Prof. Rajendra Singh (Rajju Bhaiya) University, Prayagraj

Course Structure & Syllabus for Apprenticeship Embedded Degree Program

BCA in Data Science & Machine Learning

[Three years AEDP in Computer Application]

(W.E.F. 2026-27 onwards)

Prof. Rajendra Singh (Rajju Bhaiya) University

Mirzapur Road, Naini, Prayagraj- 211010

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Bachelor of Computer Applications
(Data Science & Machine Learning)

Program Outcomes (POs)

PO1: Apply knowledge of computing, mathematics, statistics and data science to solve complex problems.
PO2: Analyze real-world problems and develop data-driven solutions using appropriate computational techniques.
PO3: Design, develop and deploy software applications using modern programming tools and technologies.
PO4: Utilize contemporary data science, machine learning and cloud computing tools for analysis and decision making.
PO5: Apply statistical, analytical and machine learning techniques for extracting insights from data.
PO6: Demonstrate ethical, legal and professional responsibility in handling data and intelligent systems.
PO7: Communicate effectively and collaborate productively in multidisciplinary teams.
PO8: Assess the societal, environmental and organizational impact of data-driven technologies.
PO9: Demonstrate innovation, leadership and problem-solving abilities in professional contexts.
PO10: Engage in lifelong learning and adapt to emerging technologies and evolving industry requirements.

Program Specific Outcomes (PSOs)

PSO1: Develop data-driven solutions using data science, machine learning and analytical techniques.
PSO2: Design and implement intelligent systems using modern programming frameworks, cloud platforms and AI technologies.
PSO3: Apply advanced analytics, deep learning and generative AI techniques to solve business and societal problems.

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Course Structure for BCA in Data Science and Machine Learning

Semester -I					
Course Code	**Core/ Elective**	**Course Title**	**Credit**	**Max Marks – 100**	
				CIE	**ETE**
B250101T	Major	Problem Solving & Programming Using 'C'	3	25	75
B250102T	Major	Fundamentals of Computing and Programming	3	25	75
B250103T	Major	Fundamentals of Data Science and Artificial Intelligence	3	25	75
B250104T	Minor	Mathematics for Computing and Data Science	3	25	75
B250105T	Minor	Digital Productivity and AI Tools	2	25	75
	Elective	Vocational / Skill Enhancement Course	3		
	Elective	Value-Added Course (Select anyone) (1) Understanding India (2) Environmental Studies	2	25	75
B250106P	Lab	Principles of Programming Using 'C' Lab	1	25	75
Semester – II					
Course Code	**Core/ Elective**	**Course Title**	**Credit**	**Max Marks – 100**	
				CIE	**ETE**
B250201T	Major	Computer Organization and Architecture	3	25	75
B250202T	Major	Data Structure Using C/C++	3	25	75
B250203T	Major	Discrete Mathematics	3	25	75
B250204T	Minor	Probability and Statistics for Data Science and Machine Learning	3	25	75
B250205T	Minor	Cyber Security	2	25	75
	Elective	Ability Enhancement Courses – Hindi Bhasha Kaushal Evam Sanchar	3	25	75
	Elective	Summer Training	2		
B250206P	Lab	Data Structure Using C / C++ Lab	1	25	75
Semester – III					
Course Code	**Core/ Elective**	**Course Title**	**Credit**	**Max Marks – 100**	
				CIE	**ETE**
B250301T	Major	Java Programming	3	25	75
B250302T	Major	Design and Analysis of Algorithms	3	25	75
B250303T	Major	Python Programming	3	25	75
B250304T	Minor	Artificial Intelligence	2	25	75
B250305T	Minor	Data Preprocessing and Introduction to Machine Learning	3	25	75
	Elective	Vocational / Skill Enhancement Course	3		

	Elective	Value-Added Course (Select from List) (1) Digital and Technological Solutions (2) Health and Wellness (3) NCC (4) NSS	2	25	75
		(5) Rovers and Rangers			
B250306P	Lab	Java ProgrammingLab	1	25	75

Semester – IV

Course Code	Core/ Elective	Course Title	Credit	Max Marks – 100	
				CIE	ETE
B250401T	Major	Data Communication & Computer Network	3	25	75
B250402T	Major	Database Management Systems	3	25	75
B250403T	Major	Machine Learning	3	25	75
B250404T	Minor	Software Engineering	2	25	75
B250405T	Minor	Applied Machine Learning and Model Evaluation	3	25	75
	Elective	Ability Enhancement Courses (English Language Skill and Communication)	3		
	Elective	Summer Training	2		
B250406P	Lab	Applied Machine Learning Lab	1	25	75

Semester – V

Course Code	Core/ Elective	Courses Title	Credit	Max Marks – 100	
				CIE	ETE
B250501T	Major	Data Analytics & Visualization	3	25	75
B250502T	Major	Data Engineering and Data Management	3	25	75
B250503T	Major	Predictive Analytics and ML Deployment	3	25	75
B250504T	Major	Generative AI & Intelligent Applications	3	25	75
B250505T	Major	Computer Vision and Video Analytics	3	25	75
B250506P	Lab	Data Science and Machine Learning Lab Lab	1	25	75
B250506R		Project Report	4	25	75

Semester – VI

Course Code	Core/ Elective	Course Title	Credit	
B250601R		**Apprenticeship**	**20**	**100**

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: First
Course Code: B250101T	Course Title: Problem Solving and Programming Using C	Credits: 3

Course Outcomes:	
CO 1:	Explain the structure and execution process of C programs.
CO 2:	Use variables, data types, operators and expressions in program development.
CO 3:	Develop programs using decision-making and iterative constructs.
CO 4:	Apply functions, recursion and modular programming concepts.
CO 5:	Develop applications using arrays and strings for problem solving.
Units	**Topics**
1	**Introduction to C Programming:** Structure of a C Program, Character Set, Tokens, Keywords, Identifiers, Constants, Variables, Data Types, Compilation and Execution Process, Standard Input and output functions.
2	**Operators and Control Statements:** Arithmetic, Relational, Logical, Assignment, Increment-Decrement, Conditional and Bitwise Operators, Type Conversion, Expressions and Operator Precedence, if, if-else, nested if, switch statement, while, do-while, for loop, nested loops, break and continue statements.
3	**Array and Pointers:** One-Dimensional and Two-Dimensional Arrays, Array Operations, Character Arrays, String Handling Concepts and Standard String Functions Pointer variable, Pointer arithmetic, Dynamic Memory Allocation, Pointer and Array
4	**Functions and Structure:** Function Definition and Calling, Function Prototypes, Scope of Variables, Parameter Passing Concepts, Returning Values from Function, Recursive Functions , Structure, Union, Enumeration, Storage Classes
5	**File Handling and Preprocessor:** File concept, Opening Modes, Closing a File, File Operations, Preprocessor Directive, Symbolic Constants, Conditional Compilation, Header Files and Standard Library Functions
Suggested Reference Books	1. E. Balagurusamy – Programming in ANSI C, McGraw Hill. 2. Yashavant Kanetkar – Let Us C, BPB. 3. Byron Gottfried – Programming with C, Schaum Series. 4. Reema Thareja – Programming in C, Oxford University Press. 5. Brian W. Kernighan & Dennis Ritchie – The C Programming Language.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: First
Course Code: B250102T	Course Title: Fundamentals of Computing and Programming	Credits: 3

Course Outcomes:

CO1: Explain the fundamentals of computer systems and data representation.
CO2: Apply computational thinking and problem-solving techniques.
CO3: Demonstrate understanding of basic programming concepts.
CO4: Describe the principles of Object-Oriented Programming.
CO5: Explain modern computing technologies and digital practices.

Units	Topics
1	**Computer Systems and Digital Foundations:** Evolution and Generations of Computers, Characteristics, Classification and Applications of Computers, Hardware and Software Concepts, Number Systems (Binary, Octal, Decimal and Hexadecimal), Number System Conversions, Binary Arithmetic, Data Representation and Character Encoding.
2	**Computational Thinking and Problem Solving:**Problem Solving Concepts, Algorithms and Characteristics, Flowcharts and Pseudocode, Computational Thinking, Program Development Cycle, Debugging and Testing Concepts
3	**Programming Fundamentals:** Programming Languages and Language Translators, Variables, Constants and Data Types, Operators and Expressions, Input and Output Concepts, Decision Making Constructs, Looping Concepts, Functions and Modular Programming.
4	**Object-Oriented Programming Concepts:**Procedural Programming versus Object-Oriented Programming, Classes and Objects, Encapsulation and Abstraction, Inheritance, Polymorphism, Advantages and Applications of OOP
5	**Modern Computing Technologies:** Internet and Web Fundamentals, Basics of Computer Networks, Cyber Security Fundamentals, Cloud Computing Overview, Artificial Intelligence and Generative AI Overview, Digital Ethics and Responsible Computing
Suggested Reference Books	1. P.K. Sinha & Priti Sinha – Computer Fundamentals (BPB Publications) 2. Anita Goel – Computer Fundamentals (Pearson Education) 3. V. Rajaraman – Fundamentals of Computers (PHI Learning) 4. E. Balagurusamy – Object Oriented Programming with C++ (McGraw Hill Education) 5. Reema Thareja – Computer Fundamentals and Programming in C (Oxford University Press)
Suggested Online Learning Platforms	1. SWAYAM – https://swayam.gov.in 2. NPTEL – https://nptel.ac.in 3. e-PG Pathshala – https://epgp.inflibnet.ac.in 4. National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in 5. DIKSHA – https://diksha.gov.in 6. Spoken Tutorial (IIT Bombay) – https://spoken-tutorial.org

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: First
Course Code: B250103T	Course Title: Fundamentals of Data Science and Artificial Intelligence	Credits: 3

Course Outcomes:

CO1: Explain the fundamentals of Data Science and Artificial Intelligence.
CO2: Identify different types, sources and characteristics of data.
CO3: Perform basic data exploration and visualization.
CO4: Explain AI concepts, applications and ethical issues.
CO5: Use AI-powered tools responsibly for simple analytical tasks.

