierarchies, method overriding, and abstract classes, and evaluate access control mechanisms using packages.

CO4: Develop Java applications using interfaces, custom exceptions, and multithreading, and analyze program behavior under different execution flows and exception conditions.

CO5: Apply Java I/O streams, generics, and Swing components to create interactive, type-safe, and file-handling GUI applications

UNIT I: INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 8 Hrs.

Java Buzz words- Simple, Object Oriented, Robust, Multithreaded, Architecture-Neutral, Interpreted and High Performance, Distributed , Dynamic. Overview of Java- Object Oriented Paradigm, Abstraction, Three OOP Principles-Encapsulation, Inheritance, Polymorphism, Simple Program, Data types, Variables, Arrays, Operators, Control Statements.

UNIT II : CLASSES, OBJECTS AND METHODS 8 Hrs.

Classes and Objects- class fundamentals, Declaring objects, Introducing methods, Constructors, The this keyword, The finalize() method. Overloading methods- Overloading constructors, using object as parameter, Returning objects. Recursion, Nested and Inner classes, Exploring string class , Command line arguments

UNIT III : INHERITANCE AND PACKAGES 8 Hrs

Inheritance- Basics, member access and inheritance, Using super- using super to call superclass constructors, Second use of super. Creating a Multilevel Hierarchy, Method Overriding, Abstract classes, Using final with Inheritance, Object class

Packages – Defining package, Finding packages and CLASSPATH, Access protection, importing packages

UNIT IV: INTERFACE, EXCEPTION HANDINLING AND MULTITHREADED PROGRAMMING 8 Hrs

Interface- Defining an interface, Implementing Interfaces, nested interfaces, Applying interfaces.

Exception Handling- Fundamentals, Exception types, uncaught Exception, Using try and catch, Multiple catch clauses, Nested try Statements, throw, finally, Java Built-in Exception, Creating your own exception.

Multithreaded Programming- The java thread Model, Thread priorities, The main thread, Creating a thread, Implementing runnable, suspending, resuming and stopping threads

UNIT V: INPUT / OUTPUT BASICS , GENERIC JAVA AND SWING **8 Hrs**

Input/Output: File, Directories, The Stream classes, The byte streams- InputStream, OutputStream, FileInput Stream, FileOutput Stream, The Character Streams- Reader, Writer, FileReader, FileWriter

Generics –Introduction to Generics, What are generics, the general form of generic class, Creating generic methods

Swing : Origins of swing, Swing features, Components and Containers, Exploring Swing- JLabel, JTextField, The swing Buttons, JList, JComboBox

SELF STUDY **5 Hrs**

REFERENCES:

1. Herbert Schildt, ―Java The complete reference‖, 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, ―Core Java Volume –I Fundamentals‖, 9th Edition, Prentice Hall,

   2013.

SUGGESTED BOOKS

1. Paul Deitel, Harvey Deitel, ―Java SE 8 for programmers‖, 3rd Edition, Pearson, 2015.

2. Steven Holzner, ―Java 2 Black book‖, Dreamtech press, 2011.

3. Timothy Budd, ―Understanding Object-oriented programming with Java‖, Updated Edition, Pearson Education, 2000.

Semester	V
Paper Code	BCADA5326
Paper Title	CLOUD COMPUTING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

- To understand the concept of cloud computing.
- To appreciate the evolution of cloud from the existing technologies.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Articulate the main concepts, key technologies, strengths and limitations of cloud computing.

CO2: Learn the key and enabling technologies that help in the development of cloud.

CO3: Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.

CO4: Explain the core issues of cloud computing such as resource management and security and being able to install and use current cloud technologies.

UNIT I: INTRODUCTION **10 Hrs**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning

UNIT II: CLOUD ENABLING TECHNOLOGIES **10 Hrs**

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish-Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices –Virtualization Support and Disaster Recovery.

UNIT III: CLOUD ARCHITECTURE, SERVICES AND STORAGE **10 Hrs**

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

UNIT IV: RESOURCE MANAGEMENT AND SECURITY IN CLOUD **10 Hrs**

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.

SELF STUDY **5 Hrs**

TEXT BOOKS:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.

2. Rittinghouse, John W., and James F. Ransome, “Cloud Computing: Implementation, Management and Security”, CRC Press, 2017.

REFERENCE BOOKS:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, “Mastering Cloud Computing”, Tata Mcgraw Hill, 2013.

