Annexure-IV

BCA in Machine Learning & Data Science

Jointly by

Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

&

National Institute of Electronics and Information Technology, Gorakhpur

(An Autonomous Scientific Society of Ministry of Electronics and Information Technology, Government of India)

BCA in Machine Learning & Data Science

Year	Semester	Subject Code	Subject	L	P	C
First Year	1st Semester	BDS101	Introduction to Mathematics & Operational Research	4	0	4
		BDS102	IT Tools & Fundamentals of Computer Architecture	4	0	4
		BDS103	C Programming	4	0	4
		BDS104	Data Structures & Algorithm	4	0	4
		BDS105L	C Programming Lab	0	8	4
	2nd Semester	BDS201	Statistical methods for Data Science	4	0	4
		BDS202	Python Programming	4	0	4
		BDS203	Data Science & Visualization	4	0	4
		BDS204	Introduction to Machine Learning	4	0	4
		BDS205L	Machine Learning with Python Lab	0	8	4
Second Year	3rd Semester	BDS301	Cyber Security & Computer Networks	4	0	4
		BDS302	Data Mining & Warehousing	4	0	4
		BDS303	Deep Learning & Neural Networks	4	0	4
		BDS304	Statistical Data Modelling using R Programming	4	0	4
		BDS305L	R Programming Lab	0	8	4
	4th Semester	BDS401	Database Management System	4	0	4
		BDS402	Cloud Computing	4	0	4
		BDS403	Speech & Video Processing	4	0	4
		BDS404N	Effective Communication Skills	4	0	4
		BDS405L	Database Management System Lab	0	8	4
Third Year	5th Semester	BDS501	DevOps	4	0	4
		BDS502	Big Data Analytics	4	0	4
		BDS503	Natural Language Processing	4	0	4
		BDS504	Prompt Engineering	4	0	4
		BDS505P	Project-I	0	8	4

	6th Semester	BDS601	Ethics and Privacy in Data Science	4	0	4
		BDS602N	Employability & Practitioner Skills	4	0	4
		BDS603P	Project-II	0	24	12

Note: L: Lecture**, P:** Practical**, C:** Credit

Note: Student may carry project of 5th Semester to 6th Semester also. Project must be meaningfully concluded.

First Semester

Subject Code	BDS101
Course Name	Introduction to Mathematics & Operational Research
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Develop a solid understanding of foundational mathematical concepts. 2. Understand the principles of Set theory, Determinants, algebraic structure etc.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Set theory: Definition of sets, representation of sets, universal set, empty set, singleton set, finite and infinite set, equal set, subsets, proper subset, superset, power set, improper set, comparability of sets, union and intersection of sets, complement of sets, De- Morgan's law, disjoint sets, difference and symmetric difference, Venn diagram and its applications. Relations, equivalence relation, functions or mapping, domain, co-domain and range of a function, Introduction to Indices and Logarithms, principle of mathematical induction.	**10**
Unit 2: Determinants and its properties, matrix theory, types of matrices: Horizontal matrix, vertical matrix, square matrix, row matrix, column matrix, null matrix, identity matrix, diagonal matrix, scalar matrix, triangular matrix, Operation on matrices: Matrix addition, subtraction, product of matrices, difference of two matrices, transpose of a matrix, inverse of a matrix by adjoint method	**12**
Unit 3: Algebraic Structures, Groups, Rings, Fields, Partial Orders, Posets, Homomorphisms, Isomorphisms, Substructures, Quotient Structures, Fundamental Theorem of Homomorphisms, Fundamental Theorem of Isomorphisms, Direct Products, Cosets and Lagrange's Theorem, Normal Subgroups, Factor Groups, Field Extensions, Algebraic Closure, Galois Theory.	**10**
Unit 4: Sequences and series, Limits and continuity, Linear algebra basics, Vector spaces, Eigen values and Eigen vectors, Combinatorics, System of linear equations, Solving by substitution, solving by elimination, solving with matrices, Gaussian elimination, Cramer's rule, homogeneous systems, non-homogeneous systems, consistency assessment, linear independence	**15**
Unit 5: Rectangular coordinate axes, Cartesian coordinates of point, quadrants, Linear Programming Problem (LPP), Mathematical Model of Linear Programming, Problem in two variables, Objective function, Constraint, Non-negative Restrictions, Feasible solution and Optimal solution, Graphical method for Linear Programming, Problem in two variables. Limit, continuity and differentiability of a single variable, Differential coefficients of x^n , sin x, cos x, e^x , $\log_e x$, constant, Differential coefficients of sum, product and quotient of two functions, Differential coefficient of a function of a function, Problems related to business, Economics and Social Sciences.	**13**

COURSE OUTCOME
1. Understand the fundamental mathematical concepts. 2. Apply linear algebra basics to solve problems related to data manipulation and analysis. 3. Understand the principles of Set theory, Determinants, algebraic structure etc.

Recommended Readings

1. "Discrete Mathematics and Its Applications" by Kenneth H. Rosen
2. "Concrete Mathematics: A Foundation for Computer Science" by Ronald L. Graham, Donald E. Knuth, and Oren Patashnik
3. "Discrete Mathematics with Applications" by Susanna S. Epp
4. "Elements of Discrete Mathematics" by C.L. Liu
5. "A Walk Through Combinatorics: An Introduction to Enumeration and Graph Theory" by Miklós Bóna
6. "Combinatorial Problems and Exercises" by László Lovász, József Pelikán, and Katalin L. Vesztergombi
7. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley.
8. Mathematics ,R.D.Sharma, Dhanpat Rai Publications.
9. Mathematics, Sudhir Kumar Pundir,Shri Balaji Publication.
10. Taha, Hamdy H, Opearations Research- An Introduction, Pearson Education.

Subject Code	BDS102
Course Name	IT Tools & Fundamentals of Computer Architecture
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Develop understanding of the basic framework of computer & its architecture and process, and various techniques. 2. Understand the fundamentals of Computer Applications. 3. Develop an understanding of the techniques of different tools & software.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Computer & Latest IT gadgets, Characteristics of Computers, Input, Output, Computer Memory & storage, Application Software, Systems Software, Utility Software, Open source and Proprietary Software, Mobile Apps. Number system, Conversion of number system; Binary Coded Decimal (BCD) Code, ASCII Code. Introduction to Operating System, Operating Systems for Desktop, Laptop, Mobile Phone and Tablets, User Interface for Desktop and Laptop, Operating System setting, add or remove Program, adding/ removing & sharing Peripherals, File and Folder management, types of file extensions.	**10**
Unit 2: Word Processing: Basics, different parts of application window, Document handling, Save & Save As, Help, Page Setup & Layout, Borders, Watermark, Print, Document Creation, Editing & formatting Text, Undo & Redo, AutoCorrect, Spelling & Grammar, Find and Replace, Header & Footer, Table Creation/ Draw & Manipulation, Border and Shading, Mail Merge, Table of Contents, Indexes, Adding Comments, Tracking changes, Macros. **Spread Sheet:** Creation, Cell Address [Row and Column] & selecting a Cell, Entering Data [text, number, date] in Cells, Page Setup, Printing of Sheet, Manipulation of Cells & Sheet, Modifying / Editing Cell Content , Formatting Cell, Paste & Paste Special, Cell Height and Width, Inserting and Deleting Rows, Column, AutoFill, Sorting & Filtering, Freezing panes, Formulas, Functions and Charts, Using Formulas for Numbers, AutoSum, Functions (Sum, Count, MAX, MIN, AVERAGE, PMT etc.), Sort, Filter, Advanced Filter, Database Functions, What-if Analysis, Pivot table, Data Validation. **Presentation:** Creation of Presentation, Inserting & Editing Text on Slides, Manipulating Slides, Text Formatting, Inserting Table, Adding Pictures, Inserting Other Objects, Resizing and Scaling an Object, Creating & using Master Slide, Set Up for Presentation, Slide Show, Transition and Slide Timings, Automating a Slide Show, Providing Aesthetics to Slides, Presentation, Adding Movie and Sound, Headers, Footers and Notes, Printing Slides and Handouts.	**10**
Unit 3: Introduction to Computer Architecture, Von Neumann Architecture, CPU Structure and Function, Memory Hierarchy, Input and Output Systems, Instruction Set Architecture, Bus Structures, Parallel Processing Concepts, Performance Metrics in Computer Architecture. Binary number system, Boolean algebra basics, Logic gates and	**12**

truth tables, Logic expressions and simplification.	
Unit 4: Advanced Concepts in Computer Architecture Pipeline Processing, Instruction Level Parallelism, Superscalar and VLIW Architectures, Memory Management Techniques, Cache Memory Organization, Virtual Memory Systems, Input/output Processing, Interrupts and Exception Handling, Multiprocessing Systems.	**15**
Unit 5: Future Trends and Challenges Emerging Trends in Computer Architecture, Quantum Computing, Neuromorphic Computing, Energy-Efficient Architectures, IoT and Embedded Systems, Security Considerations in Computer Architecture, Challenges in Parallel Computing, Research Opportunities in Computer Architecture.	**13**

COURSE OUTCOME

1. Identify computers, IT gadgets and explain their evolution and applications & get familiar with various input, output and hardware components of a computer along with storage devices.
2. Get familiar with various types of software, utilities used for computer and mobile apps.
3. Word Processing, their usage, details of word processing screen.
4. Basic Knowledge of Spreadsheet Processing, their usage.