Units	Topics
1	**Introduction to Data Science and Artificial Intelligence** Evolution of Computing and Digital Transformation; Introduction to Data Science; Need and Scope of Data Science; Data Science Lifecycle; Data Science, Data Analytics, Artificial Intelligence and Machine Learning—Concepts and Differences; Role of Data in Decision Making; Applications of Data Science and AI in Business, Healthcare, Education, Agriculture, Finance, Manufacturing and Governance; Career Opportunities in Data Science and Artificial Intelligence.
2	**Data Fundamentals** Concept of Data, Information and Knowledge; Types of Data—Structured, Semi-Structured and Unstructured; Qualitative and Quantitative Data; Sources of Data; Data Collection Methods; Data Quality; Introduction to Databases, Data Warehouses and Big Data; Characteristics of Big Data (5 Vs); Open Data and Government Data Portals; Basics of Data Privacy and Security.
3	**Data Exploration and Visualization** Introduction to Data Exploration; Organizing Data using Tables; Basic Data Cleaning Concepts; Introduction to Descriptive Statistics (Mean, Median and Mode); Data Visualization using Tables, Bar Charts, Pie Charts, Line Charts, Histograms and Scatter Plots; Principles of Effective Data Visualization; Introduction to Dashboards; Interpretation of Data through Simple Case Studies using Spreadsheet Tools.
4	**Fundamentals of Artificial Intelligence (08 Lectures)** Introduction to Artificial Intelligence; History and Evolution of AI; Types of AI; Overview of Machine Learning, Deep Learning and Generative AI; Natural Language Processing; Computer Vision; Intelligent Assistants; AI Applications in Various Industries; Responsible AI; AI Ethics, Bias, Privacy, Security and Limitations of Artificial Intelligence.
5	**AI Tools and Emerging Trends (08 Lectures)** AI-powered Productivity Tools; AI for Content Creation; AI for Learning and Research; AI for Data Analysis; Fundamentals of Prompt Engineering; Responsible Use of AI Tools; AI in Industry 4.0, Smart Cities and Digital Governance; Future Trends in Data Science and Artificial Intelligence; Emerging Career Opportunities and Professional Certifications.
Course Practical Requirements	1. Explore structured, semi-structured and unstructured datasets from different sources. 2. Collect and organize data using Google Forms and Microsoft Excel/Google Sheets. 3. Perform basic data cleaning and formatting using spreadsheet software. 4. Create bar charts, pie charts, line charts, histograms and scatter plots for data visualization. 5. Download and explore datasets from Open Government Data portals or Kaggle.

	6. Use AI assistants such as ChatGPT, Gemini or Microsoft Copilot for information retrieval and summarization. 7. Practice prompt engineering for educational and analytical tasks. 8. Analyze simple datasets using spreadsheet functions and AI-assisted features. 9. Create a basic dashboard using Microsoft Excel, Tableau Public or Power BI (introductory level). 10. Develop a mini project involving data collection, visualization, AI-assisted analysis and presentation of findings.
Suggested Reference Books	1. Data Science for Business – Foster Provost & Tom Fawcett. 2. Artificial Intelligence: A Modern Approach – Stuart Russell & Peter Norvig. 3. Data Science from Scratch – Joel Grus. 4. Doing Data Science – Cathy O'Neil & Rachel Schutt. 5. Introduction to Artificial Intelligence – Wolfgang Ertel.
Suggested Online Learning Platforms	1. National Programme on Technology Enhanced Learning (NPTEL) 2. SWAYAM 3. National Digital Library of India 4. Kaggle Learn 5. Microsoft Learn 6. Google Cloud Skills Boost 7. IBM SkillsBuild

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: First
Course Code:B250104T	Course Title: Mathematics for Computing and Data Science	Credits: 3

Course Outcomes:	
CO 1:	Apply mathematical concepts to computational problems.
CO 2:	Perform matrix operations and solve linear equations.
CO 3:	Apply probability concepts in data analysis and decision-making.
CO 4:	Analyze data using statistical techniques.
CO 5:	Explain mathematical foundations of Artificial Intelligence and Data Science.
Units	**Topics**
1	**Mathematical Foundations for Computing:** Sets and Set Operations, Functions and Graphs, Mathematical Modelling, Sequences and Series, Applications in Computing.
2	**Linear Algebra:** Matrices and Matrix Operations, Determinants, Inverse of Matrix, Solution of Simultaneous Linear Equations, Applications of Linear Algebra in Computing.
3	**Probability Theory:** Basic Concepts of Probability, Conditional Probability, Bayes' Theorem, Random Variables, Applications of Probability in Computing and Artificial Intelligence.
4	**Statistics and Data Analytics:** Measures of Central Tendency, Measures of Dispersion, Correlation, Regression, Data Interpretation, Data Visualization Concepts.

5	**Mathematical Foundations of AI and Data Science:** Vectors and Vector Operations, Distance Measures, Introduction to Derivatives, Basic Optimization Concepts, Applications in Artificial Intelligence, Machine Learning and Data Science.
Suggested Reference Books	1. B.S. Grewal, Higher Engineering Mathematics, 45th Edition, Khanna Publishers, 2023. 2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley India, 2015. 3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Latest Edition. 4. Joel Grus, Data Science from Scratch, 2nd Edition, O'Reilly Media, 2019. 5. Richard N. Aufmann and Joanne Lockwood, Mathematical Thinking and Problem Solving, Cengage Learning, Latest Edition.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in Khan Academy DIKSHA – https://diksha.gov.in

BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: First	**Semester**: Second
Course Code B250105T	**Course Title**: Digital Productivity & AI Tools	**Credits**: 2
Course Outcomes: Upon successful completion of the course, students will be able to:		
CO1: Understand digital workplace practices and professional communication requirements in modern business environments.		
CO2: Use digital tools for workplace organization, task management and productivity enhancement		
CO3: Develop business presentations, professional profiles and visual communication materials using digital platforms.		
CO4: Apply collaboration and virtual workplace tools for team coordination and remote work.		
CO5: Utilize AI-assisted tools for communication, content creation and workplace productivity		
CO6: Demonstrate ethical, secure and responsible use of digital and AI technologies in business organizations.		
Units	**Topics**	
1	**Digital Workplace & Professional Communication:** Digital workplace concepts and evolving nature of work; Professional communication in organizations; Business email writing and email etiquette; Virtual communication and workplace conduct;	

	Digital professionalism; Cyber safety and responsible technology use.
2	**Digital Organization & Productivity Tools:** Digital file and information management; Cloud storage and document sharing; Digital scheduling and calendar management; Task and workflow management; Workplace productivity and time management practices.
3	**Business Presentation & Professional Presence:** Business presentation design principles; Visual communication and infographic creation; Resume and professional
	profile development; LinkedIn and professional networking basics; Personal branding and professional visibility.
4	**Collaboration & Virtual Workplace Practices:** Virtual meetings and online meeting etiquette; Team collaboration and communication; Cloud-based file sharing and collaborative working; Remote workplace coordination; Digital project and team management practices.
5	**AI Tools for Business Productivity:** Introduction to Artificial Intelligence and Generative AI; Prompt writing fundamentals; AI-assisted communication and content creation; AI tools for presentations, summaries and workplace tasks; Ethical, responsible and effective use of AI in business environments.
Course Practical Requirements	(1). Professional email writing exercises. (2). Digital file management and cloud storage activities using Google Drive or OneDrive. (3). Digital scheduling and task management exercises using Google Calendar, Trello or Notion. (4). Business presentation and infographic creation using PowerPoint or Canva. (5). Resume preparation and LinkedIn profile development. (6). Virtual meeting and collaboration activities using Google Meet, Microsoft Teams or Zoom. (7). Team-based digital collaboration exercises. (8). AI-assisted content creation and summarization activities. (9). AI-assisted presentation and report preparation. (10). Workplace productivity exercises using digital and AI tools.
Suggested Reference Books	(1). Bovee, C.L. & Thill, J.V. – *Business Communication Today*, Pearson. (2). Guffey, M.E. & Loewy, D. – *Essentials of Business Communication*, Cengage. (3). Alexis Leon & Mathews Leon – *Fundamentals of Information Technology*, Vikas Publishing House. (4). Joan Lambert – *Microsoft Office 365 Step by Step*, Microsoft Press. (5). Ethan Mollick – *Co-Intelligence: Living and Working with AI*. (6). Bernard Marr – *Generative AI in Practice*.
Suggested Online Learning Platforms	(1). SWAYAM – https://swayam.gov.in (2). NPTEL – https://nptel.ac.in (3). National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in (4). e-PG Pathshala – https://epgp.inflibnet.ac.in (5). DIKSHA – https://diksha.gov.in (6). FutureSkills Prime – https://futureskillsprime.in (7). Microsoft Learn – https://learn.microsoft.com (8). LinkedIn Learning – https://www.linkedin.com/learning

