DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

Evaluation Scheme & Syllabus

For

B. TECH THIRD YEAR

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

On

Choice Based Credit System

(Effective from the Session: 2024-25)

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY

UTTAR PRADESH, LUCKNOW

B.TECH.
COMPUTER SCIENCE & ENGINEERING - (DATA SCIENCE)
CURRICULUM STRUCTURE

SEMESTER- V

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	BCS501	Database Management System	3	1	0	20	10	30		70		100	4
2	BCDS501	Introduction to Data Analytics and Visualization	3	1	0	20	10	30		70		100	4
3	BCS503	Design and Analysis of Algorithm	3	1	0	20	10	30		70		100	4
4	Dept. Elective-I	Departmental Elective-I	3	0	0	20	10	30		70		100	3
5	Dept. Elective-II	Departmental Elective-II	3	0	0	20	10	30		70		100	3
6	BCS551	Database Management System Lab	0	0	2				50		50	100	1
7	BCDS551	Data Analytics and Visualization Lab	0	0	2				50		50	100	1
8	BCS553	Design and Analysis of Algorithm Lab	0	0	2				50		50	100	1
9	BCS554	Mini Project or Internship Assessment*	0	0	2				100			100	2
10	BNC501/ BNC502	Constitution of India. Law and Engineering / Indian Tradition, Culture and Society	2	0	0	20	10	30		70			
		Total										**900**	**23**

***The Mini Project or Internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.

***It is desirable that the students should do their Summer Internship or Mini Project in their specialization area in line with the B.Tech. program

SEMESTER- VI												
Sl. No.	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	BCS601	Software Engineering	3	1	0	20	10	30		70		100	4
2	BCDS601	Big Data and Analytics	3	1	0	20	10	30		70		100	4
3	BCS603	Computer Networks	3	1	0	20	10	30		70		100	4
4	Dept. Elective-III	Departmental Elective-III	3	0	0	20	10	30		70		100	3
5		Open Elective-I	3	0	0	20	10	30		70		100	3
6	BCS652	Software Engineering Lab	0	0	2				50		50	100	1
7	BCDS651	Big Data and Analytics Lab	0	0	2				50		50	100	1
8	BCS653	Computer Networks Lab	0	0	2				50		50	100	1
9	BNC601/ BNC602	Constitution of India. Law and Engineering / Indian Tradition, Culture and Society	2	0	0	20	10	30		70			
		Total										**800**	**21**

* The Mini Project or Internship (4 weeks) will be done during summer break after VI Semester and will be assessed during VII semester.
* It is desirable that the students should do their Summer Internship or Mini Project in their specialization area in line with the B.Tech. program.

Departmental Elective-I

1. BCAI051 - Mathematical Foundation AI, ML and Data Science
2. BCS058 – Data Warehouse & Data Mining
3. BCDS051 - Business Intelligence and Analytics
4. BCS054 - Object Oriented System Design with C++

Departmental Elective-II

1.BCAM051 - Cloud Computing
2.BCAI052 - Natural Language Processing
3.BCS056-Application of Soft Computing
4.BCS057 Image Processing

Departmental Elective-III

1. BCAI061 - Cyber Forensic Analytics
2.BCDS061 - Image Analytics
3.BCAM061 – Social Media Analytics and Data Analysis
4.BCDS062 – Machine Learning Techniques

B.TECH.

Computer Science and Engineering (Data Science)

BCS501	**DATABASE MANAGEMENT SYSTEM**	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to understand		
CO 1	Apply knowledge of database for real life applications.	K_3
CO 2	Apply query processing techniques to automate the real time problems of databases.	K_3, K_4
CO 3	Identify and solve the redundancy problem in database tables using normalization.	K_2, K_3
CO 4	Understand the concepts of transactions, their processing so they will familiar with broad range of database management issues including data integrity, security and recovery.	K_2, K_4
CO 5	Design, develop and implement a small database project using database tools.	K_3, K_6
DETAILED SYLLABUS		**3-1-0**

