Social Network Analysis		Semester	7
Course Code	**BAD714D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To introduce the fundamentals of Social Network Analysis and its significance in understanding societal connections and behaviors.
- To analyze various models of network growth and understand the properties of real-world networks.
- To explore link analysis algorithms and their applications in understanding relationships within a network.
- To study community detection methods and their relevance in identifying meaningful clusters within networks.
- To understand link prediction techniques and their application in forecasting future connections within a network.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, can make use of digital tools to visually demonstrate key ideas that could be adopted to attain the outcomes.
2. Use think-pair-share strategies where students collaborate in pairs or groups to discuss concepts and solve small problems before sharing their understanding with the class.
3. Use real-world examples such as social media platforms or professional networks (e.g., LinkedIn) to demonstrate the concepts of Social Network Analysis.
4. Conduct practical sessions using software like Python with network libraries (e.g., NetworkX) to model and visualize network growth.
5. Use step-by-step explanations to demonstrate algorithms like PageRank and SimRank, followed by coding sessions for implementation.
6. Use network visualization tools (e.g., Gephi, Cytoscape) to help students identify and analyze communities in networks.
7. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information.
8. Demonstrate ways to solve the same problem and encourage the students to come up with their own creative solutions.

Module-1

Networks and Society - What is Social Network Analysis, why do We Study Social Networks, Applications of Social Network Analysis, Preliminaries, Three Levels of Social Network Analysis.

Network Measures - Network Basics, Node Centrality, Assortativity, Transitivity and Reciprocity, Similarity, Degeneracy.

T1 – Chapter 1 (1.1. – 1.5), Chapter 2 (2.1 – 2.6)

Module-2

Network Growth Models - Properties of Real-World Networks, Random Network Model, Ring Lattice Network Model, Watts–Strogatz Model, Preferential Attachment Model, Price's Model, Local-world Network Growth Model, Network Model with Accelerating Growth, Aging in Preferential Attachment.

T1 – Chapter 3 (3.1 – 3.9)

Module-3

Link Analysis - Applications of Link Analysis, Signed Networks, Strong and Weak Ties, Link Analysis Algorithms, PageRank, Personalised PageRank, DivRank, SimRank, PathSIM.
T1 – Chapter 4 (4.1 – 4.8)

Module-4

Community Structure in Networks - Applications of Community Detection, Types of Communities, Community Detection Methods, Disjoint Community Detection, Overlapping Community Detection, Local Community Detection, Community Detection vs Community Search, Evaluation of Community Detection Methods.
T1 – Chapter 5 (5.1 – 5.8)

Module-5

Link Prediction - Applications of Link Prediction, Temporal Changes in a Network, Problem Definition Evaluating Link Prediction Methods, Heuristic Models, Probabilistic Models, Supervised Random Walk, Information-theoretic Model, Latest Trends in Link Prediction.
T1 – Chapter 6 (6.1 – 6.9)

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Illustrate the core concepts of Social Network Analysis and its levels of study.
2. Demonstrate the different network growth models for real-world networks
3. Apply algorithms of PageRank and SimRank to analyze and interpret link relationships.
4. Apply community detection methods and evaluating their effectiveness in real-world scenarios.
5. Analyze heuristic, probabilistic, and supervised models to predict network link formations and changes.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Tanmoy Chakraborty, "Social Network Analysis", Wiley India Pvt. Ltd., 2021

Reference Books

1. Albert-Laszlo Barabasi, "Network Science", Cambridge University Press, 2016
2. Stanley Wasserman, Katherine Faust, "Social Network Analysis: Methods and Applications", Cambridge University Press, 1994

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- https://social-network-analysis.in/
- https://www.coursera.org/learn/social-network-analysis

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Activity 1: Network Visualization and Analysis (10 Marks)

Understand network basics, measures, and visualization techniques using a real-world dataset.

Instructions:

1. Choose a small real-world dataset (e.g., social media connections, collaboration networks, or communication networks).
2. Use a network analysis tool such as Gephi, NetworkX, or Cytoscape to visualize the dataset.
3. Analyze the following:
   - Node centrality measures (degree, closeness, and betweenness).
   - Network transitivity and reciprocity.
   - Similarity or assortativity in the network.
4. Submit a report that includes the network visualization and a summary of key findings.

