



**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
FACULTY OF ENGINEERING AND TECHNOLOGY
UNIVERSITY OF LUCKNOW**

Course Structure and Syllabus

For

**BACHELOR OF COMPUTER APPLICATION
(BCA)**

3rd Year

as per

NEP-2020

(To be effective from the session 2025-2026)

BACHELOR OF COMPUTER APPLICATION (BCA)

YEAR: THIRD, SEMESTER-V

(To be effective from the session 2025-2026)

S. No.	Paper Code	Subject	Periods			Evaluation Scheme				Sub Total	Credit
			L	T	P	Sessional Exam			Exam ESE		
						CT	TA	Total			
1.	NBCA-501	Computer Network	3	1	0	20	10	30	70	100	4
2.	NBCA-502	Data Analytics	3	1	0	20	10	30	70	100	4
3.	NBCA-503	Artificial Intelligence	3	0	0	20	10	30	70	100	3
4.	NBCA-504	Cyber Law and Internet Security	3	0	0	20	10	30	70	100	3
5.	NBCA-505X	Departmental Elective-I	3	0	0	20	10	30	70	100	3
Practical											
6.	NBCA-506P	Data Analytics Lab	0	0	3		20	20	30	50	2
7.	NBCA-507P	Industrial Training viva-voce	0	0	2		20	20	30	50	1
8.	NBCA-508P	Project Phase-I	0	0	6		20	20	30	50	4
9.	NBCA-GP	General Proficiency	-	-	-		-	--	-	50	
		Total	12	2	15					650	24

Departmental Elective-I

NBCA-5051	Graph Theory
NBCA-5052	Software Testing and Audit
NBCA-5053	UNIX Operating System
NBCA-5054	Data Mining and Data Warehousing

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COMPUTER NETWORK

L	T	P
3	1	0

Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Understand basic computer network technology.
- Identify the different types of network topologies and protocols.
- Enumerate the layers of the OSI model and TCP/IP.
- Understand the concept of IP addressing, subnetting and routing mechanisms.

Unit -I

08

Introduction: Goals and applications of networks, network structure and architecture, the OSI reference model, services, Network Topology Design: Delay analysis, back bone design, local access network design, physical layer transmission media, switching methods, ISDN, and terminal handling.

Unit-II

08

Medium Access Sub Layer: Channel allocations, LAN protocols - ALOHA protocols - overview of IEEE standards - FDDI. Data Link Layer - Elementary data link protocols, sliding window protocols, and error handling.

Unit - III

08

Network Layer: Point to point networks, routing, and congestion control. Internet Working -TCP / IP, IP packet, IP address, IPv6.

Unit - IV

08

Transport Layer: Transport layer design issues, connection management, session layer design issues, and remote procedure call. Presentation layer design issues, data compression techniques, cryptography - TCP - window management.

Unit-V

08

Application Layer: File transfer, access and management, electronic mail, virtual terminals. Internet and public networks.

Text Book:

1. Forouzen, "Data Communication and Networking", TMH
2. A.S. Tanenbaum, Computer Networks, Pearson Education

Reference Books:

1. W. Stallings, Data and Computer Communication, Macmillan Press
2. Anuranjan Misra, "Computer Networks", Acme Learning
3. G. Shanmugarathinam, "Essential of TCP/ IP", Firewall Media

DATA ANALYTICS

L	T	P
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Course Outcomes (COs):

After the completion of the course, students are expected to have the ability to:

- Understand Data and its analytics in the real world
- Demonstrate proficiency with statistical analysis of data.
- Develop the ability to build and assess data-based models.
- Handle large scale analytics projects from various domains.
- Develop intelligent decision support systems.

Unit-I

08

Introduction: Sources and nature of data, classification of data, characteristics of data; Introduction to data analytics: need, types, analytic process, tools and techniques, and applications of data analytics. Data Analytics Lifecycle: various phases of data analytics lifecycle-discovery, data preparation, model planning, model building, communicating results and operationalization.

Unit-II

08

Data Exploration: Data profiling, analysing target data, Statistics and Probability: basic probability, conditional probability, Bayes' theorem, Distribution: continuous vs discrete Distributions, Normal Distribution: sample mean, and population mean, bias and variance and Maximum Likelihood Estimation.