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Second Semester

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: Second
Course Code: B250201T	Course Title: Computer Organization and Architecture	Credits: 3

Course Outcomes:	
CO 1:	Explain computer organization and architectural concepts.
CO 2:	Analyze processor organization and instruction execution.
CO 3:	Describe memory hierarchy and storage systems.
CO 4:	Explain input-output mechanisms and bus architectures.
CO 5:	Understand modern processor technologies and architectures.
Units	**Topics**
1	**Processor Organization** CPU Architecture, Registers and Register Organization, Arithmetic Logic Unit (ALU), Control Unit, Instruction Cycle, Instruction Execution.
2	**Instruction Set Architecture** Machine Instructions, Instruction Formats, Addressing Modes, Program Control Instructions, RISC Architecture, CISC Architecture.
3	**Memory Organization** Memory Hierarchy, Cache Memory, Main Memory, Secondary Storage, Virtual Memory, Memory Performance and Optimization.
4	**Input-Output Organization** Input-Output Techniques, I/O Interfaces, Interrupts, Direct Memory Access (DMA), Bus Architecture, Peripheral Communication.
5	**Advanced Computer Architectures** Parallel Processing Concepts, Pipelining, Multicore Processors, GPU Architecture, Cloud and Edge Computing Architecture, Performance Evaluation of Computer Systems.
Suggested Reference Books	1. William Stallings, *Computer Organization and Architecture: Designing for Performance*, 11th Edition, Pearson Education, 2019. 2. Carl Hamacher, Zvonko Vranesic, Naraig Manjikian and Safwat Zaky, *Computer Organization and Embedded Systems*, 6th Edition, McGraw Hill, 2017. 3. M. Morris Mano, *Computer System Architecture*, Revised 3rd Edition, Pearson Education, 2017. 4. David A. Patterson and John L. Hennessy, *Computer Organization and Design*, 5th Edition, Morgan Kaufmann, 2017. 5. V. Carl Hamacher, *Computer Organization*, McGraw Hill Education, Latest Edition.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in
	DIKSHA – https://diksha.gov.in

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: Second
Course Code: B250202T	Course Title: Data Structure using C/C++	Credits: 3

Course Outcomes:	
CO 1:	Explain Abstract Data Types and fundamental data structures.
CO 2:	Implement linear data structures using C/C++.
CO 3:	Apply tree and graph structures to solve computational problems.
CO 4:	Analyze the efficiency of data structure operations.
CO 5:	Develop solutions using appropriate data structures.
Units	**Topics**
1	**Introduction to Data Structures and Algorithm Analysis:** Data and Information, Data Types, Abstract Data Types (ADT), Data Structure Classification, Operations on Data Structure, Algorithm, Complexity of Algorithm, Time Complexity, Space Complexity, Analysis of Algorithms, Performance Evaluation of Algorithms.
2	**Linear Data Structure- Array, Stake and Queue:** Range of Arrays, Memory Representation of Arrays, Address Calculation and Mapping Functions Stack ADT, Stack Operations, Array and Linked List Implementation of Stacks, Applications of Stacks, Infix, Prefix and Postfix Expressions, Expression Evaluation, Queue ADT, Circular Queue, Priority Queue, Double Ended Queue, Applications of Queues.
3	**Linked Lists:** Dynamic Data Structures, Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists, Linked List Operations (Insertion, Deletion, Traversal), Applications of Linked Lists.
4	**Trees, Graphs and Hashing:** Tree Terminology, Binary Trees, Binary Tree Traversals, Binary Search Trees, AVL Trees, Heap Data Structures, Graph Terminology, Graph Representation using Matrix and List, Breadth First Search (BFS), Depth First Search (DFS), Hashing Techniques, Hash Functions, Collision Resolution Methods, Applications of Trees, Graphs and Hashing.
5	**Searching and Sorting Techniques:** Linear Search, Binary Search, Searching Performance Analysis, Internal and External Sorting Concepts, Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort, Heap Sort, Comparison of Sorting Techniques, Applications of Searching and Sorting Algorithms.
Suggested Reference Books	1. Seymour Lipschutz – Data Structures with C 2. Ellis Horowitz, Sartaj Sahni – Fundamentals of Data Structures 3. Reema Thareja – Data Structures Using C 4. Yedidyah Langsam – Data Structures Using C and C++ 5. Mark Allen Weiss – Data Structures and Algorithm Analysis
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: Second
Course Code: B250203T	Course Title: Discrete Mathematics	Credits: 3

Course Outcomes:	
CO 1:	Apply logical reasoning to computational problems.
CO 2:	Solve combinatorial and recurrence-based problems.
CO 3:	Analyze relations and functions in computing applications.
CO 4:	Apply graph and tree concepts in computer science.
CO 5:	Use Boolean algebra in digital and computational systems.
Units	**Topics**
1	**Mathematical Logic:** Propositions and Logical Connectives, Truth Tables, Logical Equivalences, Predicate Logic, Rules of Inference, Applications of Logic in Computing.
2	**Combinatorics:** Principles of Counting, Permutations, Combinations, Pigeonhole Principle, Binomial Theorem, Recurrence Relations.
3	**Relations and Functions:** Relations and their Properties, Equivalence Relations, Partial Order Relations, Functions and Types of Functions, Applications in Computing.
4	**Graph Theory:** Graphs and Types of Graphs, Graph Representation, Graph Traversal Concepts, Connected Graphs, Euler and Hamiltonian Graphs, Matrix representation of diagraph, Warshall's algorithm.
5	**Trees and Boolean Algebra:** Trees and Binary Trees, Tree Traversal Techniques, Spanning Trees, Boolean Algebra, Boolean Functions, Logic Gates and Applications.
Suggested Reference Books	1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, 8th Edition, McGraw Hill, 2019. 2. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Education, Reprint Edition, 2017. 3. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, PHI Learning, Reprint Edition, 2017. 4. C.L. Liu and D.P. Mohapatra, Elements of Discrete Mathematics, 4th Edition, McGraw Hill Education, 2017. 5. V. Krishnamurthy, Combinatorics: Theory and Applications, Affiliated East-West Press, Latest Edition.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: Second
Course Code: B250204T	Course Title: Probability and Statistics for Data Science and Machine Learning	Credits: 3

Course Outcomes:

CO1: Explain the fundamental concepts of probability and statistics.
CO2: Apply descriptive statistical measures to summarize data.
CO3: Solve probability problems using probability laws and theorems.
CO4: Analyze random variables and probability distributions.
CO5: Apply statistical inference techniques for data-driven decision-making.

Units	Topics
1	**Unit I: Fundamentals of Statistics** Introduction to Statistics; Role of Statistics in Data Science and Machine Learning; Descriptive and Inferential Statistics; Population and Sample; Types of Data; Scales of Measurement; Data Collection Methods; Classification and Tabulation of Data; Frequency Distribution; Graphical Representation of Data using Histogram, Frequency Polygon, Ogive and Box Plot.
2	**Unit II: Descriptive Statistics (08 Lectures)** Measures of Central Tendency—Arithmetic Mean, Median and Mode; Measures of Dispersion—Range, Mean Deviation, Variance, Standard Deviation and Coefficient of Variation; Quartiles, Deciles and Percentiles; Moments; Skewness; Kurtosis; Interpretation of Statistical Measures.
3	**Unit III: Probability Theory (08 Lectures)** Random Experiments; Sample Space; Events and Types of Events; Axioms of Probability; Addition and Multiplication Theorems; Conditional Probability; Independent Events; Total Probability Theorem; Bayes' Theorem; Permutations and Combinations; Applications of Probability in Data Science.
4	**Unit IV: Random Variables and Probability Distributions (08 Lectures)** Random Variables; Probability Mass Function (PMF); Probability Density Function (PDF); Mathematical Expectation; Variance; Covariance; Binomial Distribution; Poisson Distribution; Normal Distribution; Standard Normal Distribution; Central Limit Theorem; Introduction to Correlation and Simple Linear Regression (Statistical Perspective).
5	**Unit V: Sampling and Statistical Inference (08 Lectures)** Sampling Techniques; Sampling Distribution; Point and Interval Estimation; Confidence Intervals; Hypothesis Testing; Type I and Type II Errors; Chi-Square Test