Assessment Criteria:

- Clarity of visualization (3 marks)
- Accuracy in calculating and interpreting network measures (5 marks)
- Quality of the report (2 marks)

Activity 2: Community Detection and Link Prediction Project (15 Marks)

Apply community detection techniques and predict future connections within a network.

Instructions:

1. Select a medium-sized dataset (e.g., email communications, citation networks, or transport networks).
2. Perform the following tasks:
   - Identify and visualize communities using two different community detection methods (e.g., Disjoint and Overlapping Community Detection).
   - Evaluate the detected communities using appropriate evaluation metrics (e.g., modularity).
   - Use a link prediction algorithm (e.g., supervised random walk or probabilistic models) to forecast future connections within the network.
3. Prepare a detailed report with visuals and findings.

Assessment Criteria:

- Accuracy and comparison of community detection methods (7 marks)
- Implementation and results of link prediction (5 marks)
- Overall presentation and report quality (3 marks)

	Business Analytics		Semester	7
	Course Code	**BAD714B**	CIE Marks	50
	Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
	Total Hours of Pedagogy	40	Total Marks	100
	Credits	03	Exam Hours	03
	Examination type (SEE)	Theory		

Course objectives:

- Understand the nature of data, statistical Modelling and visualization.
- Learn concepts of Business analytics and Data Warehousing.
- Gain knowledge on Data mining process and SNA, text & Web analytics.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, can make use of digital tools to visually demonstrate key ideas that could be adopted to attain the outcomes.
2. Use think-pair-share strategies where students collaborate in pairs or groups to discuss concepts and solve small problems before sharing their understanding with the class.
3. Use case studies that apply machine learning in fields like finance, healthcare, and marketing to reinforce practical applications.
4. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information.
5. Utilize tools to visually demonstrate the impact of different concepts and methods of animation.
6. Demonstrate ways to solve the same problem and encourage the students to develop their own creative solutions.

Module-1

An Overview of Business Intelligence, Analytics, Data Science, and AI: Changing Business Environments and Evolving Needs for Decision Support and Analytics, Decision-Making Processes and Computerized Decision Support Framework, Evolution of Computerized Decision Support to Analytics/Data Science, A Framework for Business Intelligence, Analytics Overview.

Artificial Intelligence - Concepts, Drivers, Major Technologies, and Business Applications: Artificial Intelligence: Concepts, Drivers, Major Technologies, and Business Applications, Conversational AI—Chatbots.

[Note: Analytics in action – Excluded]

Chapter 1 (1.2-1.6), Chapter 2(2.4-2.6, 2.9)

Module-2

Descriptive Analytics I -Nature of Data, Big Data, and Statistical Modeling: The Nature of Data in Analytics, A Simple Taxonomy of Data, The Art and Science of Data Preprocessing, Definition of Big Data, Fundamentals of Big Data Analytics, Big Data Technologies, Big Data and Stream Analytics, Statistical Modeling for Business Analytics, Regression Modeling for Inferential Statistics.

[Note: Analytics in action – Excluded]

Chapter 3 (3.2-3.10)

Module-3

Descriptive Analytics II: Business Intelligence Data Warehousing, and Visualization: Business Intelligence and Data Warehousing, Data Warehousing Process, Data Warehousing Architectures, Data Management and Warehouse Development, Data Warehouse Administration, Security Issues, and

	Future Trends, Business Reporting, Data Visualization, Different Types of Charts and Graphs, The Emergence of Visual Analytics, Information Dashboards. [Note: Analytics in action – Excluded] **Chapter 4 (4.2-4.11)**
	Module-4
	Predictive Analytics I - Data mining process, methods, and Algorithms: Data Mining Concepts and Applications, Data Mining Applications, Data Mining Process, Data Mining Methods. **Prescriptive Analytics - Optimization and Simulation**: Model-Based Decision-Making, Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Decision Modeling with Spreadsheets. [Note: Analytics in action – Excluded] **Chapter 5 (5.2-5.5), Chapter-8 (8.2-8.5)**
	Module-5
	Predictive Analytics II - Text, Web, and Social Media Analytics: Text Analytics and Text Mining Overview, Natural Language Processing (NLP), Text Mining Applications, Text Mining Process, Sentiment Analysis and Topic Modeling, Web Mining Overview, Search Engines, Web Usage Mining (Web Analytics), Social Analytics. [Note: Analytics in action – Excluded] **Chapter 6 (6.2-6.10)**