Unit	**Topic**	**Proposed Lecture**
I	**Introduction:** Overview, Database System vs File System, Database System Concept and Architecture, Data Model Schema and Instances, Data Independence and Database Language and Interfaces, Data Definitions Language, DML, Overall Database Structure. Data Modeling Using the Entity Relationship Model: ER Model Concepts, Notation for ER Diagram, Mapping Constraints, Keys, Concepts of Super Key, Candidate Key, Primary Key, Generalization, Aggregation, Reduction of an ER Diagrams to Tables, Extended ER Model, Relationship of Higher Degree.	**08**
II	**Relational data Model and Language:** Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Keys Constraints, Domain Constraints, Relational Algebra, Relational Calculus, Tuple and Domain Calculus. Introduction on SQL: Characteristics of SQL, Advantage of SQL. SQl Data Type and Literals. Types of SQL Commands. SQL Operators and Their Procedure. Tables, Views and Indexes. Queries and Sub Queries. Aggregate Functions. Insert, Update and Delete Operations, Joins, Unions, Intersection, Minus, Cursors, Triggers, Procedures in SQL/PL SQL	**08**
III	**Data Base Design & Normalization:** Functional dependencies, normal forms, first, second, 8 third normal forms, BCNF, inclusion dependence, loss less join decompositions, normalization using FD, MVD, and JDs, alternative approaches to database design	**08**
IV	**Transaction Processing Concept:** Transaction System, Testing of Serializability, Serializability of Schedules, Conflict & View Serializable Schedule, Recoverability, Recovery from Transaction Failures, Log Based Recovery, Checkpoints, Deadlock Handling. Distributed Database: Distributed Data Storage, Concurrency Control, Directory System.	**08**
V	**Concurrency Control Techniques:** Concurrency Control, Locking Techniques for Concurrency Control, Time Stamping Protocols for Concurrency Control, Validation Based Protocol, Multiple Granularity, Multi Version Schemes, Recovery with Concurrent Transaction, Case Study of Oracle.	**08**

Text books:

1. Korth, Silbertz, Sudarshan," Database Concepts", McGraw Hill
2. Date C J, "An Introduction to Database Systems", Addision Wesley
3. Elmasri, Navathe, "Fundamentals of Database Systems", Addision Wesley
4. O'Neil, Databases, Elsevier Pub.
5. RAMAKRISHNAN"Database Management Systems",McGraw Hill
6. Leon & Leon,"Database Management Systems", Vikas Publishing House
7. Bipin C. Desai, "An Introduction to Database Systems", Gagotia Publications
8. Majumdar & Bhattacharya, "Database Management System", TMH

BCDS501	INTRODUCTION TO DATA ANALYTICS AND VISUALIZATION	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to understand		
CO 1	Describe the life cycle phases of Data Analytics through discovery, planning and building.	K_3
CO 2	Understand and apply Data Analysis Techniques.	K_3, K_4
CO 3	Implement various Data streams.	K_2, K_3
CO 4	Understand item sets, Clustering, frame works & Visualizations.	K_2, K_4
CO 5	Understand the Data Visualizations & Human Vision	K_2, K_3
DETAILED SYLLABUS		**3-1-0**

Unit	Topic	Proposed Lecture
I	**Introduction to Data Analytics:** Sources and nature of data, classification of data (structured, semi-structured, unstructured), characteristics of data, introduction to Big Data platform, need of data analytics, evolution of analytic scalability, analytic process and tools, analysis vs reporting, modern data analytic tools, applications of data analytics. **Data Analytics Lifecycle:** Need, key roles for successful analytic projects, various phases of data analytics lifecycle – discovery, data preparation, model planning, model building, communicating results, operationalization.	**08**
II	**Data Analysis:** Regression modeling, multivariate analysis, Bayesian modeling, inference and Bayesian networks, support vector and kernel methods, analysis of time series: linear systems analysis & nonlinear dynamics, rule induction, neural networks: learning and generalisation, competitive learning, principal component analysis and neural networks, fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, stochastic search methods.	**08**
III	**Mining Data Streams:** Introduction to streams concepts, stream data model and architecture, stream computing, sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting oneness in a window, decaying window, Real-time Analytics Platform (RTAP) applications, Case studies – real time sentiment analysis, stock market predictions.	**08**
IV	**Frequent Itemsets and Clustering:** Mining frequent itemsets, market based modelling, Apriori algorithm, handling large data sets in main memory, limited pass algorithm, counting frequent itemsets in a stream, clustering techniques: hierarchical, K-means, clustering high dimensional data, CLIQUE and ProCLUS, frequent pattern based clustering methods, clustering in non-euclidean space, clustering for streams and parallelism.	**08**
V	Introduction to Visualization and Stages – Computational Support – Issues – Different Types of Tasks – Data representation – Limitation: Display Space- Rendering Time – Navigation Links. Human Vision – Space Limitation – Time Limitations – Design – Exploration of Complex Information Space – Figure Caption in Visual Interface – Visual Objects and Data Objects - Space Perception and Data in Space – Images, Narrative and Gestures for Explanation.	**08**