	(Introduction); Student's t-Test (Introduction); Statistical Decision Making; Applications of Statistical Inference in Data Science and Machine Learning.
Practical Requirements	1. Prepare frequency distribution tables using spreadsheet software. 2. Construct histograms, frequency polygons, ogives and box plots. 3. Calculate mean, median, mode, variance and standard deviation. 4. Compute quartiles, deciles, percentiles and coefficient of variation. 5. Solve probability problems using addition, multiplication and conditional probability rules. 6. Apply Bayes' theorem to simple decision-making problems. 7. Calculate probabilities using Binomial, Poisson and Normal distributions. 8. Compute expectation and variance for random variables. 9. Perform confidence interval estimation and basic hypothesis testing using spreadsheet tools. 10. Prepare a statistical analysis report using a real-world dataset in Microsoft Excel or Google Sheets.
Suggested Reference Books	• Douglas C. Montgomery & George C. Runger, *Applied Statistics and Probability for Engineers*, Pearson. • Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Academic Press. • Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, Cengage Learning. • Peter Bruce, Andrew Bruce & Peter Gedeck, *Practical Statistics for Data Scientists*, O'Reilly Media. • Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, *Probability and Statistics for Engineers and Scientists*, Pearson.
Suggested Online Learning Platforms	• NPTEL – Probability and Statistics • SWAYAM • MIT OpenCourseWare – Probability and Statistics • Khan Academy – Statistics and Probability • Kaggle Learn – Statistics • Google Machine Learning Crash Course (Statistics Modules) • National Digital Library of India (NDLI)

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: First	Semester: Second
Course Code: B250205T	Course Title: Cyber Security	Credits: 2

Course Outcomes:	
CO 1:	Explain fundamental concepts of cyber security and cyber threats.
CO 2:	Identify common security risks and protective measures.
CO 3:	Apply safe computing and data protection practices.
CO 4:	Explain network and web security concepts.
CO 5:	Describe emerging cyber security challenges and solutions.
Units	**Topics**
1	**Introduction to Cyber Security:** Fundamentals of Cyber Security, Cyber Threats and Cyber Attacks, Types of Hackers, Cyber Crime and Cyber Laws, Security Principles: Confidentiality, Integrity and Availability (CIA), Digital Footprint and Online Privacy
2	**Information and System Security:** Authentication and Authorization, Password Security and Multi-Factor Authentication, Malware: Virus, Worm, Trojan, Ransomware, Spyware, Data Backup and Recovery, Endpoint Security, Safe Computing Practices
3	**Network and Web Security:** Network Security Fundamentals, Firewalls and Intrusion Detection Systems, Phishing and Social Engineering, Email Security, Web Security Concepts, Secure Browsing Practices
4	**Data Security and Cloud Security:** Data Protection and Privacy, Encryption and Decryption Concepts, Digital Signatures, Cloud Security Fundamentals, Mobile Security Concepts, Security Challenges in Digital Platforms
5	**Emerging Trends in Cyber Security:** Cyber Security in AI and Machine Learning, Internet of Things (IoT) Security, Blockchain and Security Applications, Cyber Security Governance and Compliance, Ethical Hacking Overview, Career Opportunities in Cyber Security
Suggested Reference Books	1. Nina Godbole and Sunit Belapure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley India, Latest Edition. 2. Charles P. Pfleeger and Shari Lawrence Pfleeger, Security in Computing, Pearson Education, Latest Edition. 3. William Stallings, Cryptography and Network Security, Pearson Education, Latest Edition. 4. Joseph Migga Kizza, Guide to Computer Network Security, Springer, Latest Edition. 5. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, Cengage Learning, Latest Edition.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in

Third Semester

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Second	Semester: Third
Course Code: B250301T	Course Title: Java Programming	Credits: 3
Course Outcomes:		
CO 1:	Explain Java programming fundamentals and object-oriented programming principles.	
CO 2:	Develop applications using classes, objects, inheritance and polymorphism.	
CO 3:	Apply packages, interfaces, string handling and exception handling mechanisms.	
CO 4:	Utilize collection framework and multithreading for application development.	
CO 5:	Develop event-driven applications using AWT components and event handling techniques.	
Units	**Topics**	
1	Introduction to Java Programming Fundamentals: Features of Java, Java Environment, Structure of Java Program, Compilation and Execution Process, Data Types, Variables and Constants, Operators, Input and Output using Scanner Class, Control Statements, Type Conversion and Casting, Wrapper Classes	
2	Object-Oriented Programming Concepts: Characteristics of OOPS, Classes and Objects, Access Modifiers, Methods, Constructors, Constructor Overloading, Method Overloading, Inheritance, Types of Inheritance, Method Overriding, Runtime Polymorphism, Abstract Classes, Interfaces	
3	Array, String Handling and Exception Handling: Array, Immutable string, Mutable string, Exception Handling Mechanism, try-catch-finally Blocks, Multiple Catch Blocks, Nested try Statements, Static Members	
4	Collections Framework, Package and Multithreading: Introduction to Collection Framework, ArrayList, Package in java, Thread Life Cycle, Creating Threads, Runnable Interface, Thread Priorities, Thread Synchronization.	
5	AWT and Event Handling: Introduction to Abstract Window Toolkit (AWT), Components and Containers, Labels, Buttons, Text Fields, Text Areas, Check Boxes, Choice Controls, Lists, Menus and Menu Bars, Layout Managers, Event Handling Mechanism, Event Classes, Event Listener Interfaces, Adapter Classes, Mouse Events, Keyboard Events, Window Events, Developing Simple Event-Driven Applications	
Suggested Reference Books	1. Herbert Schildt, *Java: The Complete Reference*, 12th Edition, McGraw-Hill Education, 2021. 2. Cay S. Horstmann, *Core Java Volume I: Fundamentals*, 12th Edition, Pearson Education, 2021. 3. Kathy Sierra, Bert Bates and Trisha Gee, *Head First Java*, 3rd Edition, O'Reilly Media, 2022. 4. E. Balagurusamy, *Programming with Java: A Primer*, 7th Edition, McGraw-Hill Education, 2024. 5. P. Radha Krishna, *Object-Oriented Programming through Java*, Universities Press, 2022.	
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in	

BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: Second	**Semester**: Third
Course Code: B250302T	**Course Title:** Design and Analysis of Algorithm	**Credits**: 3

Upon successful completion of the course, students will be able to:
CO1: Analyze algorithm efficiency using complexity measures and recurrence relations.
CO2: Apply divide-and-conquer and greedy techniques to solve computational problems.
CO3: Design solutions using dynamic programming approaches.
CO4: Implement backtracking and graph-based algorithms.
CO5: Evaluate advanced algorithmic techniques for modern computing applications.

Units	Topics
1	**Algorithm Analysis and Complexity** Introduction to Algorithms, Characteristics of Algorithms, Performance Analysis, Time and Space Complexity, Asymptotic Notations (Big O, Big Omega and Big Theta), Recurrence Relations, Substitution Method, Iteration Method, Master Method.
2	**Divide and Conquer and Greedy Algorithms** Divide and Conquer Strategy, Binary Search, Merge Sort, Quick Sort, Matrix Multiplication Concepts, Greedy Method, Activity Selection Problem, Fractional Knapsack Problem, Minimum Spanning Tree, Dijkstra's Algorithm, Huffman Coding.
3	**Dynamic Programming** Principles of Dynamic Programming, Matrix Chain Multiplication, 0/1 Knapsack Problem, Longest Common Subsequence, All-Pairs Shortest Paths, Optimal Binary Search Tree, Applications of Dynamic Programming.
4	**Backtracking and Graph Algorithms** Backtracking Strategy, N-Queen Problem, Sum of Subsets Problem, Graph Coloring, Traveling Salesperson Problem, Graph Traversal Concepts, Applications of Graph Algorithms.
5	**Advanced Algorithm Concepts** Approximation Algorithms, Heuristic Approaches, Introduction to NPCompleteness, Amortized Analysis, Algorithmic Problem Solving, Applications of Algorithms in Artificial Intelligence, Machine Learning and Data Science.
Suggested Reference Books	1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, 4th Edition, MIT Press, 2022. 2. Anany Levitin, *Introduction to the Design and Analysis of Algorithms*, 4th Edition, Pearson Education, 2023. 3. Steven S. Skiena, *The Algorithm Design Manual*, 3rd Edition, Springer, 2020. 4. Sara Baase and Allen Van Gelder, *Computer Algorithms: Introduction to Design and Analysis*, 3rd Edition, Pearson Education, 2000. 5. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, *The Design and Analysis of Computer Algorithms*, Pearson Education, Reprint Edition, 2013

Suggested Online Learning Platforms	(1). SWAYAM (2). NPTEL (3). National Digital Library of India (NDLI) (4). MIT OpenCourseWare – Algorithms (5). Stanford Online – Algorithms (6). GeeksforGeeks Learning Portal (7). VisuAlgo

BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: Second	**Semester**: Third
Course Code:B250303T	**Course Title**: Python Programing	**Credits**: 3

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Develop Python programs using appropriate programming constructs.
CO2: Apply functions, modules and data structures in Python applications.
CO3: Implement object-oriented programming concepts using Python.
CO4: Perform data manipulation and visualization using Python libraries.
CO5: Develop Python-based solutions for automation, analytics and emerging applications.

Units	Topics
1	**Python Fundamentals** Python Environment and Jupyter Notebook, Python Interpreter, Variables and Data Types, Type Casting, Operators and Expressions, Input and Output Operations, Comments and Indentation, Conditional Statements, Looping Constructs, Range Function, Pass Statement.
2	**Data Structures and Functions** Strings, Lists, Tuples, Dictionaries and Sets, Sequence Operations and Slicing, List, Set and Dictionary Comprehensions, Functions, Scope and Namespace, Lambda Functions, Modules and Packages.
3	**Object-Oriented Programming and File Handling** Classes and Objects, Constructors, Inheritance, Polymorphism, Exception Handling, File Handling, Working with CSV Files, Introduction to APIs and JSON Data.
4	**Data Analysis with Python** Introduction to NumPy, Array Operations and Indexing, Random Number Generation, Introduction to Pandas, Series and DataFrames, Data Import and Export, Data Cleaning and Transformation, Data Analysis using Common Pandas Functions.
5	**Visualization and Applications of Python** Matplotlib Fundamentals, Line Charts, Bar Charts, Histograms and Scatter Plots, Introduction to Scikit-Learn, Python for Automation and Scripting, Python Applications in Artificial Intelligence, Machine Learning and Data Science.