Recommended Readings

1. LibreOffce, Getting Started Guide by LibreOffce Documentation Team
2. OpenOffice.org for DUMMIES by GurdyLeete, Ellen Finkelstein and Mary Leete
3. "Computer Organization and Design: The Hardware/Software Interface" by David A. Patterson and John L. Hennessy
4. "Structured Computer Organization" by Andrew S. Tanenbaum

Subject Code	BDS103
Course Name	C Programming
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Gain proficiency in fundamental C programming concepts, including variables, data types, control flow, and functions. 2. Develop problem-solving skills through hands-on exercises and programming assignments. 3. Understand memory management, dynamic memory allocation, pointers, and file handling in C programming.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Basics of C Programming: Introduction to C programming, Variables and Data Types, Input and Output Operations, Operators and Expressions, Control Flow Statements, Functions and Modular Programming, Arrays and their Initialization, Decision Making in C, Looping Constructs in C, Scope and Lifetime of Variables	**12**
Unit 2: Arrays and Strings: Introduction to Arrays, One-dimensional Arrays, Multi-dimensional Arrays, Array Operations, String Manipulation, String Input and Output, Searching and Sorting Techniques for Arrays, String Handling Functions, Array of Pointers, Character Arrays and Pointers	**12**
Unit 3: Pointers and Memory Management Introduction to Pointers, Pointer Arithmetic, Pointers and Arrays, Dynamic Memory Allocation, Memory Management in C, Pointers and Functions, Passing Pointers to Functions, Pointer to Pointers, Pointer Arithmetic and Array, Null Pointers	**12**
Unit 4: Structures and File Handling Introduction to Structures, Structure Declaration and Initialization, Structure Operations, Accessing Structure Members, Array of Structures, Nested Structures, Introduction to File Handling, File Operations, Sequential File Processing, Random Access File Processing	**12**
Unit 5: Advanced Topics Preprocessor Directives, Recursion, Command Line Arguments, Error Handling and Debugging, Bitwise Operations, Introduction to Data Structures, Linked Lists, Stacks and Queues, Trees, Graphs	**12**

COURSE OUTCOME
1. Mastery of fundamental programming in the C language. 2. Proficiency in problem-solving and algorithmic thinking through practical programming exercises. 3. Ability to design, implement, test, and debug C programs for various applications.

Recommended Readings

1. "C Programming Absolute Beginner's Guide" by Greg Perry and Dean Miller
2. "The C Programming Language" by Brian W. Kernighan and Dennis M. Ritchie
3. "Programming in C" by Stephen G. Kochan
4. "C Programming: A Modern Approach" by K. N. King
5. "Head First C: A Brain-Friendly Guide" by David Griffiths and Dawn Griffiths

Subject Code	BDS104
Course Name	Data Structures & Algorithm
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand fundamental data structures such as arrays, linked lists, stacks, queues, and trees. 2. Learn essential algorithms for searching, sorting, and traversing data structures efficiently. 3. Analyze the time and space complexity of algorithms to assess their efficiency.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: What are Data Structures?, Importance of Data Structures in Programming, Basic Operations on Data Structures (Insertion, Deletion, Searching), Time Complexity Analysis, Space Complexity Analysis, Introduction to Algorithm Analysis, Overview of Abstract Data Types (ADTs), Arrays and Their Applications.	**14**
Unit 2: Linked Lists, Stacks, Queues, Implementation of Linear Data Structures, Applications of Linear Data Structures, Analysis of Linear Data Structures, Problems and Exercises	**10**
Unit 3: Trees, Binary Trees, Binary Search Trees (BST), AVL Trees, B-trees, Heaps, Priority Queues, Implementation and Applications of Non-linear Data Structures	**10**
Unit 4: Graphs, Directed and Undirected Graphs, Graph Representation (Adjacency Matrix, Adjacency List), Graph Traversal Algorithms (BFS, DFS), Spanning Trees, Shortest Path Algorithms, Minimum Spanning Tree Algorithms, Disjoint Set (Union-Find)	**14**
Unit 5: Greedy Algorithms, Divide and Conquer, Dynamic Programming, Backtracking, String Algorithms, Advanced Sorting Algorithms, NP-Completeness and Approximation Algorithms, Parallel and Distributed Algorithms	**12**

COURSE OUTCOME
1. Proficiency in implementing and analyzing fundamental data structures. 2. Mastery of common algorithms for searching, sorting, and traversal. 3. Ability to assess the time and space complexity of algorithms.

Recommended Readings

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. "Data Structures and Algorithm Analysis in C++" by Mark Allen Weiss
3. "Algorithms" by Robert Sedgewick and Kevin Wayne
4. "Cracking the Coding Interview: 189 Programming Questions and Solutions" by Gayle Laakmann McDowell
5. "The Algorithm Design Manual" by Steven S. Skiena

Subject Code	BDS105L
Course Name	C Programming Lab
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Reinforce the fundamental concepts of C programming language 2. Develop problem-solving skills by solving programming challenges and exercises that require applying various programming constructs and algorithms using C. 3. Enhance students' programming proficiency by providing them with opportunities to write, compile, debug, and execute C programs.

LAB EXPERIMENTS
Lab 1: Basic Syntax and Output
Lab 2: Variables and Data Types
Lab 3: Conditional Statements and Loops
Lab 4: Arrays and Strings Manipulation
Lab 5: Functions and Modular Programming
Lab 6: Pointers and Dynamic Memory Allocation
Lab 7: File Input/Output Operations
Lab 8: Structures and Unions Implementation
Lab 9: Advanced Data Structures (Linked Lists, Stacks, Queues)
Lab 10: Sorting and Searching Algorithms

Note*: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

COURSE OUTCOME
1. Students will demonstrate proficiency in understanding and applying basic programming constructs. 2. Students will develop problem-solving skills by effectively analyzing problems, designing algorithms, and implementing solutions using C programming techniques. 3. Students will gain a solid understanding of fundamental data structures and algorithms.

Recommended Readings

1. "The C Programming Language" by Brian Kernighan and Dennis Ritchie.
2. "C Programming Absolute Beginner's Guide" by Greg Perry and Dean Miller.
3. "Head First C" by David Griffiths and Dawn Griffiths.
4. "C Primer Plus" by Stephen Prata.
5. "C Programming: A Modern Approach" by K.N. King.