2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach”, Tata Mcgraw Hill, 2009.

3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)”, O'Reilly, 2009.

Semester	V
Paper Code	BCADA5426
Paper Title	ARTIFICIAL INTELLIGENCE
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE

The objective of this course is to equip students with practical knowledge and skills to apply modern Artificial Intelligence techniques in data analytics. Students will learn to work with contemporary AI models, deploy them using accessible cloud and API-based services, and integrate multimodal capabilities for processing text, images, and audio. The course emphasises industry-relevant applications, responsible AI practices, and lightweight deployment strategies, enabling students to design and implement AI-driven analytics solutions that are ethical, efficient, and aligned with business needs.

COURSE OUTCOME

CO1: Identify and apply modern AI models to solve data analytics problems.

CO2: Implement and deploy AI models using basic MLOps tools and cloud services.

CO3: Use *multimodal AI tools for processing text, images, and audio in analytics workflows.*

CO4: Recognise ethical issues and *apply* safe AI practices in data analytics projects.

CO5: Evaluate industry use cases and recommend suitable AI solutions for specific analytics needs.

UNIT I: AI Models and Applications in Data Analytics 9 Hrs

Overview of modern AI models – transformer-based models – introduction to generative AI – fine-tuning methods (LoRA, QLoRA) – AI agents for data-driven tasks – AI-powered search and recommendation systems – evaluation basics (accuracy, precision, recall).

UNIT II: Deploying and Managing AI Systems 9 Hrs

Basic MLOps concepts – dataset management and versioning – model training pipelines – model deployment using cloud platforms – optimisation techniques for smaller models – introduction to APIs for AI services (OpenAI, Hugging Face).

UNIT III: Multimodal AI for Data Analytics 9 Hrs

AI for images, text, and audio – document understanding (OCR, form extraction) – simple speech recognition – generating charts and summaries from data – AI-assisted data visualisation.

UNIT IV: Responsible AI and Data Ethics 9 Hrs

Ethics in AI – bias and fairness – privacy and data protection – safe AI usage in analytics – introduction to compliance standards (basic GDPR concepts).

UNIT V: AI at the Edge and Industry Use Cases 9 Hrs

On-device AI for mobile and IoT – lightweight models for analytics – case studies in finance, healthcare, and retail – AI in business decision-making – cost and performance considerations.

Reference Books

1. Russell, S., & Norvig, P. – *Artificial Intelligence: A Modern Approach* (selected chapters), Pearson.

2. Howard, J., & Gugger, S. – *Deep Learning for Coders with fastai and PyTorch*, O'Reilly, 2023.
3. Huyen, C. – *Designing Machine Learning Systems*, O'Reilly, 2022.
4. Aggarwal, C.C. – *Machine Learning for Text*, Springer, 2018.
5. Warden, P., & Situnayake, D. – *TinyML*, O'Reilly, 2020.

Semester	V
Paper Code	BCADA5526
Paper Title	OPTIMISATION TECHNIQUES
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- Formulate and solve linear programming problems (LPP)
- Evaluate Integer Programming Problems, Transportation and Assignment Problems.
- Obtain solution to network problems using CPM and PERT techniques.
- Able to optimize the function subject to the constraints.
- Identify and solve problems under Markovian queuing models.

COURSE OUTCOMES:

On successful completion of this course, the student will able to

CO1: Formulate and solve linear programming problems (LPP)

CO2: Evaluate Integer Programming Problems, Transportation and Assignment Problems.

CO3: Obtain solution to network problems using CPM and PERT techniques.

CO4: Able to optimize the function subject to the constraints.

CO5: Identify and solve problems under Markovian queuing models

UNIT I: LINEAR MODELS **9 Hrs.**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve

LPP- Simplex Method- Big M method, Two-Phase method

UNIT II: INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS 9 Hrs.

Integer programming: Branch and bound method- Transportation and Assignment problems – Travelling salesman problem.

UNIT III: PROJECT SCHEDULING 9 Hrs.

Project network -Diagram representation – Floats - Critical path method (CPM) – PERT- Cost

considerations in PERT and CPM

UNIT IV: CLASSICAL OPTIMISATION THEORY 9 Hrs.

Unconstrained problems – necessary and sufficient conditions - Newton-Raphson method, Constrained

problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.

UNIT V: QUEUING MODELS 9 Hrs.

Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing

system, Service facility, Queue discipline, Single channel models, multiple service channels.

TEXT BOOK:

1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017.