Suggested Reference Books	1. Reema Thareja, *Python Programming: Using Problem Solving Approach*, Oxford University Press, 2024 Edition. 2. Charles R. Severance, *Python for Everybody: Exploring Data Using Python 3*, Shroff Publishers/O'Reilly, 2023 Edition. 3. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist*, 2nd Edition, O'Reilly Media, 2016. 4. Wes McKinney, *Python for Data Analysis*, 3rd Edition, O'Reilly Media, 2022. 5. Eric Matthes, *Python Crash Course*, 3rd Edition, No Starch Press, 2023.
Suggested Online Learning Platforms	(1). SWAYAM (2). NPTEL (3). National Digital Library of India (NDLI) (4). Python Official Documentation (5). Google Colab (6). Kaggle Learn (7). Spoken Tutorial (IIT Bombay) (8). W3Schools Python Tutorials (9). Real Python Learning Platform

BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: Second	**Semester**: Third
Course Code:B250304T	**Course Title:** Artificial Intelligence	**Credits**: 2

Upon successful completion of the course, students will be able to:
CO1: Explain fundamental concepts and applications of Artificial Intelligence.
CO2: Describe intelligent agents and problem-solving techniques.
CO3: Apply search and reasoning methods in AI systems.
CO4: Explain knowledge representation and machine learning concepts.
CO5: Describe AI applications, challenges and ethical considerations.

Units	Topics
1	**Introduction to Artificial Intelligence** Introduction to Artificial Intelligence, History and Evolution of AI, Characteristics of Intelligent Systems, AI Domains and Technologies, Applications of AI, Future of Artificial Intelligence.
2	**Intelligent Agents and Problem Solving** Intelligent Agents, Types of Intelligent Agents, Problem Solving in AI, State Space Representation, Problem Characteristics, AI in Decision Making.
3	**Search Techniques** Uninformed Search Techniques, Breadth First Search, Depth First Search, Heuristic Search, Best First Search, A* Search Algorithm, Applications of Search Techniques.
4	**Knowledge Representation and Machine Learning Fundamentals** Knowledge Representation, Knowledge-Based Systems, Expert Systems, Reasoning Concepts, Introduction to Machine Learning, Supervised Learning, Unsupervised Learning, AI Data Requirements.

5	**Modern AI Applications and Responsible AI** Natural Language Processing, Computer Vision, Robotics, Generative AI Overview, AI Applications in Business and Industry, Responsible AI, Ethical Issues in AI, Future Trends in Artificial Intelligence.
Practical Requirements	1. Exploration of AI-enabled applications and tools. 2. Problem formulation using state-space representation. 3. Implementation of basic search algorithms. 4. Comparative analysis of search techniques. 5. Development of simple rule-based systems. 6. Case studies on expert systems. 7. Demonstration of supervised and unsupervised learning concepts. 8. Exploration of Natural Language Processing applications. 9. Study of Computer Vision and Robotics applications 10. Analysis of ethical and societal implications of AI.
Suggested Reference Books	1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson Education, 2021. 2. Ethem Alpaydin, *Introduction to Artificial Intelligence*, 2nd Edition, MIT Press, 2021. 3. Elaine Rich, Kevin Knight and Shivashankar B. Nair, *Artificial Intelligence*, 3rd Edition, McGraw Hill Education, 2009. 4. Tom Taulli, *Artificial Intelligence Basics: A Non-Technical Introduction*, Apress, 2019.
	5. Kevin Warwick, *Artificial Intelligence: The Basics*, 2nd Edition, Routledge, 2023
Suggested Online Learning Platforms	1. SWAYAM 2. NPTEL 3. National Digital Library of India (NDLI) 4. Elements of AI (University of Helsinki) 5. Google AI Learning Resources 6. Microsoft Learn – AI Fundamentals 7. IBM SkillsBuild – Artificial Intelligence

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BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: Second	**Semester**: Third
Course Code:B250305T	**Course Title:** Data Preprocessing and Introduction to Machine Learning	**Credits**: 3

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

CO1: Explain the machine learning workflow and preprocessing concepts.
CO2: Apply data cleaning and transformation techniques.
CO3: Prepare datasets using feature engineering techniques.
CO4: Implement basic supervised and unsupervised learning models.
CO5: Develop simple machine learning solutions using Python libraries.

Units	Topics
1	**Unit I: Introduction to Machine Learning** Introduction to Machine Learning; Artificial Intelligence, Machine Learning and Deep Learning—Relationship and Differences; Applications of Machine Learning; Types of Machine Learning—Supervised, Unsupervised and Reinforcement Learning; Machine Learning Workflow; Dataset, Features, Labels and Target Variables; Training, Validation and Test Datasets; Introduction to Python Libraries—NumPy, Pandas and Scikit-learn.
2	**Unit II: Data Preprocessing** Data Quality Issues; Data Cleaning; Handling Missing Values; Handling Duplicate Records; Outlier Detection and Treatment; Data Transformation; Data Integration; Data Reduction; Data Normalization; Feature Scaling; Encoding Categorical Variables; Preparing Data for Machine Learning.
3	**Unit III: Feature Engineering and Dataset Preparation** Feature Engineering Concepts; Feature Selection; Feature Extraction; Feature Construction; Dimensionality Reduction (Introduction to PCA); Handling Imbalanced Data (Introduction); Dataset Splitting; Data Pipelines (Concept); Preparing Machine Learning Ready Datasets.
4	**Unit IV: Introduction to Machine Learning Models** Concept of Regression, Classification and Clustering; Simple Linear Regression (Concept and Basic Implementation); Logistic Regression (Concept and Basic Implementation); Decision Tree (Introduction); k-Nearest Neighbour (Introduction); k-Means Clustering (Introduction); Selection of Appropriate Learning Technique for Different Problems.
5	**Unit V: Machine Learning Workflow and Applications** End-to-End Machine Learning Workflow; Building a Basic Machine Learning Pipeline; Model Training and Prediction; Introduction to Model Interpretation; Applications of Machine Learning in Healthcare, Finance, Agriculture, Business and Education; Ethical Issues in Machine Learning; Mini Project using a Real-World Dataset.

Practical Requirements	1. Load and explore datasets using NumPy and Pandas. 2. Handle missing values and duplicate records. 3. Detect and treat outliers. 4. Perform normalization, standardization and feature scaling. 5. Encode categorical variables using Label Encoding and One-Hot Encoding. 6. Perform feature selection and prepare machine learning-ready datasets. 7. Split datasets into training, validation and testing datasets. 8. Develop basic Linear Regression and Logistic Regression models using Scikit-learn. 9. Implement a simple k-Means clustering model and interpret the output. 10. Develop a mini project demonstrating data preprocessing, model building and prediction using a real-world dataset.
Suggested Reference Books	• Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, O'Reilly Media. • Andreas C. Müller & Sarah Guido, *Introduction to Machine Learning with Python*, O'Reilly Media. • Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press. • Tom M. Mitchell, *Machine Learning*, McGraw-Hill Education. • Peter Bruce, Andrew Bruce & Peter Gedeck, *Practical Statistics for Data Scientists*, O'Reilly Media.
Suggested Online Learning Platforms	• NPTEL – Machine Learning • SWAYAM • Kaggle Learn • Scikit-learn Official Documentation • Google Machine Learning Crash Course • Microsoft Learn – AI and Machine Learning • IBM SkillsBuild

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Fourth Semester

BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: Second	**Semester**: Fourth
Course Code: B250401T	**Course Title:** Data Communication & Computer Network	**Credits**: 3

Upon successful completion of the course, students will be able to:
CO1: Explain data communication principles and network architectures.
CO2: Describe network devices, transmission media, and communication protocols.
CO3: Analyze the functions of layered network models.
CO4: Explain routing, switching, and wireless communication technologies.
CO5: Describe modern networking technologies and network security practices.