Second Semester

Subject Code	BDS201
Course Name	Statistical methods for Data Science
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the basic principles and concepts of data science. 2. Gain proficiency to effectively understand algorithms used for Statistics and Data Science.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Progression, Arithmetic Progression, Geometric Progression, Harmonic Progression, Arithmetic mean, Geometric mean, Harmonic mean. Introduction to statistics, collection, and tabulation of data, different types of charts and graphs, Matrix decomposition, LU decomposition, QR decomposition, SVD, EVD, Cholesky decomposition, Schur decomposition, Polar decomposition, Jordan decomposition, NMF, Matrix completion.	**10**
Unit 2: Differential Calculus: Limits, Derivatives of functions, Differentiation rules, Chain rule, Implicit differentiation, Related rates, Optimization, Curve sketching, L'Hôpital's rule, Taylor series. Integral Calculus: Antiderivatives, Definite integrals, Integration techniques (substitution, integration by parts, trigonometric substitution), Improper integrals, Area under curves, Volume of revolution, Arc length, Surface area, Applications of integrals.	**10**
Unit 3: Descriptive Statistics: Measures of central tendency, Measures of dispersion, Frequency distributions, Histograms, Box plots, Scatter plots, Quartiles and percentiles, Skewness and kurtosis, Correlation coefficient, Covariance. Probability Theory, Probability rules, Conditional probability, Bayes' theorem, Random variables, Probability distributions (Binomial, Poisson, Normal), Joint probability distributions, Expected value, Variance, Covariance matrix, Independence and dependence	**12**
Unit 4: Inferential Statistics: Sampling distributions, Estimation, Point estimation, Interval estimation, Maximum likelihood estimation, Method of moments, Bayesian estimation, Confidence intervals, Prediction intervals, Estimating population parameters, Estimating sample statistics, Regression estimation, Confidence intervals, Hypothesis testing (Z-test, t-test), A/B testing, Chi-square test, ANOVA, Non-parametric tests, Type I & Type II error, Power and sample size calculations, Regression analysis, Correlation, Pearson correlation coefficient, Spearman's rank correlation coefficient, Kendall's tau coefficient, Correlation vs. causation, Scatter plots, Correlation matrix, Partial correlation, Cross-correlation, Multivariate Statistics: Multivariate analysis technique (MANOVA), Multivariate Regression, Principal Component analysis (PCA).	**15**
Unit 5: Optimization Techniques: Convex optimization, Nonlinear optimization, constrained optimization, Gradient descent, Stochastic gradient descent, Regularization techniques (L1 regularization, L2 regularization), Hyperparameter tuning, Grid search, Cross-validation, Model evaluation metrics (accuracy, precision, recall, F1-score),	**13**

Receiver Operating Characteristic (ROC) curve, Area Under the Curve (AUC). Simple Optimization with One Variable, Optimization with Constant, Optimization with Multiple Variables.	

COURSE OUTCOME
1. Understand the basic principles and concepts of data science. 2. Understand the concepts of Statistics and Calculus.

Recommended Readings

1. "Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
2. "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett
3. "Data Science from Scratch: First Principles with Python" by Joel GrusTop of Form

Subject Code	BDS202
Course Name	Python Programming
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Master fundamental Python syntax and data structures. 2. Learn to write clean, readable, and efficient Python code. 3. Understand object-oriented programming (OOP) principles in Python

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Python: Python Basics, Variables and Data Types, Basic Input and Output, Operators and Expressions, Control Flow: if, elif, else, Loops: for and while, Lists and Tuples, Dictionaries and Sets, Functions: Syntax and Arguments, Built-in Functions and Libraries.	**12**
Unit 2: Advanced Python Concepts: File Handling: Reading and Writing Files, Exception Handling: try, except, finally, Comprehensions: List, Dictionary, and Set Comprehensions, Iterators and Generators, Decorators: Function Decorators, Class Decorators, Object-Oriented Programming (OOP): Classes and Objects, Inheritance and Polymorphism, Encapsulation and Abstraction, Magic Methods.	**12**
Unit 3: Working with Data in Python: Working with CSV and JSON Data, Working with Excel Spreadsheets, Data Visualization with Matplotlib, Data Analysis with Pandas: Series and DataFrames, Data Cleaning and Preprocessing, Grouping and Aggregation, Merging and Joining Data, Time Series Analysis, Introduction to NumPy.	**12**
Unit 4: Python Standard Library and Modules: Overview of Python Standard Library, Commonly used modules (os, sys, datetime, math, random), Working with data (csv, json, sqlite3), Web scraping (requests, BeautifulSoup, scrapy), GUI programming (tkinter, PyQT, Kivy), Data compression and archiving (zipfile, tarfile), Working with images and audio (Pillow, pygame), Interacting with the operating system (subprocess, shutil), Email handling (smtplib, imaplib), Logging and debugging utilities (logging, pdb), Working with dates and times (datetime, time), Internationalization and localization (gettext, locale)	**12**
Unit 5: Advanced Python Applications: Introduction to GUI Programming with Tkinter, Introduction to Machine Learning with Python, Building and Training Machine Learning Models, Natural Language Processing (NLP) with Python, Introduction to Web Scraping with BeautifulSoup, Working with APIs: Consuming and Building APIs, Introduction to Django: Building Web Applications with Django, Introduction to Automation and Scripting.	**12**

COURSE OUTCOME
1. Master foundational Python syntax and data structures. 2. Write clean, efficient, and readable Python code. 3. Understand and apply object-oriented programming (OOP) principles.

Recommended Readings

1. "Effective Python: 90 Specific Ways to Write Better Python" by Brett Slatkin
2. "Fluent Python: Clear, Concise, and Effective Programming" by Luciano Ramalho
3. "Python Cookbook" by David Beazley and Brian K. Jones
4. "Learning Python" by Mark Lutz
5. "Python for Data Analysis" by Wes McKinney

Subject Code	BDS203
Course Name	Data Science & Visualization
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the basic principles and concepts of data science & AI. 2. Gain proficiency in using advanced visualization tools. 3. Learn to create interactive and dynamic visualizations.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Data Science and AI: Overview of Data Science and AI, Data Types and Data Sources, Introduction to Machine Learning, Data Preprocessing Techniques, Exploratory Data Analysis (EDA), Introduction to Python for Data Science, Tools and Libraries for Data Science, Case Studies in Data Science and AI, Ethics and Bias in Data Science, Applications of Data Science and AI.	**10**
Unit 2: Data Analysis Techniques: Statistical Analysis for Data Science, Data Visualization Techniques, Introduction to Regression Analysis, Introduction to Classification, Introduction to Clustering, Dimensionality Reduction Techniques, Time Series Analysis, Text Analytics Basics, Web Scraping for Data Collection, Handling Imbalanced Data	**10**
Unit 3: Introduction to Data Visualization, Principles of Effective Visualization, Data Types and Representation, Visualization Tools, Exploratory Data Analysis (EDA), Data Cleaning and Preparation, Static vs. Interactive Visualizations. Interactive Visualization with D3.js, Geospatial Data Visualization, Network Visualization, Hierarchical and Tree Visualization, Time-Series Visualization, 3D and Virtual Reality Visualization, Customizing Visualizations with CSS and JavaScript, Advanced Chart Types and Graphs, Animation and Transition Effects, Dashboard Design Principles	**15**
Unit 4: Data Storytelling Fundamentals, Crafting Compelling Data Narratives, Storyboarding Techniques, Visual Storytelling with Infographics, Storytelling with Data Presentation Tools, Interactive Narrative Visualization, Data-Driven Journalism, Ethics & Bias in Data Storytelling, Audience Engagement Strategies. Introduction to PowerBI, Data Connections and Transformation, Data Modeling and DAX, Creating Interactive Visualizations, Advanced Analytics with PowerBI, Sharing and Collaboration in PowerBI, Power Query M Language, PowerBI Service Administration, Custom Visualizations Development, PowerBI Mobile App Integration.	**15**
Unit 5: Practical Applications: Predictive Analytics, Image Recognition Basics, Speech Recognition Basics, Natural Language Understanding Basics, Recommendation Systems Basics, Fraud Detection Basics, Basic Time Series Forecasting, Introduction to Autonomous Systems, Healthcare Analytics Fundamentals, Financial Analytics Basics. Visualizing Complex Datasets, Case Studies in Data Visualization, Project-based Learning, Collaborative Visualization Projects, Presentation and Critique of Visualization Projects, Final Visualization Project Showcase.	**10**

COURSE OUTCOME
1. Understand the basic principles and concepts of data science. 2. Understand the concepts of advanced data science techniques. 3. Proficiency in using advanced visualization tools. 4. Ability to create interactive and dynamic visualizations.