Unit-III

08

Data Analysis: Basic analysis technique: Hypothesis testing, Types of hypothesis: null hypothesis and alternate hypothesis, types of error, P-value and level of significance, types of hypothesis testing: Z-test, t-test, Chi square, ANOVA Test, analysis of variance and regression analysis.

Unit-IV

08

Mining Data and Data Cleaning: Introduction to streams concepts, stream data model and architecture, stream computing, sampling data in a stream and filtering streams. Data cleaning: Causes and impact of missing values, types of missing values, imputing missing values, Outliers: deleting and capping, various function of data cleaning.

Unit-V

08

Data Visualization: Introduction data visualization, benefits of good data visualization, types of data visualization: Box plots, Histograms, Heat maps, Charts and Charts Types, Tree maps and Word Cloud/Network diagram.

Text Books:

1. David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big Data Analytics", EMC Education Series, John Wiley.
2. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier.
3. Learn Data Analysis with Python Lessons In Coding by Henley, Apress.

Reference Books:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press.
3. John Garrett, Data Analytics for IT Networks: Developing Innovative Use Cases, Pearson Education.
4. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer.

ARTIFICIAL INTELLIGENCE

L	T	P
3	0	0

Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Understand how to apply knowledge representation techniques to common AI applications.
- Analyse a problem in hand and do the inference to identify the computing requirements that are essential to solve the problem.
- Understand the concepts related to searching, reasoning and handling uncertainty.
- Understand the concept and type of learning.
- Understand the need and various component of expert system.
- Understand soft computing technologies like fuzzy logic, neural network etc.

Unit-I

08

Introduction: Introduction to AI, Scope and applications of AI: Natural language processing, computer vision, speech recognition, robotics, and expert system. Intelligent agents: Structure and working of intelligent agents.

Unit-II

08

Intelligent Searching Methods: Searching for solutions, solving state space search, uninformed search strategies, informed search strategies: DFS, BFS. Heuristic search: Hill climbing, best first search, branch and bound.

Unit-III

08

Knowledge Representation: Predicate logic: Unification, modus ponens, resolution, dependency directed backtracking. Rule based systems: forward reasoning: conflict resolution, backward reasoning: uses of no backtrack.

Unit-IV

08

Structured knowledge representation: Semantic nets- slots, exceptions and default frames, conceptual dependency, and scripts. Expert Systems: Need and justification for expert systems, and knowledge acquisition, and component of an expert system.

Unit-V

08

Handling Uncertainty: Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, and fuzzy logic. Learning: Concept of learning, learning automation, learning by inductions, and neural nets.

Text Book:

1. E. Rich and K. Knight, "Artificial intelligence", TMH.
2. N.J. Nilsson, "Principles of AI", Narosa Publ. House.
3. Peter Jackson, "Introduction to Expert Systems", AWP, M.A.

Reference Books:

1. D.W. Patterson, "Introduction to AI and Expert Systems", PHI.
2. R.J. Schalkoff, "Artificial Intelligence - an Engineering Approach", McGraw Hill Int Ed.
3. Charnick, "Introduction to A.I.", Addison Wesley.
4. Marcellous, "Expert System Programming", PHI.
5. Elamie, "Artificial Intelligence", Academic Press.
6. Lioyed, "Foundation of Logic Processing", Springer Verlag.

CYBER LAW AND INTERNET SECURITY

L	T	P
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Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Understand the need of information security and threats to information system.
- Identify and analyse statutory, regulatory, constitutional, and organizational laws that affect the information technology professional.
- Locate and apply case law and common law to current legal dilemmas in the technology field.
- Understand about internet security threats.

Unit-I

08

Fundamentals of Cyber Law: Jurisprudence of cyber law, object and scope of the IT Act 2000, introduction to Indian cyber law, uncitral model law, ISP guideline. Intellectual property issues and cyber space, Indian perspective, overview of intellectual property related legislation in India, patent, copyright, trademark law, law related to semiconductor layout and design.