Text 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. Bill Franks, Taming the Big Data Tidal wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & Sons.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
5. David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big Data Analytics”, EMC Education Series, John Wiley
6. Frank J Ohlhorst, “Big Data Analytics: Turning Big Data into Big Money”, Wiley and SAS Business Series
7. Colleen Mccue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Elsevier
8. Anil Maheshwari, “Data Analytics”, McGraw Hill Education
9. Paul Zikopoulos, Chris Eaton, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw Hill
10. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer
11. Mark Gardner, “Beginning R: The Statistical Programming Language”, Wrox Publication
12. Pete Warden, Big Data Glossary, O’Reilly
13. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons
14. Pete Warden, Big Data Glossary, O’Reilly.
15. Peter Bühlmann, Petros Drineas, Michael Kane, Mark van der Laan, "Handbook of Big Data", CRC Press
16. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, Second Edition, ElsevierRobert Spence, “Information Visualization Design for Interaction”, Second Edition, Pearson Education, 2006.

BCS503	DESIGN AND ANALYSIS OF ALGORITHM	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to understand		
CO 1	Design new algorithms, prove them correct, and analyze their asymptotic and absolute runtime and memory demands.	K_4, K_6
CO 2	Find an algorithm to solve the problem (create) and prove that the algorithm solves the problem correctly (validate).	K_5, K_6
CO 3	Understand the mathematical criterion for deciding whether an algorithm is efficient, and know many practically important problems that do not admit any efficient algorithms.	K_2, K_5
CO 4	Apply classical sorting, searching, optimization and graph algorithms.	K_2, K_4
CO 5	Understand basic techniques for designing algorithms, including the techniques of recursion, divide-and-conquer, and greedy.	K_2, K_3
DETAILED SYLLABUS		**3-1-0**

Unit	Topic	Proposed Lecture
I	**Introduction:** Algorithms, Analyzing Algorithms, Complexity of Algorithms, Growth of Functions, Performance Measurements, Sorting and Order Statistics - Shell Sort, Quick Sort, Merge Sort, Heap Sort, Comparison of Sorting Algorithms, Sorting in Linear Time.	**08**
II	**Advanced Data Structures:** Red-Black Trees, B – Trees, Binomial Heaps, Fibonacci Heaps, Tries, Skip List	**08**
III	**Divide and Conquer** with Examples Such as Sorting, Matrix Multiplication, Convex Hull and Searching. **Greedy Methods** with Examples Such as Optimal Reliability Allocation, Knapsack, Minimum Spanning Trees – Prim's and Kruskal's Algorithms, Single Source Shortest Paths - Dijkstra's and Bellman Ford Algorithms.	**08**
IV	**Dynamic Programming** with Examples Such as Knapsack. All Pair Shortest Paths – Warshal's and Floyd's Algorithms, Resource Allocation Problem. Backtracking, Branch and Bound with Examples Such as Travelling Salesman Problem, Graph Coloring, n-Queen Problem, Hamiltonian Cycles and Sum of Subsets.	**08**
V	**Selected Topics:** Algebraic Computation, Fast Fourier Transform, String Matching, Theory of NP Completeness, Approximation Algorithms and Randomized Algorithms	**08**

Text books:

1. Thomas H. Coreman, Charles E. Leiserson and Ronald L. Rivest, "Introduction to Algorithms", Printice Hall of India.
2. E. Horowitz & S Sahni, "Fundamentals of Computer Algorithms",
3. Aho, Hopcraft, Ullman, "The Design and Analysis of Computer Algorithms" Pearson Education, 2008.
4. LEE "Design & Analysis of Algorithms (POD)",McGraw Hill
5. Richard E.Neapolitan "Foundations of Algorithms" Jones & Bartlett Learning
6. Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson, 2005.
7. Michael T Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Wiley, 2006.
8. Harry R. Lewis and Larry Denenberg, Data Structures and Their Algorithms, Harper Collins, 1997
9. Robert Sedgewick and Kevin Wayne, Algorithms, fourth edition, Addison Wesley, 2011.
10. Harsh Bhasin,"Algorithm Design and Analysis",First Edition,Oxford University Press.
11. Gilles Brassard and Paul Bratley,Algorithmics:Theory and Practice,Prentice Hall,1995.