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Explain the role of business analytics in a dynamic business environment.
2. Demonstrate modern tools for Statistical Modelling and Visualization.
3. Illustrate analytics for Business Analytics and Data Warehousing.
4. Implement algorithms for data mining techniques and processes.
5. Develop scripts for Text & Web mining and social network analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Textbook:

1. Ramesh Sharda, Dursun Delen and Efraim Turban, "Business Intelligence, Analytics, Data Science and AI – A Managerial Perspective", 5th edition, Global Edition, Pearson Education Limited, 2024.

Reference Books:

1. Steve Williams, Business Intelligence Strategy and Big Data Analytics - A General Management Perspective, Morgan Kaufmann (Elsevier), 2016.
2. Vincent Charles, Pratibha Garg, Neha Gupta and Mohini Agarwal, Data Analytics and Business Intelligence - Computational Frameworks, Practices, and Applications, CRC Press, 2023.
5. Ira J. Haimowitz, DATA ANALYTICS FOR BUSINESS - Lessons for Sales, Marketing, and Strategy, Routledge (Taylor & Francis), 2023.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc24_cs65/preview
- https://onlinecourses.nptel.ac.in/noc21_cs45/preview
- https://www.geeksforgeeks.org/what-is-data-analytics/
- https://onlinecourses.nptel.ac.in/noc20_mg11/preview
- https://onlinecourses.nptel.ac.in/noc23_mg104/preview
- https://onlinecourses.nptel.ac.in/noc20_mg24/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- For a batch of TWO students, submission of analytics report and conduction of group discussion (one example/case per batch) on examples (refer section 1.7) and Analytics in Action (Cases) of Textbook **[10 Marks]**
- Implementation (Individual): **15 Marks**
    1. Cluster analysis using k-means algorithm for a given customer data set (use Python/R/any other tool).
    2. Identify frequent item sets using the Apriori algorithm for a given transaction data set (use Python/R/any other tool).
    3. Use a dataset of customer product reviews (e.g., Amazon reviews) to classify the sentiment of each review as positive, negative, or neutral using a pre-trained machine learning model (e.g., Naïve Bayes). Evaluate the accuracy of your sentiment classifier. (use Python/R/any other tool).
    4. Use text mining techniques to analyse a collection of news articles. Identify the most frequent terms and perform topic modelling using Latent Dirichlet Allocation (LDA) to find hidden topics within the articles. (use Python/R/any other tool).
    5. Given a dataset representing a social network (e.g., Twitter follower data), create a graph and perform Social Network Analysis (SNA) to find the most influential users using centrality measures like degree, closeness, and betwenness centrality. (use Python/R/any other tool).

	DATA ENGINEERING AND MLOps		Semester	7
	Course Code	BAD714C	CIE Marks	50
	Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
	Total Hours of Pedagogy	50	Total Marks	100
	Credits	04	Exam Hours	3
	Examination type (SEE)	Theory		

Course objectives:

1. To introduce the concepts and lifecycle of Data Engineering.
2. To explore principles of data architecture and distributed systems.
3. To familiarize students with MLOps pipelines for scalable ML solutions.
4. To understand model deployment, CI/CD, monitoring, and feedback loops.
5. To ensure governance, reproducibility, and responsible AI compliance.

Teaching-Learning Process

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding
9. Use any of these methods: Chalk and board, Active Learning, Case Studies

Module-1

Data Engineering: Definition, The Data Engineering Lifecycle, Evolution of the Data Engineer, Data Engineering and Data Science, Data Engineering Skills and Activities, Data Maturity and the Data Engineer, The Background and Skills of a Data Engineer, Business Responsibilities, Technical Responsibilities, The Continuum of Data Engineering Roles, Data Engineers Inside an Organization ,

Internal-Facing Versus External-Facing Data Engineers, Data Engineers and Other Technical Roles, Data Engineers and Business Leadership.