Unit-II

08

E-commerce Security: Security threats to e-commerce, virtual organization, business transactions on web, e-governance and EDI, concepts in electronic payment systems, e-cash, credit/debit cards, e-agreement, legal recognition of electronic and digital records, e-commerce issues of privacy, wireless computing-security challenges in mobile devices.

Unit-III

08

Security Policies: Development of policies, www policies, email security policies, policy review process-corporate policies-sample security policies, publishing and notification requirement of the policies, Evolving technology security: mobile, cloud, outsourcing and SCM.

Unit-IV

08

Internet Security Threats: Role of security in internet and web services, classification of threats and attacks, security challenges, security implication for organizations, security services-authentication, confidentiality, integrity, and availability in information security, basic concepts of network security, perimeters of network protection & network attack, hacking, cracking, sneaking, viruses, Trojan horse, malicious code and logic bombs.

Unit-V

08

Investigation and Ethics: cyber-crime and evidence, act, treatment of different countries of cyber-crime, ethical issues in data and software privacy, plagiarism, pornography, tampering computer documents, data privacy and protection, domain name system, software piracy, issues in ethical hacking.

Text Book:

1. Charles P. Pfleeger, Shari Lawerance Pfleeger, "Analyzing Computer Security", Pearson Education India.
2. Harish Chander, "Cyber Law and IT Protection", PHI Publication, New Delhi.
3. Sarika Gupta & Gaurav Gupta, Information Security and Cyber Laws, Khanna Publishing House.

Reference Books:

1. Schou, Shoemaker, "Information Assurance for the Enterprise", Tata McGraw Hill.
2. Anshul Kaushik, "Cyber Security", Khanna Publishing House.
3. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House, Delhi.

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NBCA-5051
GRAPH THEORY

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Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Solve problems using graph theory and apply some basic algorithms for graphs.
- Determine whether a graph is a Hamiltonian and/or an Euler graph.
- Demonstrate different traversal methods for trees and graphs.
- Solve problems involving vertex and edge connectivity, planarity and crossing numbers.
- Represent graphs in Vector space and using Matrix.
- Model real world problems using graph theory like four color problem.

Unit-I

08

Introduction: Graphs, sub graphs, some basic properties, various example of graphs & their sub graphs, walks, path & circuits, connected graphs, disconnected graphs and component, Euler graphs, various operation on graphs, Hamiltonian paths and circuits, and the traveling sales man problem.

Unit- II

08

Trees: Distance diameters, radius and pendent vertices, rooted and binary trees, spanning trees, fundamental circuits, finding all spanning trees of a graph and a weighted graph, Prim's and Kruskal's algorithm.

Unit -III

08

Cut Set and Planarity: Cuts sets and cut vertices, some properties, all cut sets in a graph, fundamental circuits and cut sets, connectivity and separability, network flows planer graphs, Combinatorial and Geometric dual: Kuratowski's graphs, detection of planarity, geometric dual, discussion on criterion of planarity, thickness and crossings.

Unit -IV

08

Vector Space: Vector space of a graph and vectors, basis vector, cut set vector, circuit vector, circuit and cut set subspaces, matrix representation of graph – basic concepts; incidence matrix, circuit matrix, path matrix, cut-set matrix, and adjacency matrix.

Unit -V

08

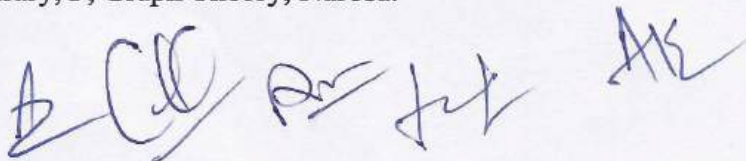
Graph Colouring: Colouring, covering and partitioning of a graph, chromatic number, chromatic partitioning, chromatic polynomials, matching, covering, and four colour problem.

Text Book:

1. Deo, N, Graph theory with applications to Engineering and Computer Science, PHI.

Reference Books:

1. Gary Chartrand and Ping Zhang, Introduction to Graph Theory, TMH.
2. Robin J. Wilson, Introduction to Graph Theory, Pearson Education.
3. Harary, F, Graph Theory, Narosa.