BCAI051	MATHEMATICAL FOUNDATION AI, ML AND DATA SCIENCE	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Understand and apply the probability distributions, random number generation and density estimations to perform analysis of various kinds of data	$K2, K_4, K_6$
CO 2	Understand and manipulate data, design and perform simple Monte Carlo experiments, and be able to use resampling methods	K_5, K_6
CO 3	Perform statistical analysis on variety of data	K_2, K_5
CO 4	Perform appropriate statistical tests using R and visualize the outcome	K_2, K_4
CO 5	Discuss the results obtained from their analyses after creating customized graphical and numerical summaries	K_2, K_3

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**Descriptive Statistics:** Diagrammatic representation of data, measures of central tendency, measures of dispersion, measures of skewness and kurtosis, correlation, inference procedure for correlation coefficient, bivariate correlation, multiple correlations, linear regression and its inference procedure, multiple regression. **Probability:** Measures of probability, conditional probability, independent event, Bayes' theorem, random variable, discrete and continuous probability distributions, expectation and variance, markov inequality, chebyshev's inequality, central limit theorem.	**08**
II	**Inferential Statistics:** Sampling & Confidence Interval, Inference & Significance. Estimation and Hypothesis Testing, Goodness of fit, Test of Independence, Permutations and Randomization Test, ttest/z-test (one sample, independent, paired), ANOVA, chi-square. **Linear Methods for Regression Analysis:** multiple regression analysis, orthogonalization by Householder transformations (QR); singular value decomposition (SVD); linear dimension reduction using principal component analysis (PCA).	**08**
III	**Pseudo-Random Numbers:** Random number generation, Inverse-transform, acceptance-rejection, transformations, multivariate probability calculations. **Monte Carlo Integration:** Simulation and Monte Carlo integration, variance reduction, Monte Carlo hypothesis testing, antithetic variables/control variates, importance sampling, stratified sampling Markov chain Monte Carlo (McMC): Markov chains; Metropolis-Hastings algorithm; Gibbs sampling; convergence	**08**
IV	**Vector Spaces-** Vector Space, Subspace, Linear Combination, Linear Independence, Basis, Dimension, Finding a Basis of a Vector Space, Coordinates, Change of Basis **Inner Product Spaces-** Inner Product, Length, Orthogonal Vectors, Triangle Inequality, Cauchy-Schwarz Inequality, Orthonormal (Orthogonal) Basis, Gram-Schmidt Process	**08**

V	**Linear Transformations**- Linear Transformations and Matrices for Linear Transformation, Kernel and Range of a Linear Transformations, Change of Basis **Eigenvalues and Eigenvectors**- Definition of Eigenvalue and Eigenvector, Diagonalization, Symmetric Matrices and Orthogonal Diagonalization	**08**

References:

1. S.C. Gupta & V.K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons
2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press.
3. Dudewicz, E.J., Mishra, S.N., "Modern Mathematical Statistics", Willy
4. Purohit S. G., Gore S. D., Deshmukh S. K., "Statistics using R, Narosa
5. Rizzo, M. L., "Statistical Computing with R", Boca Raton, FL: Chapman & Hall/CRC Press
6. Normal Maltoff, The Art of R programming, William
7. Dalgaard, Peter, "Introductory statistics with R", Springer Science & Business Media
8. M. D. Ugarte, A. F. Militino, A. T. Arnholt, "Probability and Statistics with R", CRC Press
9. Kundu, D. and Basu, A., "Statistical computing – existing methods and recent developments", Narosa
10. Gentle, James E., Härdle, Wolfgang Karl, Mori, Yuich, "Handbook of Computational Statistics", Springer
11. Givens and Hoeting, "Computational Statistics", Wiley Series in Prob. and Statistics
12. Elementary Linear Algebra by Ron Larson, 8th edition, Cengage Learning, 2017

BCS058	DATA WAREHOUSING & DATA MINING	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Be familiar with mathematical foundations of data mining tools.	K_1, K_2
CO 2	Understand and implement classical models and algorithms in data warehouses and data mining	K3
CO 3	Characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering	K_1, K_2
CO 4	Master data mining techniques in various applications like social, scientific and environmental context	K3
CO 5	Develop skill in selecting the appropriate data mining algorithm for solving practical problems.	K_1, K_2