Data Engineering Lifecycle: The Data Lifecycle Versus the Data Engineering Lifecycle, Generation: Source Systems, Major Undercurrents Across the Data Engineering Lifecycle

Textbook 1:Chapter 1 (1.1–1.5), Chapter 2 (2.1–2.4)

Module-2

Data Architecture: Enterprise Architecture Defined, Data Architecture Defined, "Good" Data Architecture, Principles of Good Data Architecture, Major Architecture Concepts, Domains and Services , Distributed Systems, Scalability, and Designing for Failure ,Tight Versus Loose Coupling: Tiers, Monoliths, and Microservices , User Access: Single Versus Multitenant , Event-Driven Architecture , Examples and Types of Data Architecture

Choosing Technologies Across the Data Engineering Lifecycle: Team Size and Capabilities, Speed to Market, Interoperability, Cost Optimization and Business Value, Total Cost of Ownership Total Opportunity Cost of Ownership, FinOps, Today Versus the Future: Immutable Versus Transitory Technologies: Hybrid Cloud, Multicloud , Decentralized: Blockchain and the Edge ,Monolith Versus Modular , Serverless Versus Servers, Server Versus Serverless evaluation

	Textbook 1:Chapter 3 (3.1–3.7), Chapter 4 (4.1–4.6)
	Module-3
	MLOps Challenges, MLOps to Mitigate Risk, Risk Assessment, Risk Mitigation, MLOps for Responsible AI,MLOps for Scale. Key MLOps Features: Model Development, Establishing Business Objectives, Data Sources and Exploratory Data Analysis, Feature Engineering and Selection, Training and Evaluation, Reproducibility, Responsible AI, Productionalization and Deployment, Model Deployment Types and Contents, Model Deployment Requirements, Monitoring Developing Models: Machine Learning Model, Required Components, Different ML Algorithms, Different MLOps Challenges, Data Exploration, Feature Engineering and Selection, Feature Engineering Techniques, How Feature Selection Impacts MLOps Strategy, Experimentation, Evaluating and Comparing Models, Choosing Evaluation Metrics, CrossChecking Model Behavior, Impact of Responsible AI on Modeling, Version Management and Reproducibility **Textbook 2: Chapter 1 (1.1–1.3), Chapter 2 (2.1–2.4)**
	Module-4
	Preparing for Production: Runtime Environments, Adaptation from Development to Production Environments, Data Access Before Validation and Launch to Production, Final Thoughts on Runtime Environments, Model Risk Evaluation, The Purpose of Model Validation, The Origins of ML Model Risk, Quality Assurance for Machine Learning. Deploying to Production: CI/CD Pipelines, Building ML Artifacts, The Testing Pipeline, Deployment Strategies, Categories of Model Deployment, Considerations When Sending Models to Production, Maintenance in Production, Containerization, Scaling Deployments, Requirements and Challenges. **Textbook 2:Chapter 3 (3.1–3.5), Chapter 4 (4.1–4.4)**
	Module-5 10 hours
	Monitoring and Feedback Loop: Models Be Retrained, Understanding Model Degradation, Ground Truth Evaluation, Input Drift Detection, Drift Detection in Practice, Example Causes of Data Drift, Input Drift Detection Techniques, The Feedback Loop, Logging, Model Evaluation, Online Evaluation Model Governance: Governance the Organization Needs, Matching Governance with Risk Level, Current Regulations Driving MLOps Governance, Pharmaceutical Regulation in the US: GxP Financial Model Risk Management Regulation, GDPR and CCPA Data Privacy Regulations, The New Wave of AI-Specific Regulation, The Emergence of Responsible AI, Key Elements of Responsible AI (Element 1 to Element 5), A Template for MLOps Governance (Step 1 to 8). **Textbook 2:Chapter 5 (5.1–5.4), Chapter 6 (6.1–6.3)**

Course outcome

At the end of the course, the student will be able to :

1. Explain Data Engineering and various roles.
2. Analyze various major architecture concepts of Data engineering.
3. Apply MLOps Features and analyze the challenges in developing and Deploying Machine Learning Models
4. Design CI/CD Pipelines for Deploying Machine Learning Models
5. Explain the need for model governance and MLOps governance.