REFERENCE BOOKS:

2. ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4th Edition, 2011.

3. J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5th Edition, 2012.

4. Hiller F.S, Liberman G.J, Introduction to Operations Research, 10th Edition McGraw Hill, 2017.

5. Jit. S. Chandran, Mahendran P. Kawatra, KiHoKim, Essentials of Linear Programming, Vikas

Publishing House Pvt.Ltd. New Delhi, 1994.

6. Ravindran A., Philip D.T., and Solberg J.J., Operations Research, John Wiley, 2nd Edition, 2007.

Semester	V
Paper Code	BCADA5626
Paper Title	AWS
Number of teaching hours per week	2 Hrs
Total number of teaching hours per semester	30 Hrs
Number of credits	2

COURSE OBJECTIVES:

- To describe what a cloud service provider (CSP) is and the value they bring to
- computing.
- To identify basic security and compliance aspects of the AWS platform and the shared
- security model.
- To understand the billing, account management, and pricing models.
- Evaluate basic or core characteristics of deploying and operating in the AWS Cloud
- Analyse and differentiate between on-premises and cloud infrastructure

COURSE OUTCOMES:

On successful completion of this course, the student will able to

CO1: the concepts of AWS Cloud and explains the AWS pricing philosophy

CO2: explain the global infrastructure components of AWS and Describe the security and compliance measures of the AWS Cloud, including AWS Identity and Access Management (IAM)

CO3: Create a virtual private cloud (VPC) by using Amazon Virtual Private Cloud (Amazon VPC) and Demonstrate when to use Amazon Elastic Compute Cloud (Amazon EC2), AWS Lambda, and AWS Elastic Beanstalk

CO4: Explain the architectural principles of the AWS Cloud. Explore key concepts related to Elastic Load Balancing, Amazon CloudWatch, and Amazon EC2 Auto Scaling

UNIT I: Cloud Concepts Overview **7 Hrs**

Introduction to cloud computing, Advantages of the cloud, Introduction to AWS, Moving to the AWS Cloud.

Cloud Economics and Billing Fundamentals of pricing, Total cost of ownership, Activity: Simple Monthly Calculator, Delaware North case study, AWS Organizations, AWS billing and cost management, Billing dashboards, Technical support models, Activity: Support Plan Scavenger Hunt.

UNIT II: AWS Global Infrastructure Overview **5 Hrs**

AWS global infrastructure, Demo: AWS global infrastructure, AWS services and service categories, Activity: AWS Management Console Clickthrough

Cloud Security

AWS shared responsibility model, Activity: AWS Shared Responsibility Model, AWS IAM, Demo: AWS IAM Console, Securing a new AWS account, Lab: Introduction to AWS IAM, Securing accounts, Securing data, Working to ensure compliance.

UNIT III: Networking and Content Delivery **5 Hrs**

Networking basics, Amazon VPC, VPC networking, Activity: Label This diagram, Demo: Amazon VPC Console, VPC security, Activity: Design a VPC, Lab: Build a VPC and Launch a Web Server, Route 53, CloudFront

Compute

Compute services overview, Amazon EC2 part 1, Amazon EC2 part 2,Amazon EC2 part 3, Demo: Amazon EC2, Lab: Introduction to Amazon EC2, Activity: Amazon EC2 Versus Managed Services, Demo: Amazon EC2 Part Console, Amazon EC2 cost optimization, Container services, Introduction to AWS Lambda, Activity: AWS Lambda, Introduction to AWS Elastic Beanstalk, Activity: AWS Elastic Beanstalk

UNIT IV: Storage **5 Hrs**

AWS EBS, Demo: Amazon Elastic Block Store Console, Lab: Working with EBS, AWS S3, Demo: AWS S3 Console, AWS EFS, Demo: AWS EFS Console, AWS S3 Glacier, Demo: AWS S3 Glacier Console, Activity: Storage Technology Selection

Databases: Amazon RDS, Demo: Amazon RDS Console, Lab: Build a Database Server, Amazon DynamoDB, Demo: Amazon DynamoDB, Amazon Redshift, Amazon Aurora, Activity: Database case study.