Recommended Readings

1. "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett
2. "Data Science from Scratch: First Principles with Python" by Joel Grus
3. "Interactive Data Visualization for the Web" by Scott Murray
4. "D3.js in Action" by Elijah Meeks
5. "The Visual Display of Quantitative Information" by Edward R. Tufte
6. "Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic
7. "Information Dashboard Design: Displaying Data for At-a-Glance Monitoring" by Stephen Few

Subject Code	BDS204
Course Name	Introduction to Machine Learning
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Introduce the fundamental concepts and terminology of machine learning. 2. Learn how to pre-process data and prepare it for machine learning tasks. 3. Develop skills in interpreting and communicating machine learning results effectively.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Machine Learning: Introduction to machine learning, Types of machine learning algorithms, Supervised learning, Unsupervised learning, Semi-supervised learning, Reinforcement learning, Bias-variance tradeoff, Overfitting and Underfitting, Model evaluation metrics, Cross-validation techniques, Ethics in machine learning, Future trends in machine learning	**12**
Unit 2: Data Preprocessing and Feature Engineering: Data preprocessing techniques, Data cleaning, Missing value imputation, Outlier detection and treatment, Data transformation, Feature scaling, Feature selection, Dimensionality reduction, Encoding categorical variables, Handling imbalanced datasets, Time series data preprocessing, Feature engineering strategies	**12**
Unit 3: Supervised Learning Algorithms: Linear regression, Polynomial regression, Ridge regression, Lasso regression, Logistic regression, Decision trees, Random forests, Gradient boosting, Support vector machines, k-Nearest neighbors, Naive Bayes, Neural networks	**12**
Unit 4: Unsupervised Learning Algorithms: K-means clustering, Hierarchical clustering, DBSCAN, Gaussian mixture models, Dimensionality reduction techniques (PCA, t-SNE), Independent component analysis (ICA), Non-negative matrix factorization (NMF), Autoencoders, Association rule learning, Anomaly detection methods, Density-based clustering algorithms, Spectral clustering	**12**
Unit 5: Advanced Topics in Machine Learning: Introduction to deep learning, Convolutional neural networks (CNNs), Recurrent neural networks (RNNs), Long Short-Term Memory (LSTM) networks, Generative adversarial networks (GANs), Reinforcement learning algorithms, Policy gradients, Q-learning, Actor-critic methods, Transfer learning, Model evaluation and hyperparameter tuning, Bias and fairness in machine learning	**12**

COURSE OUTCOME
1. Gain fundamental understanding of machine learning concepts. 2. Develop practical skills in implementing machine learning algorithms. 3. Learn data pre-processing and model evaluation techniques.

Recommended Readings

1. "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido
2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
4. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
5. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

Subject Code	BDS205L
Course Name	Machine Learning with Python Lab
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Apply theoretical knowledge to real-world data science projects. 2. Develop skills in Python programming and interpretation of results. 3. Enhance problem-solving and critical thinking abilities through hands-on projects.

LAB EXPERIMENTS
Lab 1: Basic Python Syntax: Perform arithmetic operations and manipulate strings.
Lab 2: Variables and Data Types: Declare variables and understand different data types in Python.
Lab 3: Conditional Statements: Use if-else statements for decision-making.
Lab 4: Basic Data Exploration: Load and display a dataset, view basic statistics.
Lab 5: Lists and Tuples: Create and manipulate lists and tuples.
Lab 6: Data Visualization Basics: Plot simple graphs using Matplotlib or Seaborn.
Lab 7: Loops: Implement for and while loops for iteration.
Lab 8: Basic Data Preprocessing: Handle missing values and perform simple data cleaning tasks.
Lab 9: Functions: Define and call simple functions with and without arguments.
Lab 10: Introduction to Pandas: Load data into Pandas DataFrame, perform basic operations.

Note*: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

COURSE OUTCOME
1. Apply data exploration and preprocessing techniques effectively. 2. Analyze text data and perform visualisation tasks. 3. Perform feature engineering and selection for model optimization.

Recommended Readings

1. "Python Crash Course" by Eric Matthes

2. "Data Science for Beginners: A Comprehensive Beginners Guide to Learn Data Science from Scratch" by Steven Cooper
3. "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido
4. "Python Data Science Handbook: Essential Tools for Working with Data" by Jake VanderPlas
5. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems" by Aurélien Géron

Third Semester

Subject Code	BDS301
Course Name	Cyber Security & Computer Networks
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the fundamentals of computer networks and their protocols. 2. Learn techniques for securing computer networks from cyber threats. 3. Explore common vulnerabilities and attacks in networked systems.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Network Topologies, OSI Model, TCP/IP Protocol Suite, Network Devices, IP Addressing, Subnetting, Routing Protocols, LAN Technologies, WAN Technologies, Network Security Fundamentals.	**12**
Unit 2: Firewalls, Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS), Access Control Lists (ACLs), Virtual Private Networks (VPNs), Secure Socket Layer (SSL), Transport Layer Security (TLS), Network Hardening, Security Policies	**12**
Unit 3: Denial of Service (DoS) Attacks, Distributed Denial of Service (DDoS) Attacks, Man-in-the-Middle (MitM) Attacks, Packet Sniffing, Spoofing Attacks, Phishing Attacks, Social Engineering, Malware, Ransomware, Network Forensics	**12**
Unit 4: Symmetric Encryption, Asymmetric Encryption, Hash Functions, Digital Signatures, Public Key Infrastructure (PKI), Secure Email Communication, Secure Web Communication (HTTPS), Key Management, Cryptographic Protocols	**12**
Unit 5: Network Segmentation, Defense-in-Depth Strategy, Least Privilege Principle, Secure Configuration Management, Network Monitoring, Incident Response, Disaster Recovery Planning, Secure Wireless Networks, Cloud Security	**12**

COURSE OUTCOME
1. Proficiency in understanding and analyzing computer networks. 2. Ability to implement security measures to protect networks from cyber threats. 3. Familiarity with common network vulnerabilities and attack vectors.

Recommended Readings

1. "Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross
2. "Computer Networks" by Andrew S. Tanenbaum and David J. Wetherall
3. "Network Security Essentials: Applications and Standards" by William Stallings
4. "Cybersecurity Essentials" by Charles J. Brooks

Subject Code	BDS302
Course Name	Data Mining & Warehousing
Credits	4

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Understand the principles and techniques of data mining.
2. Learn to extract meaningful patterns and insights from large datasets.
3. Gain proficiency in using data mining algorithms and tools.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Data Mining Concepts, Data Mining Process, Data Preprocessing, Exploratory Data Analysis (EDA), Data Mining Algorithms, Classification, Clustering, Association Rule Mining, Evaluation of Data Mining Models, Applications of Data Mining.	**12**
Unit 2: Data Warehousing Architecture, Data Warehouse Components, Dimensional Modeling, Fact and Dimension Tables, Snowflake and Star Schema, Data Mart Design, ETL (Extract, Transform, Load) Process, Data Warehouse Implementation, Data Quality and Cleansing	**12**
Unit 3: Regression Analysis, Decision Trees, Neural Networks, Support Vector Machines (SVM), Ensemble Learning Methods, Text Mining, Time Series Analysis, Anomaly Detection, Web Mining, Social Media Mining, Association Rule Mining, Genetic Algorithms, Feature Engineering	**12**
Unit 4: Multidimensional Data Models, OLAP Operations (Slice, Dice, Drill-down, Roll-up), OLAP Cube Implementation, Data Cube Storage and Indexing, OLAP Query Optimization, Advanced OLAP Techniques, OLAP Tools and Applications, OLAP Security and Scalability	**12**
Unit 5: Business Intelligence (BI) Systems, Customer Relationship Management (CRM), Market Basket Analysis, Fraud Detection, Healthcare Analytics, Predictive Analytics, Data Mining in Finance, Privacy and Ethical Issues in Data Mining, Emerging Trends and Technologies	**12**

COURSE OUTCOME

1. Proficiency in data mining concepts and techniques.
2. Ability to preprocess data and extract valuable insights using mining algorithms.
3. Understanding of multidimensional data analysis and OLAP operations.