Assessment Details (both CIE and SEE)

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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Textbooks:

1. Joe Reis, Matt Housley, Fundamentals of Data Engineering, O'Reilly, 2022
2. Mark Treveil & Dataiku Team, Introducing MLOps, O'Reilly, 2020

Web links and Video Lectures (e-Resources):

https://www.ibm.com/think/topics/data-engineering
https://martinfowler.com/articles/microservices.html
https://www.coursera.org/specializations/mlops

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Assignment 1 (15 marks) : Select a simple machine learning use case (e.g., house price prediction, customer churn prediction, or fraud detection). Design an MLOps pipeline that includes
  a. Problem statement and business objective
  b. Data sources and exploratory data analysis summary
  c. Feature engineering and selection approach
  d. Model training and evaluation plan
  e. Reproducibility and version control strategy
  Draw a flowchart or block diagram representing the MLOps pipeline
- Assignment 2(10 marks): Choose any one open-source MLOps tool (like MLflow, Kubeflow, or TFX). Study how the tool supports
  a. CI/CD pipelines
  b. Model testing & validation

c. Deployment strategies.

Write a report on tool overview and core components, CI/CD support, One deployment strategy explained in context, Advantages & challenges of using this tool in a real project.

BIG DATA ANALYTICS		Semester	7
Course Code	**BCS714D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

1. To implement MapReduce programs for processing big data.
2. To realize storage and processing of big data using MongoDB, Pig, Hive and Spark.
3. To analyze big data using machine learning techniques.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
6. Use any of these methods: Chalk and board, Active Learning, Case Studies.

MODULE-1

Classification of data, Characteristics, Evolution and definition of Big data, What is Big data, Why Big data, Traditional Business Intelligence Vs Big Data,Typical data warehouse and Hadoop environment.

Big Data Analytics: What is Big data Analytics, Classification of Analytics, Importance of Big Data Analytics, Technologies used in Big data Environments, Few Top Analytical Tools , NoSQL, Hadoop.

TB1: Ch 1: 1.1, Ch2: 2.1-2.5,2.7,2.9-2.11, Ch3: 3.2,3.5,3.8,3.12, Ch4: 4.1,4.2

MODULE-2

Introduction to Hadoop: Introducing hadoop, Why hadoop, Why not RDBMS, RDBMS Vs Hadoop, History of Hadoop, Hadoop overview, Use case of Hadoop, HDFS (Hadoop Distributed File System),Processing data with Hadoop, Managing resources and applications with Hadoop YARN(Yet Another Resource Negotiator).

Introduction to Map Reduce Programming: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression.

TB1: Ch 5: 5.1-,5.8, 5.10-5.12, Ch 8: 8.1 - 8.8

MODULE-3

Introduction to MongoDB: What is MongoDB, Why MongoDB, Terms used in RDBMS and MongoDB, Data Types in MongoDB, MongoDB Query Language.

TB1: Ch 6: 6.1-6.5

MODULE-4

Introduction to Hive: What is Hive, Hive Architecture, Hive data types, Hive file formats, Hive Query Language (HQL), RC File implementation, User Defined Function (UDF).

Introduction to Pig: What is Pig, Anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use case for Pig, Pig Latin Overview, Data types in Pig, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operators, Eval Function, Complex Data Types, Piggy Bank, User Defined Function, Pig Vs Hive.

TB1: Ch 9: 9.1-9.6,9.8, Ch 10: 10.1 - 10.15, 10.22

MODULE-5

Spark and Big Data Analytics: Spark, Introduction to Data Analysis with Spark.