UNIT V: Cloud Architecture **8 Hrs**

AWS Well-Architected Framework design principles, Activity: AWS Well-Architected Framework Design Principles, Operational excellence, Security, Reliability, Performance

efficiency, Cost optimization, Reliability & high availability, AWS Trusted Advisor, Activity: Interpret AWS Trusted Advisor Recommendations

Automatic Scaling and Monitoring

Elastic Load Balancing, Activity: Elastic Load Balancing, Amazon CloudWatch, Activity: Amazon CloudWatch, Amazon EC2 auto scaling, Lab: Scale & Load Balance your Architecture

REFERENCE BOOKS

1. AWS Certified Cloud Practitioner Study Guide: CLF-C01 Exam, Ben Piper, David Clinton, Sybex Publishers

2. AWS Basics: Beginner's Guides, Gordon Wong, CreateSpace Independent Publishing

3. AWS: The Beginners Guide to Amazon Web Services, Dennis Hutten, CreateSpace Independent Publishing

4. Amazon Web Services for Dummies, Bernard Golden, John Wiley & Sons

5. Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud, Mark Wilkins, Pearson Education

6. AWS Certified Cloud Practitioner (CLF-C01) Cert Guide, Anthony Sequeira, Pearson Education

Semester	V
Paper Code	BCADA5726
Paper Title	RESEARCH METHODOLOGY AND PUBLICATION ETHICS
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	30 Hrs
Number of credits	2

COURSE OBJECTIVE:

To equip students with foundational knowledge of research concepts and methodologies, develop their skills in designing and conducting systematic studies with ethical practices, and prepare them for effective dissemination of findings through peer-reviewed journals and conferences.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Understand and apply the fundamental principles of research design, methodology, and data collection techniques in scientific inquiry.

CO2: Critically evaluate different research methods and select appropriate tools and techniques for conducting ethical and impactful research.

CO3: Demonstrate the ability to identify research problems, formulate hypotheses, and structure a research proposal with clear objectives and methodology.

CO4: Recognize and adhere to ethical standards in academic research and publications, including issues of plagiarism, authorship, and peer review processes.

CO5: Develop effective academic writing and communication skills for the preparation of research papers and publications in peer-reviewed journals.

UNIT I: FOUNDATIONS OF RESEARCH **6 Hrs**

Meaning of Research, Characteristics of Scientific Research - Science and Common Sense, Introduction to Research, Scientific Research, Steps in Scientific Research, Methods of Scientific Research, Criteria of Good Research. Types of Research - Normative Research, Scientific Research, and Value-Free Research. Social Science Research Vs. Scientific Methods - Significance of Research in Social Sciences, Scientific Methods, Defining the Problem of Research, Concepts and Constructs, Meaning and Function of Research Design.

UNIT II: RESEARCH DESIGN **5 Hrs**

Important Concepts Relating to Research Design – Sampling, Sampling and Its Purposes, Steps in Sample Design, Principles of Sampling, Sample Size Determination, Non-Random Sampling, Random Sampling, Complex Random Sampling, Measurement and Scaling Techniques.

UNIT III: HYPOTHESES AND SYNOPSIS WRITING 5 Hrs

Hypotheses, Difference Between a Proposition, a Hypothesis and a Theory - Basic Concepts Concerning Testing of Hypothesis, Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Python and AI tools as a statistical tool.

UNIT IV: RESEARCH ETHICS AND PUBLICATION MISCONDUCT 8 Hrs

Ethics - Moral philosophy, nature of moral judgements and reactions. Scientific Conduct: Ethics with respect to science and research, Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing, selective reporting and misrepresentation of data. Publication ethics - definition, introduction and importance, Best practices / standards setting initiatives and guidelines: COPE, WAME.

Self-Study: Publication misconduct: Concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributorship. Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

UNIT V: OPEN ACCESS AND RESEARCH INTEGRITY TOOLS 6 Hrs

Open access publications and initiatives, SHERPN/RoMEO online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU, Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Publication Misconduct - Subject specific ethical issues, FFP, authorship, Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools - Use of plagiarism software like Turnitin, Urkund and other open-source software tools

REFERENCES:

1. C. R. Kothari, (2004). *Research methodology: Methods and techniques*, (2nd rev. ed.), New Age International, New Delhi, India.
2. Ram Ahuja (2001), Research methods, Rawat Publications, New Delhi, India.