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**Data Warehousing:** Overview, Definition, Data Warehousing Components, Building a Data Warehouse, Warehouse Database, Mapping the Data Warehouse to a Multiprocessor Architecture, Difference between Database System and Data Warehouse, Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept.	**08**
II	**Data Warehouse Process and Technology:** Warehousing Strategy, Warehouse /management and Support Processes, Warehouse Planning and Implementation, Hardware and Operating Systems for Data Warehousing, Client/Server Computing Model & Data Warehousing. Parallel Processors & Cluster Systems, Distributed DBMS implementations, Warehousing Software, Warehouse Schema Design	**08**
III	**Data Mining:** Overview, Motivation, Definition & Functionalities, Data Processing, Form of Data Pre-processing, 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, Discretization and Concept hierarchy generation, Decision Tree	**08**
IV	**Classification:** Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases, Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms. Clustering: Introduction, Similarity and Distance Measures, Hierarchical and Partitional Algorithms. Hierarchical Clustering-CURE andChameleon. Density Based Methods DBSCAN, OPTICS. Grid Based Methods- STING, CLIQUE. Model Based Method – Statistical Approach, Association rules:Introduction, Large Item sets, Basic Algorithms, Parallel and Distributed Algorithms, Neural Network approach.	**08**
V	**Data Visualization and Overall Perspective**: Aggregation, Historicalinformation, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse. Warehousing applications and Recent Trends: Types of Warehousing Applications, Web Mining, Spatial Mining and Temporal Mining.	**08**

Text Books:

1. Alex Berson, Stephen J. Smith “Data Warehousing, Data-Mining & OLAP”, TMH
2. Mark Humphries, Michael W. Hawkins, Michelle C. Dy, “Data Warehousing: Architecture and Implementation”, Pearson
3. Margaret H. Dunham, S. Sridhar,” Data Mining: Introductory and Advanced Topics” Pearson Education
4. Arun K. Pujari, “Data Mining Techniques” Universities Press
5. Pieter Adriaans, Dolf Zantinge, “Data-Mining”, Pearson Education

BCDS051	BUSINESS INTELLIGENCE AND ANALYTICS	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Understand the essentials of BI & data analytics and the corresponding terminologies	K_2
CO 2	Analyze the steps involved in the BI - Analytics process	K_3, K_4
CO 3	Illustrate competently on the topic of analytics	K_2, K_3
CO 4	Understand & Implement the K-Means Clustering with Iris Dataset	K_2, K_3
CO 5	Demonstrate the real time scenario (Case study) by using BI & Analytics techniques	K_5, K_6
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**BUSINESS INTELLIGENCE – INTRODUCTION:** Introduction - History and Evolution: Effective and Timely decisions, Data Information and Knowledge, Architectural Representation, Role of mathematical Models, Real Time Business Intelligent System.	**8**
II	**BI – DATA MINING & WAREHOUSING:** Data Mining - Introduction to Data Mining, Architecture of Data Mining and How Data mining works (Process), Functionalities & Classifications of Data Mining, Representation of Input Data, Analysis Methodologies. Data Warehousing - Introduction to Data Warehousing, Data Mart, Online Analytical Processing (OLAP) – Tools, Data Modelling, Difference between OLAP and OLTP, Schema – Star and Snowflake Schemas, ETL Process – Role of ETL	**8**
III	**BI – DATA PREPARTTION:** Data Validation - Introduction to Data Validation, Data Transformation – Standardization and Feature Extraction, Data Reduction – Sampling, Selection, PCA, Data Discretization	**8**
IV	**BI – DATA ANALYTICS PROCESS -** Introduction to analytics process, Types of Analytical Techniques in BI –Descriptive, Predictive, Perspective, Social Media Analytics, Behavioral, Iris Datasets	**8**
V	**IMPLEMENTATION OF BI:** Business Activity Monitoring, Complex Event Processing, Business Process Management, Metadata, Root Cause Analysis.	**8**

Text Books:

1. Carlo-Vercellis, “Business Intelligence Data Mining and Optimization for Decision-Making”, First Edition
2. Drew Bentely, “Business Intelligence and Analytics” ,@2017 Library Pres., ISBN: 978-1-9789-2136-8
3. Larissa T. Moss & Shaku Atre, “Business Intelligence Roadmap: The Complete Project Lifecycle
4. For Decision-Support Applications”, First Edition, Addison-Wesley Professional,2003
5. Kimball, R., Ross, M., Thornthwaite, W., Mundy, J., and Becker, B. John, “The Data Warehouse 6. Lifecycle Toolkit: Practical Techniques for Building Data Warehouse and Business Intelligence Systems”, Second Edition, Wiley & Sons, 2008.