Recommended Readings

1. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei
2. "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" by Ralph Kimball and Margy Ross

3. "Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management" by Gordon S. Linoff and Michael J. A. Berry
4. "Building the Data Warehouse" by William H. Inmon
5. "Principles of Data Mining" by David Hand, Heikki Mannila, and Padhraic Smyth

Subject Code	BDS303
Course Name	Deep Learning & Neural Networks
Credits	4

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Understand the fundamentals of deep learning and neural networks.
2. Gain practical experience in implementing deep learning algorithms for various tasks.
3. Explore advanced topics and applications in deep learning.
4. Develop skills for evaluating and fine-tuning deep learning models.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to deep learning, Basics of neural networks, Perceptron, Activation functions, Gradient descent, Backpropagation, Overfitting and regularization, Hyperparameter tuning, Optimization algorithms, Loss functions, Model evaluation, Dropout regularization, Batch normalization, Learning rate schedules, Cross-validation, Early stopping	**12**
Unit 2: Convolutional Neural Networks (CNNs) CNN architecture, Convolutional layers, Pooling layers, Transfer learning, Image classification, Object detection, Semantic segmentation, Style transfer, Data augmentation, Fine-tuning, Convolutional neural network visualization, Object localization, Adversarial training, Capsule networks, Autoencoders	**12**
Unit 3: Recurrent Neural Networks (RNNs) RNN architecture, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Sequence prediction, Natural Language Processing (NLP), Sentiment analysis, Named Entity Recognition (NER), Language translation, Text generation, Speech recognition, Attention mechanisms in RNNs, Bidirectional RNNs, Encoder-Decoder architectures, Reinforcement learning with RNNs, Reinforcement learning in dialogue systems	**12**
Unit 4: Generative Adversarial Networks (GANs) GAN architecture, Generator and Discriminator networks, Training GANs, Applications in image generation and data synthesis, Conditional GANs, CycleGAN, Wasserstein GAN, Evaluation metrics, Ethical considerations, Variational Autoencoders (VAEs), GANs for anomaly detection, GANs for style transfer, GANs for super-resolution, Multi-agent GANs	**12**
Unit 5: Advanced Topics in Deep Learning Attention mechanisms, Transformers, Reinforcement learning, Deep reinforcement learning, Self-supervised learning, Meta-learning, Adversarial attacks and defenses, Explainable AI, Federated learning, AI fairness and bias, Quantum machine learning, Neuroevolution, Transfer learning across modalities, Capsule networks, Multi-task learning	**12**

COURSE OUTCOME

1. Demonstrate proficiency in designing and training neural networks for real-world applications.
2. Apply deep learning techniques to solve complex problems in diverse domains.
3. Analyze and interpret the performance of deep learning models.

Recommended Readings

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal.
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron.
4. "Deep Reinforcement Learning Hands-On" by Maxim Lapan.
5. "Python Deep Learning" by Ivan Vasilev and Daniel Slater.

Subject Code	BDS304
Course Name	Statistical Data Modelling using R Programming
Credits	4

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Understand statistical data modelling principles and techniques.
2. Gain proficiency in using the R programming language for statistical analysis.
3. Learn to explore and visualize data using R packages.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to R, Data Import and Manipulation in R, Exploratory Data Analysis (EDA), Basic Statistical Concepts, Introduction to Statistical Modeling, Linear Regression Modeling, Model Assessment and Interpretation, Data Visualization with ggplot2, Introduction to R Markdown.	**12**
Unit 2: Simple Linear Regression, Multiple Linear Regression, Assumptions of Linear Regression, Model Diagnostics and Residual Analysis, Variable Selection Techniques, Interaction Effects and Nonlinear Relationships, Collinearity and Multicollinearity, Model Validation and Inference, Extensions to Linear Regression	**12**
Unit 3: Generalized Linear Models (GLMs), Logistic Regression, Poisson Regression, Negative Binomial Regression, Model Comparison and Selection, Model Interpretation and Inference, Model Assessment and Prediction, Bayesian Regression Models, Regularization Techniques	**12**
Unit 4: Time Series Data Handling in R, Time Series Decomposition, Autoregressive Integrated Moving Average (ARIMA) Models, Seasonal Decomposition of Time Series (STL), Exponential Smoothing Methods, Forecast Evaluation and Accuracy Measures, Time Series Cross-Validation, Dynamic Regression Models	**12**
Unit 5: Survival Data Handling in R, Kaplan-Meier Estimator, Cox Proportional Hazards Model, Parametric Survival Models, Longitudinal Data Analysis with Linear Mixed Effects Models, Generalized Estimating Equations (GEE), Model Interpretation and Inference, Applications of Survival and Longitudinal Data Analysis	**12**

COURSE OUTCOME

1. Proficiency in statistical modelling principles and techniques.
2. Ability to perform exploratory data analysis and visualization.
3. Skill in linear regression modelling and interpretation.

Recommended Readings

1. "An Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani

2. "Applied Predictive Modelling" by Max Kuhn and Kjell Johnson
3. "Regression Modelling Strategies: With Applications to Linear Models, Logistic and Ordinal Regression, and Survival Analysis" by Frank E. Harrell Jr.
4. "Time Series Analysis and Its Applications: With R Examples" by Robert H. Shumway and David S. Stoffer
5. "Survival Analysis: Techniques for Censored and Truncated Data" by John P. Klein and Melvin L. Moeschberger

Subject Code	BDS305L
Course Name	'R' Programming Lab
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Gain proficiency in the R programming language. 2. Learn to manipulate and analyze data using R. 3. Develop skills in data visualization and graphical representation.

LAB EXPERIMENTS
Lab 1: Introduction to R Programming Environment
Lab 2: Basic Data Types and Variables in R
Lab 3: Arithmetic Operations and Mathematical Functions
Lab 4: Working with Vectors and Indexing
Lab 5: Data Input and Output in R
Lab 6: Conditional Statements and Loops
Lab 7: Data Frame Manipulation and Basic Data Analysis
Lab 8: Functions and Control Structures
Lab 9: Data Visualization with ggplot2
Lab 10: Statistical Analysis with R: Hypothesis Testing and Regression Analysis

Note*: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

COURSE OUTCOME
1. Proficiency in using R for data manipulation and analysis. 2. Ability to visualize data and create graphical representations. 3. Understanding of statistical techniques and their implementation in R.

Recommended Readings

1. "R for Data Science" by Hadley Wickham and Garrett Grolemund
2. "The Art of R Programming" by Norman Matloff

3. "Advanced R" by Hadley Wickham
4. "R Cookbook" by Paul Teetor

Fourth Semester

Subject Code	BDS401
Course Name	Database Management System
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the fundamental concepts of database systems. 2. Learn to design, create, and manipulate databases. 3. Gain proficiency in querying and retrieving data using SQL.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Database Concepts, Database Architecture, Data Models, Relational Database Management Systems (RDBMS), Entity-Relationship Diagrams (ERD), Database Design Principles, Data Normalization, Database Constraints, Introduction to SQL	**12**
Unit 2: Relational Schema Design, Functional Dependencies, Normalization Techniques (1NF to 3NF), Denormalization, Indexing and Query Optimization, Transaction Management, Concurrency Control, Backup and Recovery, Stored Procedures and Triggers	**12**
Unit 3: Data Definition Language (DDL), Data Manipulation Language (DML), SQL Queries (SELECT, INSERT, UPDATE, DELETE), Aggregation Functions, Joins and Subqueries, Views and Indexes, SQL Constraints, Handling NULL Values	**12**
Unit 4: Object-Relational Databases, Distributed Databases, Data Warehousing and Data Mining, Big Data and NoSQL Databases, Database Security and Authorization, Database Performance Tuning, Query Optimization Techniques, Data Integration and Migration, Emerging Trends in Database Management	**12**
Unit 5: Database Installation and Configuration, User Management and Permissions, Backup and Recovery Strategies, Performance Monitoring and Tuning, Database Maintenance Tasks, Disaster Recovery Planning, Cloud Databases and Database as a Service (DBaaS), Data Governance and Compliance	**12**

COURSE OUTCOME
1. Proficiency in understanding database concepts and systems. 2. Ability to design, implement, and manage relational databases. 3. Understanding of advanced database topics such as normalization, indexing, and transaction management.