3. Santosh Kumar Yadav (2023), *Research and publication ethics*, Springer Nature, Cham, Switzerland.

LABORATORY

Semester	V
Paper Code	BCADA5P126
Paper Title	MACHINE LEARNING LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

Semester	V
Paper Code	BCADA5P226
Paper Title	JAVA PROGRAMMING LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

UNIT I – Introduction to OOP and Java Fundamentals

1. Simple java programming to demonstrate execution and compilation.
2. Implement a Java program using arithmetic, relational, and logical operators.
3. Write a Java program to perform array operations (insert, delete, search).
4. Searching and sorting techniques implementation
5. 2D array implementations(matrix add,sub,transpose)
6. Java programs to demonstrate control statements (if-else, switch, loops).

UNIT II – Classes, Objects, and Methods

7. Write a Java program to create a class with fields and methods, and access them through objects.
8. Demonstrate method overloading in Java.
9. Implement constructor overloading in Java.
10. Write a program to pass an object as a parameter and return an object.
11. Develop a Java program to demonstrate recursion.
12. Implement a program using nested and inner classes.
13. Write a program to explore String class methods.

UNIT III – Inheritance and Packages

14. Write a Java program to demonstrate single inheritance.
15. Write a program to demonstrate Hierarchical Inheritance
16. Write a Java program to demonstrate Multilevel Inherit
17. Implement multilevel inheritance and use the `super` keyword.
18. Develop a Java program for method overriding.
19. Write a program using abstract classes.
20. Implement a program to demonstrate the use of `final` with inheritance.
21. Creating and importing user-defined packages.

UNIT IV – Interfaces, Exception Handling, and Multithreaded Programming

20. Write a program to define and implement an interface.
21. Implement multiple inheritance using interfaces.
22. Create a program to demonstrate built-in exceptions with try-catch-finally.
23. Write a program to create a user-defined exception.
24. Implement a multithreaded program by extending `Thread` class.
25. Implement a multithreaded program by implementing `Runnable` interface.
26. Develop a program to demonstrate thread priorities and thread control methods.

UNIT V – Input/Output, Generics, and Swing

27. Write a Java program to read and write text files using character streams.
28. Implement a program to copy content from one file to another using byte streams.
29. Create a generic class and generic method in Java.
30. Develop a Swing application with `JLabel` and `JTextField`.
31. Create a Swing application using buttons (`JButton`) and combo boxes (`JComboBox`).
32. Implement a Swing program with a list (`JList`) and event handling.

SEMESTER VI

Semester	VI
Paper Code	BCADA6126
Paper Title	DEEP LEARNING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. To introduce the foundational concepts of deep learning, neural network architectures, and their applications across domains such as data analytics, NLP, computer vision, and speech processing.
2. To develop proficiency in designing, training, and optimizing deep neural networks using modern frameworks such as TensorFlow, Keras, and PyTorch.
3. To enable students to implement and analyze advanced architectures, including CNNs for image processing, RNNs/LSTMs for sequential data, and transformer-based models for attention-driven tasks.
4. To provide hands-on experience in model evaluation, hyperparameter tuning, regularization techniques, and deployment strategies for real-world applications.
5. To cultivate an understanding of the ethical considerations, bias mitigation, and explainability in AI systems, ensuring responsible and transparent deployment.

COURSE OUTCOMES:

CO1: *Explain* the fundamentals of deep learning, *differentiate* between traditional ML and DL approaches, and *illustrate* the structure and working of artificial neural networks using appropriate activation and optimisation techniques.

CO2: *Construct* multilayer perceptron models, *apply* regularisation and normalisation methods, and analyse the impact of hyperparameter tuning on model performance.

CO3: *Design* convolutional neural network architectures, *implement* convolution and pooling operations, and *evaluate* CNN performance for image analytics tasks.

CO4: *Develop* sequential models using RNN, LSTM, and GRU, *apply* attention mechanisms and autoencoders, and *assess* their suitability for time-series and dimensionality reduction tasks.

CO5: *Demonstrate* model evaluation techniques, *utilise open-source deployment tools to operationalise deep learning models, and appraise ethical considerations,* including bias, privacy, and explainability in AI.

Unit 1: Introduction to Deep Learning & Neural Networks **9 Hours**

Deep learning overview, evolution from ML, applications – data analytics, NLP, CV, speech. ANN basics – biological vs artificial neurons, perceptron, activation functions (Sigmoid, Tanh, ReLU, Leaky ReLU, Softmax). Learning process – forward propagation, loss functions (MSE, Cross-Entropy), optimization (Gradient Descent, SGD, Mini-batch GD, Adam). Python libraries – NumPy, Pandas, TensorFlow, Keras, PyTorch,OpenCV.