Text, Web Content and Link Analytics: Introduction, Text Mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and Analyzing a Web Graph.
TB2: Ch5: 5.2,5.3, Ch 9: 9.1-9.4

Course outcomes (Course Skill Set):
At the end of the course, the student will be able to:

- Illustrate Big Data concepts, tools and applications.
- Develop programs using HADOOP framework.
- Use Hadoop Cluster to deploy Map Reduce jobs, PIG,HIVE and Spark programs.
- Analyze the given data set to identify deep insights.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books:

1. Seema Acharya and Subhashini Chellappan "Big data and Analytics", Wiley India Publishers, 2nd Edition, 2019.
2. Rajkamal and Preeti Saxena, "Big Data Analytics, Introduction to Hadoop, Spark and Machine Learning", McGraw Hill Publication, 2019.

Reference Books:

1. Adam Shook and Donald Mine, "MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems" - O'Reilly 2012

2. Tom White, "Hadoop: The Definitive Guide" 4th Edition, O'reilly Media, 2015.
3. Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers & Techniques, Pearson India Education Service Pvt. Ltd., 1st Edition, 2016
4. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy -Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, MIT Press 2020, 2nd Edition

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=bAyrObl7TYE&list=PLEiEAq2VkUUJqp1k-g5W1mo37urJQOdCZ
- https://www.youtube.com/watch?v=VmO0QgPCbZY&list=PLEiEAq2VkUUJqp1kg5W1mo37urJQOdCZ&index=4
- https://www.youtube.com/watch?v=GG-VRm6XnNk https://www.youtube.com/watch?v=JglO2Nv_92A

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Implement MongoDB based application to store big data for data processing and analyzing the results [15 marks]
2. Install Hadoop and Implement the following file management such as Adding files and directories, Retrieving files, Deleting files and directories and execute Map- Reduce based programs.[10]

Introduction to DBMS		Semester	7
Course Code	**BCS755A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

- To Provide a strong foundation in database concepts, technology, and practice.
- To Practice SQL programming through a variety of database problems.
- To Understand the relational database design principles.
- To Demonstrate the use of concurrency in database.
- To Design and build database applications for real world problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
- Use of Video/Animation to explain functioning of various concepts.
- Encourage collaborative (Group Learning) Learning in the class.
- Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
- Use any of these methods: Chalk and board, Active Learning, Case Studies.

MODULE-1

Introduction to Databases: Introduction, Characteristics of database approach, Advantages of using the DBMS approach, History of database applications.

Overview of Database Languages and Architectures: Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment.

Textbook 1:Ch 1.1 to 1.8, 2.1 to 2.6

MODULE-2

Conceptual Data Modeling using Entities and Relationships: Entity types, Entity sets and structural constraints, Weak entity types, ER diagrams, Specialization and Generalization.

Mapping Conceptual Design into a Logical Design: Relational Database Design using ER-to-Relational mapping

Textbook 1: Ch 3.1 to 3.10, 9.1 & 9.2

MODULE-3

Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations.

Relational Algebra: Unary and Binary relational operations, additional relational operations (aggregate, grouping, etc.) Examples of Queries in relational algebra.

Textbook 1: Ch 5.1 to 5.3, Ch 8.1 to 8.5

MODULE-4

SQL: SQL data definition and data types, Schema change statements in SQL, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL

Normalization: Database Design Theory – Introduction to Normalization using Functional and Multivalued Dependencies: Informal design guidelines for relation schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form.

Textbook 1: Ch 6.1 to 6.5,14.1 to 14.7

MODULE-5

SQL: Advanced Queries: More complex SQL retrieval queries, Specifying constraints as assertions and action triggers, Views in SQL.

Concurrency Control in Databases: Two-phase locking techniques for Concurrency control, Concurrency control based on Timestamp ordering, Multiversion Concurrency control techniques, Validation Concurrency control techniques, Granularity of Data items and Multiple Granularity Locking.

Textbook 1: Ch 7.1 to 7.3, 21.1 to 21.5

Course outcomes (Course Skill Set):
At the end of the course, the student will be able to:

- Demonstrate the basic elements of a database management system.
- Design entity relationship and convert entity relationship diagrams into RDBMS.
- Use Structured Query Language (SQL) for database manipulation.
- Apply normalization to increase the efficiency of database design.
- Illustrate the concepts of concurrency control techniques.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Text Books:

1. Fundamentals of Database Systems, Ramez Elmasri and Shamkant B. Navathe, 7th Edition, 2017, Pearson.

Reference Books:

1. Database management systems, Ramakrishnan, and Gehrke, 3rd Edition, 2014, McGraw Hill

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Course Project (25 marks)

- For any problem selected
    - Develop the application having at least five tables & domain areas shall include health care, agriculture & so on.