Recommended Readings

1. "Database Systems: The Complete Book" by Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom

2. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe
3. "SQL Queries for Mere Mortals: A Hands-On Guide to Data Manipulation in SQL" by John L. Viescas and Michael J. Hernandez
4. "Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design" by Michael J. Hernandez
5. "Practical PostgreSQL" by Joshua D. Drake and John C. Worsley

Subject Code	BDS402
Course Name	Cloud Computing
Credits	4

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Understand the fundamentals of cloud computing architecture and deployment models.
2. Learn to deploy, manage, and scale applications in cloud environments.
3. Gain proficiency in using cloud computing services and platforms.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Cloud Computing: Cloud Computing Concepts, Service Models (IaaS, PaaS, SaaS), Deployment Models (Public, Private, Hybrid), Cloud Infrastructure Overview, Virtualization Basics, Cloud Security Fundamentals, Cloud Computing Use Cases, Cloud Migration Strategies, Cost Management in the Cloud	**12**
Unit 2: Cloud Computing Services and Platforms: Compute Services (Virtual Machines, Containers), Storage Services (Object Storage, Block Storage), Networking Services (Virtual Private Cloud, Load Balancing), Database Services (SQL, NoSQL), Serverless Computing, Content Delivery Networks (CDNs), Identity and Access Management (IAM), Monitoring and Logging Services, Disaster Recovery and Backup	**12**
Unit 3: Cloud Architecture and Design: Scalability and Elasticity in the Cloud, High Availability Architectures, Fault Tolerance and Redundancy, Multi-Region Deployments, Cloud-Native Architectures, Microservices and Containers Orchestration, DevOps Practices in the Cloud, Infrastructure as Code (IaC), Cloud Design Patterns, Performance Optimization Strategies	**12**
Unit 4: Cloud Security and Compliance: Security Best Practices in the Cloud, Identity and Access Management (IAM) Policies, Data Encryption and Key Management, Network Security (Firewalls, Security Groups), Compliance Standards (GDPR, HIPAA, SOC 2), Security Incident Response and Management, Cloud Security Tools and Services, Cloud Compliance Audits, Security Monitoring and Threat Detection	**12**
Unit 5: Advanced Cloud Computing Concepts: Serverless Computing Architectures, Machine Learning and AI Services, Big Data and Analytics in the Cloud, IoT and Edge Computing, Hybrid Cloud Deployments, Cloud Governance and Cost Management, Emerging Trends in Cloud Computing, Case Studies and Best Practices, Cloud Certification Preparation	**12**

COURSE OUTCOME

1. Understanding of cloud computing fundamentals and deployment models.
2. Proficiency in deploying and managing applications in cloud environments.
3. Knowledge of cloud storage, networking, and security concepts.

Recommended Readings

1. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
2. "Cloud Native Patterns: Designing Change-tolerant Software" by Cornelia Davis
3. "Architecting the Cloud: Design Decisions for Cloud Computing Service Models" by Michael J. Kavis
4. "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" by Tim Mather, Subra Kumaraswamy, and Shahed Latif
5. "Site Reliability Engineering: How Google Runs Production Systems" by Niall Richard Murphy, Betsy Beyer, Chris Jones, and Jennifer Petoff

Subject Code	BDS403
Course Name	Speech and Video Processing
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Provide students with a comprehensive understanding of speech and video processing fundamentals. 2. Equip students with practical skills in analyzing, processing, and synthesizing speech and video signals. 3. Enable students to design and implement algorithms for speech enhancement, noise reduction, and video enhancement.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Fundamentals of Speech Processing Speech production and perception, Digital representation of speech signals, Speech analysis techniques, Speech synthesis methods, Speech recognition basics, Applications of speech processing, Spectrogram analysis, Formant estimation, Pitch detection algorithms, Voice activity detection, Speaker diarization.	**12**
Unit 2: Speech Enhancement and Noise Reduction Noise types and characteristics, Noise reduction techniques, Single-channel and multi-channel speech enhancement, Spectral subtraction, Wiener filtering, Beamforming, Evaluation metrics for speech enhancement, Non-stationary noise suppression, Echo cancellation, Microphone array processing, Speech dereverberation, Deep learning approaches for speech enhancement	**12**
Unit 3: Speech Coding and Compression Speech coding principles, Pulse Code Modulation (PCM), Adaptive Differential Pulse Code Modulation (ADPCM), Linear predictive coding (LPC), Code Excited Linear Prediction (CELP), Speech compression standards, Evaluation of speech coding techniques, Vector quantization, Transform coding, Low bit-rate speech coding, Perceptual coding techniques	**12**
Unit 4: Speaker Recognition and Verification Speaker recognition systems, Speaker verification vs. speaker identification, Feature extraction techniques, Speaker modeling approaches, Gaussian Mixture Models (GMM), Support Vector Machines (SVM), Deep neural networks for speaker recognition, Text-dependent and text-independent speaker recognition, Channel compensation techniques, Fusion methods in speaker recognition	**12**
Unit 5: Video Processing Fundamentals Digital video representation, Video acquisition and compression, Video coding standards (MPEG, H.264, H.265), Video enhancement techniques, Video restoration, Video segmentation and tracking, Motion estimation algorithms, Motion compensation techniques, Video denoising methods, Video stabilization techniques, Video quality assessment	**12**

COURSE OUTCOME
1. Demonstrate proficiency in analyzing and processing speech signals using various algorithms.

2. Apply noise reduction and enhancement methods to improve the quality of speech signals.
3. Design and implement algorithms for speech coding and compression.

Recommended Readings

1. "Fundamentals of Speech Recognition" by Lawrence Rabiner and Biing-Hwang Juang.
2. "Digital Video Processing" by A. Murat Tekalp.
3. "Speech and Audio Signal Processing: Processing and Perception of Speech and Music" by Ben Gold and Nelson Morgan.
4. "Speaker Recognition: Features and Challenges" edited by Amy Neustein and Hemant A. Patil.
5. "Video Processing and Communications" by Yao Wang, Jôrn Ostermann, and Ya-Qin Zhang.

Subject Code	BDS404N
Course Name	Effective Communication Skills
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Enhance verbal and written communication for various contexts. 2. Improve listening, empathy, and conflict resolution skills. 3. Improve oral communication abilities in public speaking and presentations.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Communication Skills: Introduction, Definition, The Importance of Communication, The Communication Process – Source, Message, Encoding, Channel, Decoding, Receiver, Feedback, Context. Barriers to communication: Physiological Barriers, Physical Barriers, Cultural Barriers, Language Barriers, Gender Barriers, Interpersonal Barriers, Psychological Barriers, Emotional barriers	**10**
Unit 2: Elements of Communication: Introduction, Face to Face Communication – Tone of voice, Body Language (Non-Verbal Communication), Verbal Communication Physical Communication. Communication Styles: Introduction, The Communication Styles Matrix -Direct Communication style, Spirited Communication style, Systematic Communication style, Considerate Communication style. Public speaking techniques: Persuasion and influence, Captivating your audience, Executive communication: Communicating with authority and impact, Strategic storytelling: Crafting compelling narratives, Advanced body language mastery: Non-verbal cues for leadership	**15**
Unit 3: Basic Listening Skills: Introduction, Self-Awareness, Active Listening, Becoming an Active Listener, Listening in Difficult Situations. Advanced active listening strategies: Empathy and rapport building, Emotional intelligence in communication: Managing emotions effectively, Conflict resolution & negotiation tactics: Negotiation and mediation, Achieving win-win outcomes, Building high-performance teams: Communication for collaboration	**10**
Unit 4: Interview Skills: Purpose of an interview, Do's and Don'ts of an interview. Giving Presentations: Dealing with Fears, Planning your Presentation, Structuring Your Presentation, Delivering Your Presentation, Techniques of Delivery. Group Discussion: Introduction, Communication skills in group discussion, Do's and Don'ts of group discussion	**10**
Unit 5: Effective Written Communication: Subject Lines, Introduction, Know Your Audience, Organization of the Message. Put the Main Point First, Shades of Meaning, Formal Communication. Strategic report writing: Crafting influential and data-driven reports, Advanced essay composition: Argumentation and critical analysis, Professional writing for diverse audiences and purposes, Advanced grammar and style: Polishing your writing for precision, Technical writing skills: Communicating complex information clearly. Digital platform: Creating engaging content, Social media management and brand communication, Virtual communication platforms and immersive technologies,	**15**

Data-driven communication: Using analytics for strategic communication	

COURSE OUTCOME
1. Enhance oral, written, and interpersonal communication skills. 2. Adapt communication strategies for diverse contexts 3. Explore communication technology trends

Recommended Readings

1. "How to Win Friends and Influence People" by Dale Carnegie
2. "Crucial Conversations: Tools for Talking When Stakes Are High" by Kerry Patterson, Joseph Grenny, Ron McMillan, and Al Switzler
3. "The 7 Habits of Highly Effective People" by Stephen R. Covey
4. "Difficult Conversations: How to Discuss What Matters Most" by Douglas Stone, Bruce Patton, and Sheila Heen
5. "Emotional Intelligence: Why It Can Matter More Than IQ" by Daniel Goleman
6. "Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds" by Carmine Gallo
7. "Writing That Works: How to Communicate Effectively in Business" by Kenneth Roman and Joel Raphaelson
8. "Intercultural Communication in Contexts" by Judith N. Martin and Thomas K. Nakayama
9. "The Social Media Bible: Tactics, Tools, and Strategies for Business Success" by Lon Safko

Subject Code	BDS405L
Course Name	Database Management System Lab
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Gain hands-on experience in designing and implementing databases. 2. Develop proficiency in SQL for database querying and manipulation. 3. Learn database administration tasks such as backup, recovery, and security.