Unit 2: Deep Neural Networks & Regularization **9 Hours**

MLP architecture – hidden layers, weights, biases, backpropagation. Performance improvement – feature scaling, normalization, weight initialization, batch normalization. Regularization – L1, L2, dropout, early stopping. Hyperparameter tuning – learning rate, batch size, epochs, grid search, random search, Bayesian optimization.

Unit 3: Convolutional Neural Networks (CNNs) **9 Hours**

Image data representation, convolution operation, kernels, padding, stride, feature maps. CNN layers – convolutional, pooling (max, average), fully connected. Architectures – LeNet, AlexNet, VGG, ResNet. Applications – image classification, object detection, structured data pattern recognition.

Unit 4: Sequential Models & Advanced Architectures **9 Hours**

RNN architecture, applications, vanishing/exploding gradients. LSTM – gates, memory cell; GRU. Applications – time-series forecasting. Attention mechanism basics, transformer overview. Autoencoders – architecture, feature extraction, dimensionality reduction.

Unit 5: Model Deployment & Ethics **9 Hours**

Evaluation – confusion matrix, precision, recall, F1-score, ROC, AUC, log loss. Deployment – save/load models, Flask, FastAPI. Open-source tools – MLflow, Streamlit, ONNX, TensorBoard, Docker. Case studies – marketing, healthcare, sentiment analysis. Ethics – bias, privacy, Explainable AI (XAI).

Reference Books

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville – *Deep Learning* (MIT Press) *Comprehensive coverage of deep learning theory, architectures, and applications.*
2. François Chollet – *Deep Learning with Python* (Manning) *Hands-on guide to deep learning using Keras and TensorFlow with practical examples.*
3. Aurélien Géron – *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* (O'Reilly) *Balanced mix of ML and DL concepts with real-world projects.*
4. Michael Nielsen – *Neural Networks and Deep Learning* (Online/Open Access) *Beginner-friendly introduction with intuitive explanations and mathematical foundations.*
5. Rajalingappaa Shanmugamani – *Deep Learning for Computer Vision* (Packt) *Focuses on CNNs, image processing, and practical analytics-related computer vision tasks.*

Semester	VI
Paper Code	BCADA 6226
Paper Title	ENABLING TECHNOLOGIES FOR DATA SCIENCE
Number of teaching hours per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

This course explains the key issues in big data management and trains the students to have skills that will help them to solve complex real-world problems for prediction and decision making using different tools. We give them some idea about the cloud environment.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Identify the key characteristics of Big Data and components of Hadoop architecture including its ecosystem and commands.

CO2: Develop simple MapReduce programs and *demonstrate* their execution in local and pseudo-distributed modes.

CO3: Analyze data using Hive queries by creating, loading, and querying structured datasets.

CO4: Illustrate how data is imported/exported between RDBMS and Hadoop using Sqoop.

CO5: Design Pig Latin scripts for data transformation and computation tasks using real-world datasets.

UNIT I: BIG DATA AND HADOOP **12 Hrs**

Introduction to Big Data: Definition, Characteristics (5Vs), Introduction to Hadoop: Features, Need, Ecosystem Overview, Hadoop Architecture: HDFS and MapReduce overview, NameNode, DataNode, JobTracker, TaskTracker, Hadoop Versioning: Hadoop 1.x, 2.x (YARN), and 3.x features, Hadoop Configuration, Single-node and Multi-node Hadoop setup: Concepts and basic steps, Hadoop Daemons: Role of NameNode, DataNode, ResourceManager, NodeManager, Hadoop Commands: HDFS shell commands (put, get, ls, mkdir, etc.), Models in Hadoop: Programming model, Storage model, Execution model, Task Instance: Concept of Job, Task, Task Instance, Illustrations: Simple HDFS operations, uploading and retrieving files using HDFS shell commands.

UNIT II: MAP-REDUCE **12 Hrs**

MapReduce Framework: Key Concepts – Mapper, Reducer, Combiner, Developing MapReduce Program: Writing a simple Java-based program, Life Cycle Methods: Setup, Map, Reduce, Cleanup, Serialization: Writable and WritableComparable interfaces, InputFormat and OutputFormat classes, Running MapReduce in Local Mode and Pseudo-distributed Mode, Debugging and Logs, Illustrations: Word Count example, Max temperature example.