Units	Topics
1	**Fundamentals of Data Communication** Data Communication Concepts, Components of Data Communication Systems, Data Transmission Modes, Communication Channels, Network Types (LAN, MAN, WAN), Network Topologies.
2	**Network Models and Protocols** OSI Reference Model, TCP/IP Model, Functions of Network Layers, Protocols and Standards, IPv4 and IPv6 Addressing, Domain Name System (DNS).
3	**Network Devices and Transmission Media** Transmission Media (Guided and Unguided), Network Interface Cards, Repeaters, Hubs, Bridges, Switches, Routers, Gateways, Modems, Network Performance Concepts.
4	**Routing, Switching and Wireless Networks** Routing Concepts, Switching Techniques, Circuit Switching and Packet Switching, Wireless Communication Fundamentals, Wi-Fi Networks, Cellular Networks, Mobile Communication Concepts.
5	**Modern Networking Technologies** Internet Architecture, Network Virtualization, Cloud Networking Basics, Internet of Things (IoT) Networking, Software Defined Networking (SDN), Network Security
	Fundamentals.
Suggested Reference Books	1. Behrouz A. Forouzan, *Data Communications and Networking*, 5th Edition, McGraw Hill Education, 2017. 2. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, 5th Edition, Pearson Education, 2019. 3. William Stallings, *Data and Computer Communications*, 11th Edition, Pearson Education, 2020. 4. James F. Kurose and Keith W. Ross, *Computer Networking: A Top-Down Approach*, 8th Edition, Pearson Education, 2021. 5. Larry L. Peterson and Bruce S. Davie, *Computer Networks: A Systems Approach*, 6th Edition, Morgan Kaufmann, 2021

Suggested Online Learning Platforms	1. SWAYAM 2. NPTEL 3. National Digital Library of India (NDLI) 4. Cisco Networking Academy 5. MIT OpenCourseWare 6. Spoken Tutorial (IIT Bombay) 7. Wireshark Learning Resource

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Second Year	Semester: Fourth
Course Code: B250402T	Course Title: Database Management System	Credits: 3

Course Outcomes:	
CO 1:	Explain the concepts, architecture, and components of database management systems.
CO 2:	Design databases using conceptual, logical, and physical data models.
CO 3:	Apply normalization techniques for efficient database design.
CO 4:	Analyze transaction processing, concurrency control, security, and recovery mechanisms.
CO 5:	Understand advanced database technologies including distributed databases, NoSQL databases, cloud databases, and data warehousing systems
Units	**Topics**
1	Introduction: Data, Information and Knowledge, Characteristics of Database Approach, Data Independence, Architecture of Database System, Data Dictionary, Types of Database Languages, Database System Life Cycle, Overview of Hierarchical, Network and Relational Model, Relations and Codd's Rules, Concepts of Keys, Data Definition, Data Manipulation, View Definition, Nested Queries, Updation, SQL, Handling of Nulls and Cursors.
2	Data Models: Conceptual Design, Logical Design and Physical Design, Entity Relationship (ER) Model, ER Diagrams, Strong and Weak Entity Sets, Generalization, Specialization, Aggregation, Conversion of ER Model into Relational Schemas.
3	Normalization: Normalization Concepts, Functional Dependencies and Dependency Preservation, Normal Forms – 1NF, 2NF, 3NF, BCNF, 4NF, 5NF, DKNF, Indexing, Denormalization, Clustering of Tables and Indexes.
4	Transaction Processing and Database Security and Recovery: Transaction Recovery, System Recovery, Two Phase Commit Protocol, Concurrency Problems, Locking Mechanisms, Database Security and Authorization, Access Control Mechanisms, Database Backup Techniques, Advanced Recovery Techniques,
5	Advanced Database Concepts: Distributed Database Systems, Client-Server Database Architecture, Data Warehousing Concepts, Data Mining Overview, NoSQL Databases, MongoDB Fundamentals, Cloud Database Systems, Big Data Database Technologies,
	Emerging Trends in Database Management Systems.
Suggested Reference Books	1. C. J. Date, *An Introduction to Database Systems*, 8th Edition, Pearson Education. 2. Ramez Elmasri and Shamkant B. Navathe, *Fundamentals of Database Systems*, 7th Edition, Pearson Education. 3. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, *Database System Concepts*, 7th Edition, McGraw-Hill Education. 4. Thomas Connolly and Carolyn Begg, *Database Systems: A Practical Approach to Design, Implementation and Management*, 6th Edition, Pearson Education. 5. Carlos Coronel and Steven Morris, *Database Systems: Design, Implementation and Management*, 14th Edition, Cengage Learning.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in

BCA Syllabus: 2026-27 Onwards		
Program Class: Degree	**Year**: Second	**Semester**: Fourth
Course Code: B250303T	**Course Title:** Machine Learning	**Credits**: 3

Upon successful completion of the course, students will be able to:
CO1: Explain the concepts and workflow of machine learning.
CO2: Apply data preprocessing techniques for machine learning applications.
CO3: Implement supervised learning techniques for prediction and classification.
CO4: Apply unsupervised learning techniques for pattern discovery.
CO5: Evaluate machine learning models and applications.

Units	Topics
1	**Foundations of Machine Learning** Machine Learning Paradigms; Learning Process; Learning Types (Supervised, Unsupervised and Reinforcement Learning); Feature Space and Decision Boundaries; Bias-Variance Trade-off; Model Complexity; Learning Curves; Challenges and Limitations of Machine Learning; Applications of Machine Learning.
2	**Supervised Learning Algorithms** Regression and Classification Concepts; Linear Regression; Multiple Linear Regression; Logistic Regression; Decision Trees; Naïve Bayes Classifier; k-Nearest Neighbour (KNN); Comparative Analysis, Advantages and Limitations of Supervised Learning Algorithms.
3	**Advanced Machine Learning Algorithms** Support Vector Machine (Concept); Ensemble Learning (Introduction); Random Forest (Concept); Artificial Neural Networks (Introduction); Introduction to Deep Learning; Selection of Machine Learning Algorithms for Different Problems; Real-world Applications.
4	**Unsupervised Learning and Pattern Discovery** Clustering Concepts; K-Means Clustering; Hierarchical Clustering; Association Rule Mining (Concept); Dimensionality Reduction (Concept); Pattern Discovery; Applications of Unsupervised Learning.
5	**Emerging Trends in Machine Learning** Deep Learning Overview; Reinforcement Learning (Introduction); Explainable Artificial Intelligence (Overview); Ethical and Responsible AI; Future Trends and Industrial Applications of Machine Learning
Practical Requirements	1. Implement Linear Regression using Scikit-learn. 2. Develop a Logistic Regression model for a classification problem. 3. Implement Decision Tree and compare prediction results. 4. Build and evaluate a Naïve Bayes classifier. 5. Implement k-Nearest Neighbour (KNN) for classification. 6. Implement Support Vector Machine (SVM) for classification. 7. Apply K-Means clustering on a real-world dataset. 8. Perform Hierarchical Clustering and visualize clusters. 9. Compare the performance of supervised learning algorithms on a common dataset. 10. Develop a mini case study demonstrating the selection of an appropriate machine

	learning algorithm for a given problem.
Suggested Reference Books	• Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 3rd Edition, O'Reilly Media, 2022. • Ethem Alpaydin, *Introduction to Machine Learning*, 5th Edition, MIT Press, 2021. • Tom M. Mitchell, *Machine Learning*, McGraw-Hill Education. • Kevin P. Murphy, *Probabilistic Machine Learning: An Introduction*, MIT Press, 2022. • Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
Suggested Online Learning Platforms	(1). SWAYAM (2). NPTEL (3). National Digital Library of India (NDLI) (4). Kaggle Learn (5). Google Machine Learning Crash Course (6). Microsoft Learn – Machine Learning (7). Scikit-Learn Documentation

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Second	Semester: Fourth
Course Code: B250404T	Course Title: Software Engineering	Credits: 2

Course Outcomes:	
CO 1:	Explain software engineering principles and software development processes.
CO 2:	Analyze software requirements and prepare software design models.
CO 3:	Apply software testing and quality assurance techniques.
CO 4:	Understand project management and software maintenance activities.
CO 5:	Describe modern software development methodologies and practices.
Units	**Topics**
1	**Introduction:** Software and Software Engineering, Characteristics of Software, Software Crisis, Software Development Life Cycle (SDLC), Software Process Models, Waterfall Model, Prototype Model, Spiral Model, Incremental Model, Agile Development Concepts, Software Engineering Ethics.
2	**Software Requirements Engineering:** Requirement Engineering Process, Feasibility Study, Requirement Elicitation Techniques, Functional and Non-Functional Requirements, Software Requirement Specification (SRS), Requirement Validation, Requirement Management, Introduction to Use Case Modeling.
3	**Software Design and Modeling:** Software Design Concepts, Design Principles, Modular Design, Cohesion and Coupling, Structured Design, Object-Oriented Design Concepts, UML Diagrams (Use Case, Class, Sequence, Activity), User Interface Design Principles.
4	**Software Testing and Quality Assurance:** Software Testing Fundamentals, Testing Levels, Unit Testing, Integration Testing, System Testing, Acceptance Testing, Black Box Testing, White Box Testing, Software Quality Assurance, Software Reliability, Software Metrics, Debugging Concepts.
5	**Project Management and Modern Software Development:** Software Project Planning, Cost Estimation Basics, Risk Management, Configuration Management, Software
	Maintenance, Software Re-engineering, Agile Methodologies (Scrum Overview), DevOps Fundamentals, Version Control using Git, Continuous Integration Concepts.
Suggested Reference Books	1. Roger S. Pressman and Bruce Maxim, *Software Engineering: A Practitioner's Approach*, 9th Edition, McGraw-Hill, 2019. 2. Ian Sommerville, *Software Engineering*, 10th Edition, Pearson Education, 2016. 3. Pankaj Jalote, *An Integrated Approach to Software Engineering*, 3rd Edition, Springer, 2005. 4. Rajib Mall, *Fundamentals of Software Engineering*, 5th Edition, PHI Learning, 2018. 5. K. K. Aggarwal and Yogesh Singh, *Software Engineering*, 3rd Edition, New Age International.
Suggested Online Learning Platforms	SWAYAM – https://swayam.gov.in NPTEL – https://nptel.ac.in e-PG Pathshala – https://epgp.inflibnet.ac.in National Digital Library of India (NDLI) – https://ndl.iitkgp.ac.in DIKSHA – https://diksha.gov.in

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Second	Semester: Fourth
Course Code: B250405T	Course Title: Applied Machine Learning and Model Evaluation	Credits: 3

Course Outcomes:

Implement machine learning models using Python libraries.
CO2: Evaluate machine learning models using appropriate performance metrics.
CO3: Optimize machine learning models through validation and hyperparameter tuning.
CO4: Interpret model predictions using explainable AI techniques.
CO5: Develop and document end-to-end machine learning solutions for real-world applications.