LAB EXPERIMENTS
Lab 1: Introduction to SQL - Basic SQL queries (SELECT, INSERT, UPDATE, DELETE)
Lab 2: Creating and Manipulating Tables - Creating tables, altering table structure, adding and deleting data
Lab 3: Retrieving Data - Using WHERE clause, sorting data, using aggregate functions (COUNT, SUM, AVG)
Lab 4: Working with Multiple Tables - Performing INNER JOIN, LEFT JOIN, RIGHT JOIN operations
Lab 5: Data Modification - Updating and deleting records, using transactions
Lab 6: Indexing and Query Optimization - Creating indexes, optimizing query performance
Lab 7: Database Security - Managing user accounts, granting and revoking privileges
Lab 8: Backup and Recovery - Performing database backups, restoring data from backups
Lab 9: Understanding database normalization principles, identifying and resolving data anomalies
Lab 10: Creating stored procedures, implementing triggers for data integrity constraints

Note*: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner.*

COURSE OUTCOME
1. Understanding of database administration tasks. 2. Familiarity with data modelling and normalization. 3. Competence in ETL processes for data integration.

Recommended Readings

1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan
2. "SQL in 10 Minutes, Sams Teach Yourself" by Ben Forta

3. "Database Administration: The Complete Guide to Practices and Procedures" by Craig S. Mullins
4. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe

Fifth Semester

Subject Code	BDS501
Course Name	DevOps
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the principles and practices of DevOps and its significance in modern software development. 2. Acquire practical skills in implementing Continuous Integration (CI) and Continuous Deployment/Delivery (CD) pipelines. 3. Learn to automate infrastructure provisioning and configuration using Infrastructure as Code (IaC) tools.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Evolution of DevOps, Key principles and practices, Benefits of DevOps adoption, DevOps culture and mindset, Continuous Integration (CI) fundamentals, Continuous Deployment and Delivery (CD) overview, Infrastructure as Code (IaC) introduction, Containerization basics, DevOps toolchain overview, DevOps adoption challenges.	**12**
Unit 2: Version control basics, Introduction to Git, Git fundamentals and commands, Branching and merging strategies in Git, Collaborative workflows with Git, GitHub and GitLab platforms, Git branching models, Git best practices, Git hooks and customizations.	**12**
Unit 3: Introduction to Continuous Integration (CI), CI pipeline setup and configuration, Automated testing in CI, Test-driven development (TDD) principles, Continuous integration with Jenkins, Travis CI, and CircleCI, Code quality checks in CI, Static code analysis tools, CI/CD pipeline optimization.	**12**
Unit 4: Introduction to Continuous Deployment and Delivery (CD), Automated deployment pipelines, Deployment strategies (e.g., blue-green, canary), Infrastructure provisioning with Terraform, Configuration management with Ansible, Container orchestration with Kubernetes, Deployment automation tools (e.g., Spinnaker), Continuous monitoring and feedback loops.	**12**
Unit 5: DevOps best practices for security, scalability, and reliability, DevSecOps principles, Monitoring and logging best practices, Incident management and response, Chaos engineering practices, DevOps communication and collaboration tools (e.g., Slack, Microsoft Teams), Cross-functional collaboration between development, operations, and QA teams	**12**

COURSE OUTCOME
1. Develop the ability to design and implement Continuous Integration (CI) and Continuous Deployment/Delivery (CD) pipelines for software projects. 2. Gain proficiency in using version control systems.

3. Acquire skills in automating infrastructure provisioning and configuration.

Recommended Readings

1. "The Phoenix Project" by Gene Kim, Kevin Behr, and George Spafford.
2. "The DevOps Handbook" by Gene Kim, Patrick Debois, John Willis, and Jez Humble.
3. "Continuous Delivery" by Jez Humble and David Farley.
4. "Site Reliability Engineering" by Niall Richard Murphy, Betsy Beyer, Chris Jones, and Jennifer Petoff.
5. "Accelerate" by Nicole Forsgren, Jez Humble, and Gene Kim.

Subject Code	BDS502
Course Name	Big Data Analytics
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the fundamentals of big data analytics. 2. Learn to process, analyze, and interpret large volumes of data. 3. Gain proficiency in big data technologies and tools.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Big Data Fundamentals, Characteristics of Big Data, Big Data Technologies Overview, Hadoop Ecosystem, Apache Spark, NoSQL Databases, Data Ingestion and Storage, Data Processing Techniques, Introduction to Data Mining	**12**
Unit 2: Data Cleaning Techniques, Data Transformation and Integration, Handling Missing Values, Outlier Detection and Removal, Data Sampling Methods, Feature Scaling and Normalization, Dimensionality Reduction Techniques, Handling Noisy Data, Data Quality Assessment	**12**
Unit 3: Supervised Learning Algorithms, Unsupervised Learning Algorithms, Semi-supervised and Reinforcement Learning, Ensemble Learning Methods, Deep Learning Techniques, Model Evaluation and Validation, Hyperparameter Tuning, Model Deployment, Model Interpretability	**12**
Unit 4: Association Rule Mining, Sequential Pattern Mining, Frequent Itemset Mining, Graph Mining, Text Mining and Sentiment Analysis, Stream Mining, Time Series Analysis, Anomaly Detection, Ensemble Learning for Data Mining, Transfer Learning	**12**
Unit 5: Real-time Data Processing Technologies, Stream Processing Frameworks, Event Stream Processing, Real-time Analytics Tools, Internet of Things (IoT) Analytics, Social Media Analytics, Healthcare Analytics, Financial Analytics, Case Studies and Applications	**12**

COURSE OUTCOME
1. Proficiency in big data analytics fundamentals. 2. Ability to process and analyze large datasets. 3. Skills in data preprocessing and cleaning.

Recommended Readings

1. "Big Data: A Revolution That Will Transform How We Live, Work, and Think" by Viktor Mayer-Schönberger and Kenneth Cukier
2. "Hadoop: The Definitive Guide" by Tom White
3. "Spark: The Definitive Guide" by Bill Chambers and Matei Zaharia

4. "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph" by David Loshin
5. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei

Subject Code	BDS503
Course Name	Natural Language Processing
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the fundamentals of natural language processing (NLP). 2. Learn to process and analyze human language data computationally. 3. Gain proficiency in NLP techniques and algorithms.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Natural Language Processing: Tokenization, Stopword Removal, Stemming and Lemmatization, Part-of-Speech (POS) Tagging, Named Entity Recognition (NER), Text Normalization, Language Models, Word Embeddings, Text Classification	**12**
Unit 2: Text Representation and Feature Engineering: Bag-of-Words (BoW) Model, TF-IDF Representation, Word2Vec Embeddings, GloVe Embeddings, Document Embeddings, Feature Selection Techniques, Feature Extraction Methods, Topic Modeling, Dimensionality Reduction	**12**
Unit 3: Syntactic and Semantic Analysis: Syntax Analysis (Parsing), Constituency Parsing, Dependency Parsing, Semantic Role Labeling (SRL), Sentiment Analysis, Aspect-Based Sentiment Analysis, Coreference Resolution, Semantic Similarity	**12**
Unit 4: Advanced NLP Techniques: Sequence-to-Sequence Models, Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) Networks, Attention Mechanisms, Transformer Models, Pretrained Language Models (BERT, GPT), Transfer Learning in NLP, Neural Machine Translation, Text Summarization	**12**
Unit 5: Applications of Natural Language Processing: Named Entity Recognition in Healthcare, Sentiment Analysis in Social Media, Text Classification in Finance, Machine Translation in Multilingual Communication, Question Answering Systems, Chatbots and Virtual Assistants, Information Extraction from Text, Ethical Considerations in NLP	**12**

COURSE OUTCOME
1. Understanding of fundamental NLP concepts and techniques. 2. Proficiency in text preprocessing and feature engineering. 3. Ability to build and evaluate NLP models for various tasks.