UNIT III: HIVE **6 Hrs**

Introduction to Hive: Architecture, Features, and Use Cases, Hive Data Types: Primitive and Complex types, Hive Commands: DDL- CREATE, DROP, DESCRIBE, ALTER, DML - LOAD DATA, INSERT, SELECT, Table Creation, Loading Data into Tables, Illustrations: Creating a table in Hive, querying student data.

UNIT IV: SQOOP **5 Hrs**

Introduction to Sqoop: Purpose and Architecture, Importing Data from RDBMS to Hadoop, Exporting Data from Hadoop to RDBMS, Sqoop Jobs: Syntax and Execution, Illustrations: Importing employee data from MySQL into HDFS and exporting back.

UNIT V: PIG **5 Hrs**

Introduction to Pig: Features and Pig Latin Language, Pig Schema: Declaring and using schemas, Common Pig Commands: LOAD, DUMP, FILTER, FOREACH, GROUP, JOIN, STORE. Execution modes: Local and MapReduce.Illustrations: Filtering records from a CSV file, computing average salary.

SELF STUDY **5 Hrs**

REFERENCES:

1. Hadoop in Action: Chuck Lam, 2010, ISBN: 9781935182191

2. Data-intensive Text Processing with Map Reduce: Jimmy Lin and Chris Dyer, Morgan& Claypool Publishers, 2010

Semester	VI
Paper Code	BCADA6326
Paper Title	NATURAL LANGUAGE PROCESSING
Number of teaching hours per week	3 Hrs
Total number of teaching hours per semester	45
Number of credits	3

COURSE OBJECTIVE:

This course provides a comprehensive introduction to the field of Natural Language Processing (NLP), equipping learners with both the theoretical foundations and practical skills required to process and analyze human language using computational methods. Students will begin by understanding the core concepts, applications followed by essential text processing techniques such as tokenization, stemming, lemmatization, and part-of-speech tagging. The course then progresses to different text representation models ranging from traditional Bag-of-Words and TF–IDF to modern embedding techniques. The course also covers ethical considerations and biases in language models.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Describe NLP concepts, applications, and challenges.
CO2: Perform text preprocessing techniques.
CO3: Construct text representations using BoW, TF–IDF, embeddings and develop NLP models for common tasks.
CO4: Implement neural and transformer-based models.
CO5: Integrate NLP techniques into projects and analyze ethical issues in NLP.

UNIT I: INTRODUCTION TO NLP **5 Hrs**

Introduction, Applications & Challenges, History & Evolution of NLP, Text preprocessing basics, Overview of NLP tasks (classification, translation, summarization).

UNIT II: TEXT PROCESSING FUNDAMENTALS **10 Hrs**

Tokenization, Stopword removal, stemming, lemmatization, Part-of-Speech (POS) tagging, Named Entity Recognition (NER) basics.

UNIT III: TEXT REPRESENTATION **10 Hrs**

Bag of Words (BoW) model, TF–IDF representation, Word embeddings (Word2Vec, GloVe, FastText), Contextual embeddings (ELMo, BERT basics).

UNIT IV: LANGUAGE MODELING **10 Hrs**

N-gram models and smoothing techniques, Neural language models, Introduction to Transformers

UNIT V: NLP APPLICATIONS **10 Hrs**

Sentiment analysis, Text classification, Question answering, Machine translation basics, Text summarization, Ethics & Challenges in NLP - Bias in language models, Data privacy issues.

REFERENCES:

1. Christopher Manning & Hinrich Schütze, **Foundations of Statistical Natural Language Processing**, MIT Press *(Great for statistical methods and early NLP)*
2. Daniel Jurafsky & James H. Martin, **Speech and Language Processing** *(Gold standard, covers fundamentals to deep learning in NLP)*
3. Steven Bird, Ewan Klein, and Edward Loper Steven Bird, **Natural Language Processing with Python** *(Practical, uses NLTK)*
4. Palash Goyal, Sumit Pandey, Karan Jain, **Deep Learning for Natural Language Processing** *(Focus on deep learning methods)*
5. Denis Rothman**, Transformers for Natural Language Processing** *(Hands-on guide to modern transformer architectures)*

Semester	VI
Paper Code	BCADA6426
Paper Title	DIGITAL INFORMATION PROCESSING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. Introduce the fundamental concepts of digital signal processing (DSP) and digital image processing (DIP).
2. Develop analytical skills to model, analyze, and design DSP systems using transform methods and filter design techniques.
3. Provide knowledge of image acquisition, enhancement, restoration, and transformation methods.
4. Integrate DSP and DIP concepts for solving real-time engineering problems.
5. Equip students with the ability to implement DSP and DIP algorithms on hardware and software platforms.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Classify different types of signals and systems and apply sampling and transformation techniques for signal analysis.