7. Cindi Howson, “Successful Business Intelligence”, Second Edition, McGraw-Hill Education, 2013.

BCS054	OBJECT ORIENTED SYSTEM DESIGN with C++	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	To understand the application development and analyze the insights of object-oriented programming to implement application	K_2, K_4
CO 2	To understand, analyze and apply the role of overall modeling concepts (i.e. System, structural)	K_2, K_3
CO 3	To understand, analyze and apply oops concepts (i.e. abstraction, inheritance)	K_2, K_3, K_4
CO 4	To understand the basic concepts of C++ to implement the object-oriented concepts	K_2, K_3
CO 5	To understand the object-oriented approach to implement real world problem.	K_2, K_3
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**Introduction:** The meaning of Object Orientation, object identity, Encapsulation, information hiding, polymorphism, generosity, importance of modelling, principles of modelling, object-oriented modelling, Introduction to UML, conceptual model of the UML, Architecture.	**08**
II	**Basic Structural Modeling:** Classes, Relationships, common Mechanisms, and diagrams. Class &Object Diagrams: Terms, concepts, modelling techniques for Class & Object Diagrams. **Collaboration Diagrams:** Terms, Concepts, depicting a message, polymorphism in collaboration Diagrams, iterated messages, use of self in messages. Sequence Diagrams: Terms, concepts, depicting asynchronous messages with/without priority, call-back mechanism, broadcast messages. **Basic Behavioural Modeling:** Use cases, Use case Diagrams, Activity Diagrams, State Machine, Process and thread, Event and signals, Time diagram, interaction diagram, Package diagram. **Architectural Modeling:** Component, Deployment, Component diagrams and Deployment diagrams.	**08**
III	Object Oriented Analysis: Object oriented design, Object design, Combining three models, Designing algorithms, design optimization, Implementation of control, Adjustment of inheritance, Object representation, Physical packaging, Documenting design considerations. **Structured analysis and structured design (SA/SD),** Jackson Structured Development (JSD). Mapping object-oriented concepts using non-object-oriented language, Translating classes into data structures, Passing arguments to methods, Implementing inheritance, associations encapsulation. **Object oriented programming style:** reusability, extensibility, robustness, programming in the large. Procedural v/s OOP, Object oriented language features. Abstraction and Encapsulation.	**08**
IV	**C++ Basics:** Overview, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures **C++ Functions:** Simple functions, Call and Return by reference, Inline functions, Macro Vs. Inline functions, Overloading of functions, default arguments, friend functions, virtual functions	**08**
V	**Objects and Classes:** Basics of object and class in C++, Private and public members, static data and function members, constructors and their types, destructors, operator overloading, type conversion. **Inheritance:** Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding, virtual base class **Polymorphism :** Pointers in C++, Pointes and Objects, this pointer, virtual and pure virtual functions, Implementing polymorphism	**08**

Text Books

1. James Rumbaugh et. al, “Object Oriented Modeling and Design”, 2nd Edition Pearson Education
2. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Language User Guide”, Pearson Education
3. Object Oriented Programming With C++, E Balagurusamy, McGraw-Hill Education
4. C++ Programming, Black Book, Steven Holzner, dreamtech
5. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia
6. Object Oriented Programming with ANSI and Turbo C++, Ashok Kamthane, Pearson
7. The Compete Reference C++, Herbert Schlitz, McGraw-Hill Education

BCAI052	NATURAL LANGUAGE PROCESSING	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able:		
CO 1	To learn the fundamentals of natural language processing	K_1, K_2
CO 2	To understand the use of CFG and PCFG in NLP	K_1, K_2
CO 3	To understand the role of semantics of sentences and pragmatic	K_2
CO 4	To Introduce Speech Production And Related Parameters Of Speech.	K_1, K_2
CO 5	To Show The Computation And Use Of Techniques Such As Short Time Fourier Transform, Linear Predictive Coefficients And Other Coefficients In The Analysis Of Speech.	K_3, K_4
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**INTRODUCTION:** Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance **WORD LEVEL ANALYSIS:** Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Word Tokenization, Math with words TF-IDF Vectors, Finding meaning in word count (Semantic Analysis), Linguistic Background: Outline of English Syntax, Introduction to Semantics and Knowledge Representation, Zipf's Law	**08**
II	**SYNTACTIC ANALYSIS:** Context Free Grammars, Grammar rules for English, Grammars and Parsing: Grammars and sentence Structure, Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top- Down Chart Parsing. Feature Systems and Augmented Grammars: Basic Feature system for English, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks. Ambiguity Resolution: Statistical Methods, Probabilistic Language Processing, Estimating Probabilities, Part-of-Speech tagging, Obtaining Lexical Probabilities, Probabilistic Context-Free Grammars, Best First Parsing Feature structures, Unification of feature structures.	**08**
III	**SEMANTICS AND PRAGMATICS:** Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.	**08**
IV	**BASIC CONCEPTS of Speech Processing:** Speech Fundamentals: Articulatory Phonetics – Production And Classification Of Speech Sounds; Acoustic Phonetics – Acoustics Of Speech Production; Review Of Digital Signal Processing Concepts; Short-Time Fourier Transform, FilterBank And LPC Methods.	**08**
V	**SPEECH-ANALYSIS**: Features, Feature Extraction And Pattern Comparison Techniques: Speech Distortion Measures– Mathematical And Perceptual Real World NLP Challenges-Information Extraction and Question Answering, Dialog Engines, Optimization, Parallelization and batch processing.	**08**