Recommended Readings

1. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition" by Daniel Jurafsky and James H. Martin.
2. "Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit" by Steven Bird, Ewan Klein, and Edward Loper.

3. "Foundations of Statistical Natural Language Processing" by Christopher D. Manning and Hinrich Schütze.
4. "Deep Learning for Natural Language Processing" by Palash Goyal, Sumit Pandey, Karan Jain, and Karan Mittal.
5. "Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning" by Benjamin Bengfort, Tony Ojeda, and Rebecca Bilbro.

Subject Code	BDS504
Course Name	Prompt Engineering
Credits	4

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Intuit instructional design for shaping answers.
2. Select and order demonstrations.
3. Decompose complex tasks into multi-stage prompts.
4. Design experiments to evaluate prompt designs.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Prompt Engineering : Basic Concepts of Prompt Engineering, History and Evolution of Prompts, Role of Prompts in Human-Computer Interaction, Types of Prompts, Prompt Design Principles, Prompt Evaluation Methods, Ethical Considerations in Prompt Engineering, Application of Prompts in Various Domains, Case Studies in Prompt Design, Future Trends in Prompt Engineering	**12**
Unit 2: Cognitive Aspects of Prompt Design : Cognitive Load Theory, Attention and Perception in Prompt Processing, Memory and Recall in Prompt Interaction, Cognitive Models of Prompt Processing, Human Factors in Prompt Design, Cognitive Ergonomics in Prompt Engineering, Usability Guidelines for Prompts, User-Centered Prompt Design, Error Prevention Techniques	**12**
Unit 3: Linguistic Aspects of Prompt Design : Syntax and Semantics of Prompt Language, Pragmatics of Prompt Communication, Language Generation Techniques for Prompts, Natural Language Understanding in Prompt Systems, Dialog Management in Prompt-Based Interfaces, Language Generation Models for Prompts, Multimodal Prompt Design, Cross-Cultural Considerations in Prompt Language	**12**
Unit 4: Technological Foundations of Prompt Systems: Artificial Intelligence Techniques for Prompt Generation, Machine Learning for Prompt Design, Natural Language Processing (NLP) for Prompt Understanding, Speech Recognition and Synthesis for Vocal Prompts, Gesture Recognition for Non-Verbal Prompts, Human-Robot Interaction in Prompt Systems, Integration of Prompt Systems with IoT Devices	**12**
Unit 5: Advanced Topics in Prompt Engineering: Adaptive Prompt Systems, Personalization and Customization of Prompts, Context-Aware Prompt Generation, Conversational Agents and Virtual Assistants, Ethical AI in Prompt Engineering, Prompt Security and Privacy Issues, Evaluation and Metrics for Prompt Systems, Future Directions in Prompt Engineering, Challenges and Opportunities in Prompt Research	**12**

COURSE OUTCOME

1. Students will acquire a deep understanding of the fundamental principles and theories underlying prompt engineering.
2. Students will develop proficiency in designing effective prompts for human-computer interaction.

3. Students will be able to apply various technologies, including artificial intelligence, natural language processing, and multimodal interfaces.

Recommended Readings

1. "GPT-3.5: Language Models for Prompt Engineering and Beyond" by OpenAI.
2. "Prompt Engineering for Language Models: Strategies and Techniques" by Mark Riddell.
3. "Engineering Effective Prompts: A Guide for Machine Learning Practitioners" by Emily Wu and Alex Wang.
4. "The Prompt Engineering Handbook: Techniques for Crafting Effective Model Inputs" by Sarah Johnson.
5. "Mastering Prompt Design: Strategies for Optimizing Language Model Outputs" by Kevin Lee.
6. "Advanced Prompt Engineering: Unlocking the Full Potential of Language Models" by Jason Chen and Lisa Zhang.

Sixth Semester

Subject Code	BDS601
Course Name	Ethics and Privacy in Data Science
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Understand the ethical implications of data science practices and technologies. 2. Explore privacy concerns related to data collection, storage, and usage. 3. Analyze case studies and real-world examples to understand ethical dilemmas in data science.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Ethics in data science, Importance of privacy, Legal frameworks, Ethical decision-making, Case studies, Privacy regulations, Data ethics guidelines, Ethical implications of data collection, Ethical implications of data analysis, Privacy-preserving techniques	**12**
Unit 2: Ethical principles, Decision-making frameworks, Ethical dilemmas in data science, Accountability, Transparency, Fairness, Responsibility, Professional ethics, Code of conduct, Bias in algorithms, Fairness-aware algorithms	**10**
Unit 3: Data privacy principles, De-identification techniques, Anonymization methods, Data governance frameworks, Data stewardship, Consent management, Data minimization, Encryption methods, Privacy-enhancing technologies, Privacy regulations compliance	**12**
Unit 4: Understanding bias in data, Bias mitigation techniques, Fairness metrics, Algorithmic fairness, Bias in machine learning models, Fairness-aware algorithms, Ethical implications of biased algorithms, Fair decision-making, Ethical considerations in algorithmic decision-making, Fairness in data-driven systems	**12**
Unit 5: Informed consent, Data scraping ethics, Responsible data sharing, Data reuse, Ethical research practices, Data ownership, Data sovereignty, Data stewardship, Data ethics in research, Ethical considerations in data-driven innovation. Ethical Considerations in AI Development, AI Ethics and Regulation, AI and Human Augmentation, AI-driven Creativity and Generative Models, AI in Robotics and Automation.	**14**

COURSE OUTCOME
1. Demonstrate awareness of ethical considerations in data science and privacy implications. 2. Evaluate the ethical implications of data collection, processing, and sharing practices. 3. Apply ethical frameworks to analyze and address ethical dilemmas in data science.

Recommended Readings

1. "Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy" by Cathy O'Neil.

2. "Data and Goliath: The Hidden Battles to Collect Your Data and Control Your World" by Bruce Schneier.
3. "Ethics of Big Data" edited by Kord Davis and Doug Patterson.
4. "The Tyranny of Metrics" by Jerry Z. Muller.

Subject Code	BDS602N
Course Name	Employability & Practitioner Skills
Credits	4

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Develop essential employability skills for the workplace. 2. Enhance communication, teamwork, and interpersonal skills. 3. Cultivate problem-solving and critical thinking abilities.

Total Number of Lectures: 60

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Essential Employability Skills: Communication Skills, Teamwork and Collaboration, Problem-Solving Techniques, Time Management Strategies, Resume Writing Essentials, Interview Preparation, Workplace Etiquette	**12**
Unit 2: Professional Development: Networking Skills, Career Planning Strategies, Goal Setting Techniques, Personal Branding, Leadership Skills, Conflict Resolution, Adaptability and Flexibility	**12**
Unit 3: Industry Insights: Trends in the Job Market, Industry-specific Skills, Emerging Technologies, Continuing Education Opportunities, Professional Certifications, Workplace Diversity, Cultural Sensitivity	**12**
Unit 4: Work Readiness: Workplace Ethics and Integrity, Professionalism in the Workplace, Customer Service Skills, Stress Management Techniques, Effective Feedback and Communication, Conflict Resolution Strategies, Work-Life Balance	**12**
Unit 5: Career Advancement: Performance Evaluation and Feedback, Career Growth Strategies, Mentorship and Coaching, Job Search Strategies, Entrepreneurial Skills, Continuing Professional Development, Lifelong Learning	**12**

COURSE OUTCOME
1. Enhanced employability through essential skills development. 2. Improved communication, teamwork, and problem-solving abilities. 3. Proficiency in time management and organizational techniques.

Recommended Readings

1. "What Color Is Your Parachute? 2022: Your Guide to a Lifetime of Meaningful Work and Career Success" by Richard N. Bolles

2. "The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change" by Stephen R. Covey
3. "How to Win Friends and Influence People" by Dale Carnegie
4. "The Power of Habit: Why We Do What We Do in Life and Business" by Charles Duhigg