Units	Topics
1	**Unit I: End-to-End Machine Learning Implementation** Machine Learning Project Lifecycle; Problem Definition; Dataset Selection; Data Understanding; Review of Data Preparation; Building Machine Learning Pipelines using Scikit-learn; Model Training; Model Prediction; Best Practices for Machine Learning Implementation; Reproducible Machine Learning Workflows. **Unit II: Model Evaluation Techniques** Training, Validation and Testing Strategies; Train-Test Split; Cross-Validation Techniques; Bias-Variance Trade-off; Underfitting and Overfitting; Evaluation Metrics for Classification—Confusion Matrix, Accuracy, Precision, Recall, F1-Score and ROC-AUC; Evaluation Metrics for Regression—MAE, MSE, RMSE and R^2 Score; Comparative Model Evaluation. **Unit III: Model Optimization and Performance Improvement** Hyperparameter Tuning; Grid Search; Random Search; Pipeline Optimization; Feature Importance Analysis; Model-based Feature Selection; Regularization Concepts; Improving Model Performance; Introduction to Automated Machine Learning (AutoML). **Unit IV: Model Interpretation and Explainable Artificial Intelligence** Model Interpretation; Global and Local Model Explainability; Feature Importance Techniques; Introduction to SHAP; Introduction to LIME; Error Analysis; Bias and Fairness in Machine Learning; Explainable AI (XAI); Responsible AI Practices; Model Documentation and Reporting. **Unit V: Applied Machine Learning Project and Case Studies** End-to-End Machine Learning Case Studies; Problem Identification; Dataset Selection; Model Development; Model Evaluation and Comparison; Result Interpretation; Preparation of Technical Reports; Presentation of Machine Learning Solutions; Mini Project using Real-World Datasets.
Practical Requirements	1. Build complete machine learning pipelines using Scikit-learn. 2. Implement train-test split and k-fold cross-validation. 3. Evaluate classification models using confusion matrix, accuracy, precision, recall, F1-score and ROC-AUC. 4. Evaluate regression models using MAE, MSE, RMSE and R^2 Score.

	5. Compare the performance of multiple machine learning models on the same dataset. 6. Perform hyperparameter tuning using GridSearchCV and RandomizedSearchCV. 7. Analyze feature importance and apply model-based feature selection. 8. Interpret model predictions using SHAP or LIME (introductory level). 9. Prepare comprehensive model evaluation reports with appropriate visualizations. 10. Develop and present an end-to-end machine learning mini project using a real-world dataset.
Suggested Reference Books	• Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, O'Reilly Media. • Andreas C. Müller & Sarah Guido, *Introduction to Machine Learning with Python*, O'Reilly Media. • Gareth James, Daniela Witten, Trevor Hastie & Robert Tibshirani, *An Introduction to Statistical Learning with Applications in Python*, Springer. • Sebastian Raschka & Vahid Mirjalili, *Python Machine Learning*, Packt Publishing. • Max Kuhn & Kjell Johnson, *Applied Predictive Modeling*, Springer.
Suggested Online Learning Platforms	• NPTEL – Machine Learning • SWAYAM • Scikit-learn Official Documentation • Kaggle Learn • Google Machine Learning Crash Course • Microsoft Learn – AI and Machine Learning • IBM SkillsBuild

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Fifth Semester

BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Third	Semester: Fifth
Course Code: B250501T	Course Title: **Data Analytics & Visualization**	Credits: 3

Course Outcomes:	
CO 1:	Understand the fundamentals of data analytics and its lifecycle.
CO 2:	Perform data preprocessing and exploratory data analysis.
CO 3:	Apply statistical techniques for data summarization.
CO 4:	Design effective data visualizations for decision-making.
CO 5:	Develop interactive dashboards using analytical tools.
CO6:	Analyze real-world datasets using Python libraries.

Units	**Topics**
1	**Introduction to Data Analytics:** Introduction to Data Analytics, lifecycle of data analytics (collection, cleaning, transformation, analysis, visualization, interpretation). Types of analytics: descriptive, diagnostic, predictive, prescriptive. Data-driven decision making. Types of data: structured, semi-structured, unstructured. Basic data structures. Role of Data Analyst and industry applications in healthcare, finance, retail, and e-commerce.
2	**Data Preprocessing & EDA:** Data preprocessing techniques: cleaning, missing value handling, outlier detection, and transformation. Exploratory Data Analysis (EDA) for pattern and trend discovery. Statistical measures: mean, median, mode, variance, standard deviation, correlation. Importance of data quality in analytics.
3	**Data Visualization:** Introduction to data visualization and its importance. Charts: bar, line, histogram, scatter, heat map. Visualization principles: clarity, accuracy, simplicity, consistency. Data storytelling for effective communication of insights.
4	**Advanced Visualization:** Multivariate visualization, interactive dashboards, geospatial visualization, and time-series visualization. Analysis of complex datasets and trend representation using advanced
	visualization techniques.
5	**Tools and Mini Project:** Multimedia Authoring Tools, Interactive Multimedia Systems, User Interface Design for Multimedia Applications, Web Multimedia, Virtual Reality Concepts, Augmented Reality Concepts, Multimedia Applications in Education,Entertainment and Digital Marketing.
Suggested Reference Books	**(1). McKinney, Wes (2017)** – *Python for Data Analysis*, O'Reilly Media. **(2). Healy, Kieran (2018)** – *Data Visualization: A Practical Introduction*, Princeton University Press. **(3). Knaflic, Cole Nussbaumer (2015)** – *Storytelling with Data: A Data Visualization Guide for Business Professionals*, Wiley. **(4). Wilke, Claus O. (2019)** – *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*, O'Reilly Media. **(5). Bruce, Peter & Bruce, Andrew (2017)** – *Practical Statistics for Data Scientists: 50 Essential Concepts*, O'Reilly Media.

Suggested Online Learning Platforms	**(1).** https://www.coursera.org — Data Analysis & Visualization courses **(2).** https://www.kaggle.com/learn — Python, Pandas, EDA practice **(3).** https://www.udemy.com — Data Analytics & Power BI courses **(4).** https://www.datacamp.com — Interactive Data Science learning **(5).** https://www.youtube.com/@freecodecamp — Free Python & Data Analysis tutorials

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Third	Semester: Fifth
Course Code: B250502T	Course Title: Data Engineering & Data Management	Credits: 3

Course Outcomes:	
CO 1:	Understand data engineering and data management concepts.
CO 2:	Design basic data pipelines using ETL concepts.
CO 3:	Perform SQL-based data operations.
CO 4:	Understand data storage systems and architectures.
CO 5:	Apply data modeling techniques.
CO6:	Work with basic big data tools and concepts.
Units	**Topics**
1	**Introduction To Data Engineering :** Relational database concepts, SQL fundamentals, normalization, ER modeling, NoSQL databases, document and key-value stores, data modeling techniques.
2	**Database Systems & Data Modelling :** Relational database concepts, SQL fundamentals, normalization, ER modeling, NoSQL databases, document and key-value stores, data modeling techniques.
3	**ETL & Data Processing:** ETL (Extract, Transform, Load) process, data transformation techniques, data cleaning in pipelines, batch processing, real-time streaming concepts, data integration methods.
4	**Data Warehouse & Big Data:** Data warehouse architecture, data marts, data lakes, introduction to Hadoop ecosystem, Spark basics, distributed data processing concepts.
5	**Tools and Mini Project:** SQL tools, Python for ETL, basic Spark concepts, data pipeline implementation, mini ETL project using real dataset.
Suggested Reference Books	(1)**"Designing Data-Intensive Applications"** – Martin Kleppmann (2) **"Fundamentals of Database Systems"** – Elmasri & Navathe (3) **"Database System Concepts"** – Silberschatz, Korth, Sudarshan (4) **"Data Engineering Cookbook"** – Andreas Kretz **(5.)"SQL Performance Explained"** – Markus Winand
Suggested Online Learning Platforms	(1) https://www.coursera.org — Data Engineering Specialization (2) https://www.udacity.com — Data Engineer Nanodegree (3) https://www.hackerrank.com — SQL practice (4) https://www.w3schools.com/sql — SQL tutorials (5) https://www.mongodb.com/learn — NoSQL learning (MongoDB)

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Third	Semester: Fifth
Course Code: B250503T	Course Title: Predictive Analytics and ML Deployment	Credits: 3

Course Outcomes:

CO1: Apply predictive analytics techniques to solve real-world business problems.
CO2: Interpret predictive insights for data-driven decision-making.
CO3: Deploy trained machine learning models using appropriate deployment platforms.
CO4: Monitor, maintain, and improve deployed machine learning models.
CO5: Develop end-to-end predictive analytics solutions following MLOps principles.