Text books:

1. Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, ―Natural Language Processing with Python, First Edition, OReilly Media, 2009.
3. Lawrence Rabiner And Biing-Hwang Juang, "Fundamentals Of Speech Recognition", Pearson Education, 2003.
4. Daniel Jurafsky And James H Martin, "Speech And Language Processing – An Introduction To Natural Language Processing, Computational Linguistics, And Speech Recognition", Pearson Education, 2002.
5. Frederick Jelinek, "Statistical Methods Of Speech Recognition", MIT Press, 1997.
6. 1. Breck Baldwin, ―Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
7. Richard M Reese, ―Natural Language Processing with Java, OReilly Media, 2015.
8. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
9. Tanveer Siddiqui, U.S. Tiwary, ―Natural Language Processing and Information Retrieval, Oxford University Press, 2008.

BCAM051	CLOUD COMPUTING	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Describe architecture and underlying principles of cloud computing.	K_3
CO 2	Explain need, types and tools of Virtualization for cloud.	K_3, K_4
CO 3	Describe Services Oriented Architecture and various types of cloud services.	K_2, K_3
CO 4	Explain Inter cloud resources management cloud storage services and their providers Assess security services and standards for cloud computing.	K_2, K_4
CO 5	Analyze advanced cloud technologies.	K_3, K_6

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**Introduction To Cloud Computing:** Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning.	**08**
II	**Cloud Enabling Technologies Service Oriented Architecture:** REST and Systems of Systems – Web Services – Publish, Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices –Virtualization Support and Disaster Recovery.	**08**
III	**Cloud Architecture, Services And Storage:** Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.	**08**
IV	**Resource Management And Security In Cloud:** Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.	**08**
V	**Cloud Technologies And Advancements Hadoop:** MapReduce – Virtual Box — Google App Engine – Programming Environment for Google App Engine — Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation.	**08**

Text books:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, ―Cloud Computing: Implementation, Management and Security, CRC Press, 2017.
3. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, ―Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009.

BCS056	APPLICATION OF SOFT COMPUTING	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Recognize the feasibility of applying a soft computing methodology for a particular problem	K2, K4
CO 2	Know the concepts and techniques of soft computing and foster their abilities in designing and implementing soft computing- based solutions for real-world and engineering problems	K4, K6
CO 3	Apply neural networks to pattern classification and regression problems and compare solutions by various soft computing approaches for a given problem.	K3, K5
CO 4	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems	K3, K4
CO 5	Apply genetic algorithms to combinatorial optimization problems	K3
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**Neural Networks-I (Introduction & Architecture):** Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.	**08**
II	**Neural Networks-II (Back propagation networks):** Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training, applications.	**08**
III	**Fuzzy Logic-I (Introduction):** Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.	**08**
IV	**Fuzzy Logic –II (Fuzzy Membership, Rules)** : Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications	**08**
V	**Genetic Algorithm(GA):** Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.	**08**

Text books:

1. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications" Prentice Hall of India.
2. N.P.Padhy,"Artificial Intelligence and Intelligent Systems" Oxford University Press. Reference Books:
3. Siman Haykin,"Neural Networks"Prentice Hall of India
4. Saroj Kaushik, Sunita Tiwari, "Soft Computing: Fundamentals, Techniques and Applications", McGraw Hill Education
5. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
6. Kumar Satish, "Neural Networks" Tata Mc Graw Hill

BCS057	IMAGE PROCESSING	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Explain the basic concepts of two-dimensional signal acquisition, sampling, quantization and color model.	K_1, K_2
CO 2	Apply image processing techniques for image enhancement in both the spatial and frequency domains.	K_2, K_3
CO 3	Apply and compare image restoration techniques in both spatial and frequency domain.	K_2, K_3
CO 4	Compare edge based and regio- based segmentation algorithms for ROI extraction.	K_3, K_4
CO 5	Explain compression techniques and descriptors for image processing.	K_2, K_3