	Introduction to Algorithms		Semester	7
	Course Code	BCS755B	CIE Marks	50
	Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
	Total Hours of Pedagogy	40	Total Marks	100
	Credits	03	Exam Hours	03
	Examination type (SEE)	Theory		

Course objectives:

- To learn the methods for analyzing algorithms and evaluating their performance.
- To demonstrate the efficiency of algorithms using asymptotic notations.
- To solve problems using various algorithm design methods, including brute force, greedy, divide and conquer, decrease and conquer, transform and conquer, dynamic programming, backtracking, and branch and bound.
- To learn the concepts of P and NP complexity classes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but different types of teaching methods may be adopted to achieve the outcomes.
2. Utilize video/animation films to illustrate the functioning of various concepts.
3. Promote collaborative learning (Group Learning) in the class.
4. Pose at least three HOT (Higher Order Thinking) questions in the class to stimulate critical thinking.
5. Incorporate Problem-Based Learning (PBL) to foster students' analytical skills and develop their ability to evaluate, generalize, and analyze information rather than merely recalling it.
6. Introduce topics through multiple representations.
7. Demonstrate various ways to solve the same problem and encourage students to devise their own creative solutions.
8. Discuss the real-world applications of every concept to enhance students' comprehension.

Module-1

INTRODUCTION: What is an Algorithm?, Fundamentals of Algorithmic Problem Solving, Important problem Types, Fundamental Data Structures, Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, ,Analysis Framework, Asymptotic Notations and Basic Efficiency Classes,

Chapter 1 (Sections 1.1 to 1.4), Chapter 2 (2.1, 2.2)

Module-2

FUNDAMENTALS OF THE ANALYSIS OF ALGORITHM EFFICIENCY: Mathematical Analysis of Non-recursive Algorithms, Mathematical Analysis of Recursive Algorithms.

BRUTE FORCE APPROACHES: Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching.

Chapter 2(Sections 2.3,2.4), Chapter 3(Section 3.1,3.2)

	Module-3
	Exhaustive Search (Travelling Salesman problem and Knapsack Problem). **Depth First search and Breadth First search.** **DECREASE-AND-CONQUER:** Insertion Sort, Topological Sorting. **DIVIDE AND CONQUER:** Merge Sort, Binary Tree Traversals. **Chapter 3(3.4,3.5), Chapter 4 (Sections 4.1,4.2), Chapter 5 (Section 5.1,5.3)**
	Module-4
	TRANSFORM-AND-CONQUER: Balanced Search Trees (AVL Trees), Heaps and Heapsort. **SPACE-TIME TRADEOFFS:** Sorting by Counting: Comparison counting sort, Input Enhancement in String Matching: Horspool's Algorithm, Hashing. **Chapter 6 (Sections 6.3,6.4), Chapter 7 (Sections 7.1,7.2, 7.3)**
	Module-5
	DYNAMIC PROGRAMMING: Three basic examples, The Knapsack Problem and Memory Functions. **THE GREEDY METHOD:** Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees and Codes. **Chapter 8 (Sections 8.1,8.2), Chapter 9 (Sections 9.2,9.3,9.4)**

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Explain the algorithm design steps and computational problem types.
2. Apply the asymptotic notational method to analyze the performance of the algorithms in terms of time complexity.
3. Demonstrate divide & conquer approaches and decrease & conquer approaches to solve computational problems.
4. Make use of the transform & conquer design approach to solve the given real-world or complex computational problems.
5. Apply greedy and dynamic programming methods to solve graph & string-based computational problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Textbooks

1. Introduction to the Design and Analysis of Algorithms, By Anany Levitin, 3rd Edition (Indian), 2017, Pearson.

Reference books

1. Computer Algorithms/C++, Ellis Horowitz, SatrajSahni and Rajasekaran, 2nd Edition, 2014, Universities Press.
2. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI.
3. Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education)