Units	Topics
1	**Unit I: Fundamentals of Predictive Analytics** Introduction to Predictive Analytics; Predictive Analytics Lifecycle; Business Intelligence vs Predictive Analytics; Types of Predictive Analytics; Data-driven Decision Making; Applications of Predictive Analytics in Business, Healthcare, Banking, Manufacturing, Agriculture and Education; Challenges and Limitations of Predictive Analytics.
2	**Unit II: Predictive Analytics Applications** Demand and Sales Forecasting; Customer Analytics (Customer Churn and Customer Lifetime Value); Fraud Detection and Credit Risk Assessment; Recommendation Systems (Concept); Predictive Maintenance; Business Case Studies; Selection of Predictive Solutions for Different Business Problems.
3	**Unit III: Machine Learning Model Deployment** Introduction to Machine Learning Deployment; Model Serialization using Pickle and Joblib; Batch and Real-time Prediction; REST API Concepts; Introduction to Flask or FastAPI; Streamlit for Interactive Machine Learning Applications; Cloud Deployment Concepts.
4	**Unit IV: MLOps and Model Monitoring** Introduction to MLOps; Model Versioning; Model Monitoring; Data Drift and Concept Drift; Model Retraining; Responsible AI in Production; Security and Privacy in Machine Learning Systems.
5	**Unit V: Predictive Analytics Capstone Project** End-to-End Predictive Analytics Workflow; Business Problem Identification; Dataset Selection; Predictive Solution Development; Model Deployment Demonstration; Dashboard-based Reporting; Technical Documentation; Project Presentation using Real-world Datasets.
Practical Requirements	1. Develop a predictive analytics solution using a real-world dataset. 2. Perform customer churn or sales forecasting analysis. 3. Build a recommendation or fraud detection prototype using sample datasets. 4. Serialize trained machine learning models using Pickle or Joblib. 5. Deploy a trained model using Flask or FastAPI. 6. Develop a simple interactive prediction application using Streamlit. 7. Monitor model predictions using new datasets and identify model drift. 8. Develop and present an end-to-end predictive analytics and deployment mini project.

Suggested Reference Books	• Eric Siegel, *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die*, Wiley. • Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media. • Emmanuel Ameisen, *Building Machine Learning Powered Applications*, O'Reilly Media. • Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, O'Reilly Media. • Max Kuhn & Kjell Johnson, *Applied Predictive Modeling*, Springer.
Suggested Online Learning Platforms	• NPTEL – Data Analytics and Machine Learning • SWAYAM • Kaggle Learn • Scikit-learn Official Documentation • Streamlit Documentation • Microsoft Learn – Azure AI • IBM SkillsBuild • Google Machine Learning Crash Course

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BCA Syllabus 2026-27 Onwards		
Program Class: Degree	Year: Third	Semester: Fifth
Course Code: B250504T	Course Title: **Generative AI & Intelligent Applications**	Credits: 3

Course Outcomes:	
CO 1:	Understand Generative AI concepts and models
CO 2:	Apply prompt engineering effectively
CO 3:	Build text and image generation applications
CO 4:	Understand and implement LLM-based systems
CO 5:	Develop RAG-based intelligent applications
CO6:	Design AI-powered real-world solutions
Units	**Topics**
1	**Introduction To Generative AI :** Introduction to Artificial Intelligence vs Generative AI. Evolution of Generative AI models. Basics of neural networks and deep learning. Overview of Large Language Models (LLMs) such as GPT, Claude, Gemini. Applications of Generative AI in industries like education, healthcare, finance, and media.
2	**Prompt Engineering & LLM Fundamentals:** Understanding prompts and prompts structure. Types of prompts (zero-shot, few-shot, chainof-thought). Prompt optimization techniques. Tokenization, embeddings, and context windows. Introduction to APIs for LLMs. Responsible AI usage and limitations.
3	**Text & Image Generation Systems:** Text generation applications (chatbots, summarization, translation). Image generation models (Diffusion models, GAN basics). Multimodal AI concepts. Introduction to tools like DALL·E, Stable Diffusion, and text-to-image systems. Use cases in content creation.
4	**Retrieval Augmented Generation (RAG) & AI Agents:** Data warehouse architecture, data marts, data lakes, introduction to Hadoop ecosystem, Spark basics, distributed data processing concepts.
5	**Intelligent Applications & Mini Project:** Development of AI-powered applications using APIs. Chatbot development. AI-based recommendation systems. Content generation tools. Mini project: build a Generative AI application using LLM API and document outputs.
Suggested Reference Books	**(1)Phoenix, James & Taylor, Mike (2024)** – *Prompt Engineering for Generative AI: FutureProof Inputs for Reliable AI Outputs*, O'Reilly Media. **(2)Berryman, John & Ziegler, Albert (2023)** – *Prompt Engineering for LLMs: The Art and Science of Building Large Language Model-Based Applications*, Packt Publishing. **(3)Auffarth, Ben & Kuligin, Leonid (2025)** – *Generative AI with LangChain (2nd Edition)*, Packt Publishing. **(4)Gupta, Mehul (2024)** – *LangChain in Your Pocket: Beginner's Guide to Building Generative AI Applications using LLMs*, Packt Publishing. **(5)Géron, Aurélien (2019)** – *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (2nd Edition)*, O'Reilly Media. **(6)Russell, Stuart & Norvig, Peter (2021)** – *Artificial Intelligence: A Modern Approach (4th Edition)*, Pearson.

Suggested Online Learning Platforms	(1) https://www.deeplearning.ai — Generative AI courses (Andrew Ng) (2) https://www.coursera.org — LLMs, NLP, and AI specialization courses (3) https://www.edx.org — AI & Machine Learning university courses (4) https://www.udacity.com — AI Engineer Nanodegree

BCA Syllabus 2026-27 Onwards

Program Class: Degree	Year: Third	Semester: Fifth
Course Code: B250505T	Course Title: Computer Vision and Video Analytics	Credits: 3

Course Outcomes:

CO1: Explain the fundamentals of digital images and computer vision.
CO2: Apply image processing techniques using OpenCV.
CO3: Analyze images and videos using feature extraction methods.
CO4: Implement basic computer vision applications for object and motion detection.
CO5: Develop simple computer vision solutions for real-world problems.

Units	Topics
1	**Unit I: Fundamentals of Computer Vision (08 Lectures)** Introduction to Computer Vision; Human Vision vs Computer Vision; Digital Images and Pixels; Image Resolution and Color Models (RGB and Grayscale); Image Formats; Image Acquisition; OpenCV Environment and Basic Image Operations; Applications of Computer Vision and Video Analytics. **Unit II: Image Processing Techniques (08 Lectures)** Image Reading and Display using OpenCV; Image Enhancement; Brightness and Contrast Adjustment; Image Filtering; Smoothing Techniques; Thresholding; Histogram and Histogram Equalization; Morphological Operations; Image Transformations (Resize, Rotate, Crop and Flip). **Unit III: Feature Extraction and Image Analysis (08 Lectures)** Edge Detection; Corner Detection; Contours; Feature Extraction Concepts; Image Segmentation (Introduction); Template Matching; Shape Analysis; Image Classification Concepts; Performance Measures for Computer Vision Applications. **Unit IV: Video Analytics and Object Detection (08 Lectures)** Introduction to Video Analytics; Video Frames and Frame Processing; Motion Detection; Background Subtraction; Face Detection using Pre-trained Models; Object Detection (Concept); Object Tracking (Introduction); Applications in Smart Surveillance, Healthcare, Traffic Management and Retail Analytics. **Unit V: Computer Vision Applications and Mini Project (08 Lectures)** Image Recognition Applications; Optical Character Recognition (OCR) (Introduction); Gesture Recognition (Concept); Industrial Inspection Applications; Medical Image Analysis (Overview); Ethical Issues in Computer Vision; Privacy and Security Considerations; Mini Project using OpenCV.
Practical Requirements	1. Install and configure OpenCV and process digital images. 2. Read, display and manipulate images using Python and OpenCV. 3. Perform image enhancement and filtering operations. 4. Apply histogram equalization and thresholding techniques. 5. Detect edges, corners and contours in images. 6. Perform image transformations such as resizing, cropping and rotation. 7. Develop a simple face detection application using OpenCV. 8. Implement motion detection from video streams.

	9. Develop a basic object detection demonstration using pre-trained OpenCV models. 10. Design and present a mini project based on image processing or video analytics.
Suggested Reference Books	• Richard Szeliski, **Computer Vision: Algorithms and Applications**, Springer. • Jan Erik Solem, **Programming Computer Vision with Python**, O'Reilly Media. • Adrian Kaehler and Gary Bradski, **Learning OpenCV 4**, O'Reilly Media. • Simon J.D. Prince, **Computer Vision: Models, Learning and Inference**, Cambridge University Press. • Rafael C. Gonzalez and Richard E. Woods, **Digital Image Processing**, Pearson (Reference).
Suggested Online Learning Platforms	1. NPTEL – Computer Vision 2. SWAYAM 3. OpenCV Official Documentation 4. OpenCV University 5. Google Developers – Machine Learning 6. Kaggle Learn 7. Microsoft Learn – AI 8. IBM SkillsBuild