CO2: Design and analyse FIR and IIR digital filters using time-domain and frequency-domain approaches.

CO3: Explain image acquisition, sampling, quantization, and perform basic image operations.

CO4: Apply spatial and frequency domain techniques for image enhancement and restoration.

CO5: Integrate DSP and DIP methods to develop solutions for multimedia and communication applications.

UNIT I: Fundamentals of digital signal processing **9 Hours**

Classification of signals and systems: continuous/discrete, energy/power, stability, causality, Sampling theorem, aliasing, Nyquist rate, quantization and coding.

UNIT II: Discrete Transforms & Filter Design **9 Hours**

Discrete Fourier Transform (DFT): properties, IDFT, Fast Fourier Transform (FFT): radix-2 DIT and DIF.

UNIT III: Fundamentals of Digital Image Processing **9 Hours**

Image acquisition, sampling, and quantization, Image representation, visual perception, resolution and aspect ratio, Basic image operations: negative, log, power-law transformations, Histogram processing

UNIT IV: Image Enhancement & Restoration **9 Hours**

Spatial filtering: smoothing and sharpening filters, Frequency domain filtering: low-pass, high-pass, band-pass filters and Denoising

UNIT V: Applications & Integration of DSP and DIP **9 Hours**

DSP for multimedia applications, Speech and audio signal processing basics, Image compression (JPEG, PNG), watermarking basics, Real-time implementation using DSP processors

Suggested Reference Books

1. John G. Proakis & Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algorithms & Applications*, Pearson.
2. A. V. Oppenheim, R. W. Schafer & J. R. Buck, *Discrete-Time Signal Processing*, Pearson.
3. Rafael C. Gonzalez & Richard E. Woods, *Digital Image Processing*, 4th Ed., Pearson.
   A. K. Jain, *Fundamentals of Digital Image Processing*, PHI.

Semester	VI
Paper Code	BCADA6526
Paper Title	DESIGN THINKING

Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	30 Hrs
Number of credits	2

COURSE OBJECTIVES:

This course explores the theoretical underpinnings of Design Thinking as a human-centered innovation methodology. Students will examine its origins, principles, models, application domains, and criticisms through a structured 5-chapter format. The course aims to develop a deep conceptual foundation for understanding and applying Design Thinking in various fields.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1: Understand the theoretical foundations of design thinking.

CO2: Analyze and compare different models and frameworks.

CO3: Explore the role of empathy, creativity, and iteration in problem-solving.

CO4: Evaluate real-world applications and case studies.

CO5: Reflection on the limitations and critiques of design thinking as a methodology.

UNIT I: Introduction to Design Thinking 3Hrs

Origins, evolution, key principles; interdisciplinary roots; design vs. design thinking; innovation mindset; key figures (e.g., Tim Brown, David Kelley, Richard Buchanan)

UNIT II: Models & Frameworks of Design Thinking 3Hrs

Stanford d.school 5-step model, IDEO model, Double Diamond (British Design Council), Human-Centered Design (HCD), comparison of frameworks

UNIT III: Core Elements of Design Thinking 3Hrs

Empathy and user-centered research; defining problem spaces; ideation techniques; prototyping and iteration; testing and feedback loops

UNIT IV: Applications & Case Studies 3Hrs

Design Thinking in business (Airbnb, IBM), healthcare (GE MRI), education (K–12 innovation), public services; theoretical analysis of outcomes

UNIT V: Critiques, Limitations & Future Directions 3Hrs

Common critiques (superficial use, western bias, commodification); ethical concerns; challenges in scale and implementation; evolving trends and integration with systems thinking and sustainability.

References

1. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation by Tim Brown[2009]
2. Creative Confidence by Tom Kelley & David Kelley[2013]
3. The Design of Everyday Things by Don Norman[2013]

LABORATORY

Semester	VI
Paper Code	BCADA6P126
Paper Title	DEEP LEARNING LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

Semester	VI
Paper Code	BCADA6P226
Paper Title	ENABLING TECHNOLOGIES FOR DATA SCIENCE LAB
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1

Semester	VI
Paper Code	BCADA6P326
Paper Title	PROJECT
Number of teaching hrs per week	2 Hrs
Total number of teaching hrs per semester	20
Number of credits	1