SOFTWARE TESTING AND AUDIT

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Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- Learn how to planning a test project, design test cases and data, conduct testing operations, manage software problems and defects, and generate a testing report.
- Expose the advanced software testing topics, such as object-oriented software testing methods, and component-based software testing issues, challenges, and solutions.

Unit-I

08

Introduction: Software development life cycle, testing process, terminologies in testing: error, fault, failure, test cases, testing suite, test oracles, impracticality of testing all data, and impracticality of testing all paths. **Audit:** Verification, verification methods, validation, validation methods, evolutionary nature of verification and validation, difference between verification and validation. SRS verification, source code reviews, user documentation verification, and software project audit.

Unit-II

08

Functional Testing: Boundary value analysis, equivalence class testing, decision table based testing, and cause effect graphing technique. **Structural Testing:** Control flow testing, path testing, independent paths, generation of graph from program, identification of independent paths, cyclomatic complexity.

Unit-III

08

Regression Testing: Concept, regression test cases selection, reducing the number of test cases, and code coverage prioritization technique. Reducing the number of test cases: Prioritization guidelines, priority category, scheme, and risk analysis.

Unit-IV

08

Software Testing Activities: Levels of testing, debugging, testing techniques and their applicability, and exploratory testing. **Automated Test Data Generation:** Test data, approaches to test data generation, test data generation using genetic algorithm, test data generation tools, software testing tools, and software test plan.

Unit-V

08

Object Oriented Testing: Definition, issues, class testing, object oriented integration and system testing. **Testing Web Applications:** user interface testing, usability testing, security testing, performance testing, database testing, and post deployment testing.

Text Book:

1. Yogesh Singh, "Software Testing", Cambridge University Press, New York, 2012
2. K.K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International Publishers, New Delhi, 2003.

Reference Books:

1. Roger S. Pressman, "Software Engineering -A Practitioner's Approach", Fifth Edition, McGraw Hill International Edition, New Delhi, 2001.
2. Marc Roper, "Software Testing", McGraw-Hill Book Co., London, 1994.

UNIX OPERATING SYSTEM

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Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Describe UNIX operating system commands.
- Understand the UNIX Architecture, File systems and use of basic Commands.
- Understand and analyze UNIX System calls, Process Creation, Control & Relationship.
- Understand Shell Programming and to write shell scripts.

Unit-I**08 Brief**

Introduction: History of UNIX and LINUX, strengths and weaknesses of UNIX-like operating systems. Basic concepts in UNIX-like systems: the kernel, shells, multiuser multitasking operation, remote access, file system, processes, environment and environment variables, the command line, online manual Using the vi editor – modes of operation and switching between them, text navigation, editing text, saving and quitting, using buffers (cut-copy-paste), pattern searching and replacement.

Unit-II**08**

UNIX Architecture: The UNIX operating system, LINUX and gnu. The UNIX architecture, features of UNIX, POSIX and single UNIX specification, internal and external commands, command structure, man browsing and manual pages on-line. The file system: The parent – child relationship, the home variable, pwd, cd, mkdir, absolute pathname, and relative pathname.

Unit-III**08**

Basic File Attributes: Listing directory contents, the UNIX file system, ls -l, -d option, file ownership, file permissions, chmod, directory permissions, changing file ownership, file attributes. The Process: Process basics, process status, system processes (-e or -a), mechanism of process creation, process states and zombies, and running jobs in background.

Unit-IV**08**

Simple Filters: pr, head, tail, cut, paste, sort, uniq, tr. Filters using regular expressions – grep and sed: grep, Basic Regular Expressions (BRE), Extended Regular Expressions (ERE) and egrep, the stream editor, and line addressing using multiple instructions (-E and -F) context addressing.

Unit-V**08**

The Shell: The shell's interpretive cycle, shell offerings, pattern matching, escaping and quoting, redirection, pipes, tee, command substitution, shell variables, and essential shell programming.

Text Book:

1. Sumitabha Das, "UNIX – Concepts and Applications", Tata McGraw Hill.
2. Behrouz A. Forouzan, Richard F. Gilberg, "Unix and shell Programming", Thomson Learning.
3. Neil Matthew and Richard Stones, "Beginning Linux Programming", Wrox.