Web links and Video Lectures (e-Resources):

- Design and Analysis of Algorithms: https://nptel.ac.in/courses/106/101/106101060/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Problem Solving - Competitive programming (Hacker Rank/ Hacker Earth / Leetcode) – 10 Marks
2. Problem solving (Numerical examples) related to different algorithms – 15 Marks

	SOFTWARE ENGINEERING		Semester	7
	Course Code	**BCS755C**	CIE Marks	50
	Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
	Total Hours of Pedagogy	50	Total Marks	100
	Credits	04	Exam Hours	3
	Examination type (SEE)	Theory		

Course objectives:

To understand foundational principles and the evolving nature of software engineering.
- To learn various software process models and their practical applications.
- To acquire skills in gathering, modeling, and validating software requirements.
- To apply Agile methodologies and understand core software engineering practices.
- To build a foundation for software design, testing, and quality assurance.

Teaching-Learning Process

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding
9. Use any of these methods: Chalk and board, Active Learning, Case Studies

Module-1

Software and Software Engineering: The nature of Software, The unique nature of WebApps, Software Engineering, The software Process, Software Engineering Practice, Software Myths.

Process Models: A generic process model, Process assessment and improvement, Prescriptive process models: Waterfall model, Incremental process models, Evolutionary process models, Concurrent models, Specialized process models. Unified Process , Personal and Team process models

Textbook 1: Chapter 1: 1.1 to 1.6, Chapter 2: 2.1 to 2.5

Module-2

	Understanding Requirements: Requirements Engineering, Establishing the ground work, Eliciting Requirements, Developing use cases, Building the requirements model, Negotiating Requirements, Validating Requirements. **Requirements Modeling Scenarios, Information and Analysis classes**: Requirement Analysis, Scenario based modeling, UML models that supplement the Use Case, Data modeling Concepts, Class-Based Modeling. Requirement Modeling Strategies : Flow oriented Modeling , Behavioral Modeling. **Textbook 1: Chapter 5: 5.1 to 5.7, Chapter 6: 6.1 to 6.5, Chapter 7: 7.1 to 7.3**
	Module-3
	Agile Development: What is Agility?, Agility and the cost of change. What is an agile Process?, Extreme Programming (XP), Other Agile Process Models, A tool set for Agile process . **Principles that guide practice**: Software Engineering Knowledge, Core principles, Principles that guide each framework activity. **Textbook 1: Chapter 3: 3.1 to 3.6, Chapter 4: 4.1 to 4.3**
	Module-4
	Software Design: Design within the context of software engineering, Design process and quality, Design concepts: abstraction, modularity, architecture, patterns. **Architectural Design**: Architectural styles and patterns, reference architectures, component-level design, designing class-based components, conducting component-level design, design for reuse. **Textbook 1:Chapter 8: 8.1–8.6, Chapter 9: 9.1–9.5**
	Module-5
	Software Testing: Introduction to software testing, Strategic approach, Test strategies for conventional and object-oriented software, Validation testing, System testing, White-box and Black-box testing, Basis Path Testing, Control structure testing. **Software Quality:** Concepts of quality, Software quality assurance, Reviews, Software reliability and metrics. **Textbook 1: Chapter 14: Sections 14.1 to 14.5,Chapter 15: Sections 15.1 to 15.5, Chapter 19: Sections 19.1 to 19.5**

Course outcome

At the end of the course, the student will be able to :

1. Explain the software nature, engineering practices, myths, and software process models.
2. Apply requirements engineering, elicitation, modeling, and validation in software development.
3. Demonstrate agile principles, practices, and tools for software development agility.
4. Apply design concepts, process, and architecture for quality software development.
5. Explain software testing strategies and quality assurance for reliable software.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Textbook

Roger S. Pressman: Software Engineering – A Practitioner's Approach, 7th Edition, Tata McGraw Hill, 2010.

Web links and Video Lectures (e-Resources):

https://www.geeksforgeeks.org/software-engineering/software-engineering/

Activity-Based Learning (Suggested Activities in Class)/Practical-Based learning

- Course project (Group of two students): Simulation that covers all the phases of SDLC - 25 marks