Reference Books:

1. Kernighan and Pike, "Unix programming environment", Pearson Education.
2. Rosen, Host, Klee, Farber, Rosinski, "The Complete Reference Unix", TMH.
3. Yashavant P. Kanetkar, "Unix Shell Programming", BPB Publications.

DATA MINING AND DATA WAREHOUSING

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Course Outcomes (COs):

After the successful completion of the course student will be able to:

- Learn the concepts of database technology evolutionary path which has led to the need for data mining and its applications. Gain insight into the challenges and limitations of different data mining technology.
- Provide an overview of the methodologies and approaches to data mining
- Describe the various tasks of mining such as classification, clustering, association rule mining.
- Explore data warehouse and multi-dimensional data models.

Unit-I

08

Introduction: Overview, definition, functionalities, data processing, form of data preprocessing, data cleaning: missing values, noisy data (binning, clustering, regression, computer and human inspection), inconsistent data, data integration and transformation. **Data Reduction:** Data cube aggregation, dimensionality reduction, data compression, numerosity reduction, and clustering, and discretization.

Unit-II

08

Concept Description: Definition, data generalization, analytical characterization, analysis of attribute relevance, mining class comparisons, statistical measures in large databases, measuring central tendency, measuring dispersion of data, graph displays of basic statistical class description, mining association rules in large databases, association rule mining, mining single dimensional Boolean association rules from transactional databases.

Unit-III

08

Classification and Predictions: Issues regarding classification and prediction, decision tree, Bayesian classification, classification by back propagation, multilayer feed-forward neural network, back propagation algorithm, classification methods k nearest neighbour classifiers, and genetic algorithm.

Unit-IV

08

Cluster Analysis: Data types in cluster analysis, categories of clustering methods, partitioning methods. Hierarchical clustering- CURE and Chameleon. Density based methods-DBSCAN, OPTICS. Grid based methods- STING, CLIQUE. Model based methods.

UNIT-V

08

Data Warehousing: Overview, definition, delivery process, difference between database system and data warehouse, multi-dimensional data model, data cubes, stars, snowflakes, fact constellations, concept hierarchy, process architecture, 3 tier architecture, and data marting.

Text books:

1. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Morgan Kaufman Publications.
2. Alex Berson, Stephen Smith, "Data Warehousing, Data Mining & OLAP", McGraw Hill.
3. Charu C. Aggarwal, "Data Mining -The Textbook", Springer.

Reference Books:

1. Margaret H Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.
2. Ian H. Witten Eibe Frank, "Data Mining", Morgan Kaufman Publications.
3. Pang-Ning Tan Michael Steinbach, Vipin Kumar, Data Mining, Pearson Education.

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DATA ANALYTICS LAB

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Course Outcomes (COs):

At the end of this course students will be able to:

- Understand the working of NumPy array.
- Understand the concept of Python Pandas.
- Perform various operations such as detecting outliers, identifying missing values, and removal of duplicate record etc.
- Implement reading of CSV files.
- Perform data visualization.

LIST OF PRACTICALS

1. Write a program to create a NumPy array and Access and manipulate elements in the array.
2. Write a Program to create a 5x5 2D array for random numbers between 0 and 1 using NumPy.
3. Write a Program to calculate the mean, median, standard deviation, and variance using NumPy.
4. Write a Program to generate a random array of 50 numbers having mean 110 and standard deviation 15.
5. Write a Program to read the data and perform normalization.
6. Write a Program to create a data frame using Python Pandas.
7. Write a program to sort the data frame based on the first column.
8. Write a program to detect the outliers and remove the rows having outliers.
9. Write a Program to checking for missing values using is null () and not null ().
10. Create a program to identify and count missing values in a data frame.
11. Write a program to remove all duplicates from the first column.
12. Write a Program to Reading a CSV File and reading with Specific Columns and rows.
13. Create a Program we use various functions in NumPy library to carry out the chi-square test.
14. Create a Program we use various functions in NumPy library to carry out the ANOVA test.
15. Write a program to create a data visualization like using matplotlib with taking any datasets: Do the following
 - Create a Box plots,
 - Create a Histograms,
 - Create a Heat maps,
 - Create various Charts

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