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**DIGITAL IMAGE FUNDAMENTALS:** Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – Color image fundamentals – RGB, HSI models,Two-dimensional mathematical preliminaries, 2D transforms – DFT, DCT.	**08**
II	**IMAGE ENHANCEMENT:** Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.	**08**
III	**IMAGE RESTORATION:** Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum NotchFiltering – Inverse Filtering – Wiener filtering	**08**
IV	**IMAGE SEGMENTATION:** Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.	**08**
V	**IMAGE COMPRESSION AND RECOGNITION:** Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEGstandard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching.	**08**

Text books:

1. Rafael C. Gonzalez, Richard E. Woods,Digital Image Processing Pearson, 3rd Edition, 2010
2. Anil K. Jain,Fundamentals of Digital Image Processing Pearson, 2002.
3. Kenneth R. Castleman,Digital Image Processing Pearson, 2006.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
5. D,E. Dudgeon and RM. Mersereau,Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
6. William K. Pratt,Digital Image Processing John Wiley, New York, 2002
7. Milan Sonka et al Image processing, analysis and machine vision Brookes/Cole, Vikas Publishing House, 2nd edition, 1999

BCS551	DATABASE MANAGEMENT SYSTEMS LAB	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Understand and apply oracle 11 g products for creating tables, views, indexes, sequences and other database objects.	K_2, K_4
CO 2	Design and implement a database schema for company data base, banking data base, library information system, payroll processing system, student information system.	K3, K5, K6
CO 3	Write and execute simple and complex queries using DDL, DML, DCL and TCL	K_4, K_5
CO 4	Write and execute PL/SQL blocks, procedure functions, packages and triggers, cursors.	K_4, K_5
CO 5	Enforce entity integrity, referential integrity, key constraints, and domain constraints on database.	K_3, K_4

DETAILED SYLLABUS

1. Installing oracle/ MYSQL
2. Creating Entity-Relationship Diagram using case tools.
3. Writing SQL statements Using ORACLE /MYSQL:
   a). Writing basic SQL SELECT statements.
   b). Restricting and sorting data.
   c). Displaying data from multiple tables.
   d). Aggregating data using group function.
   e). Manipulating data.
   f). Creating and managing tables.
4. Normalization
5. Creating cursor
6. Creating procedure and functions
7. Creating packages and triggers
8. Design and implementation of payroll processing system
9. Design and implementation of Library Information System
10. Design and implementation of Student Information System
11. Automatic Backup of Files and Recovery of Files
12. Mini project (Design & Development of Data and Application) for following: a) Inventory Control System.
    b) Material Requirement Processing.
    c) Hospital Management System.
    d) Railway Reservation System.
    e) Personal Information System.
    f) Web Based User Identification System.
    g) Timetable Management System.
    h) h) Hotel Management System

Note: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner
It is also suggested that open source tools should be preferred to conduct the lab (MySQL , SQL server , Oracle ,MongoDB ,Cubrid ,MariaDBetc)

Database Management Systems Lab (BCS551): Mapping with Virtual Lab

Name of the Lab	Name of the Experiment
Database Management Lab (BCS-551)	Data Definition Language (DDL) Statements: (Create table, Alter table, Drop table)
	Data Manipulation Language (DML) Statements
	Data Query Language (DQL) Statements: (Select statement with operations like Where clause, Order by, Logical operators, Scalar functions and Aggregate functions)
	Transaction Control Language (TCL) statements: (Commit (make changes permanent), Rollback (undo)
	Describe statement: To view the structure of the table created

BCDS551	DATA ANALYTICS AND VISUALIZATION LAB	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to		
CO 1	Implement numerical and statistical analysis on various data sources	K_3
CO 2	Apply data preprocessing and dimensionality reduction methods on raw data	K_3
CO 3	Implement linear regression technique on numeric data for prediction	K_3
CO 4	Execute clustering and association rule mining algorithms on different datasets	K_3
CO 5	Implement and evaluate the performance of KNN algorithm on different datasets	K_3, K_4

DETAILED SYLLABUS

1. To get the input from user and perform numerical operations (MAX, MIN, AVG, SUM, SQRT, ROUND) using in R.
2. To perform data import/export (.CSV, .XLS, .TXT) operations using data frames in R.
3. To get the input matrix from user and perform Matrix addition, subtraction, multiplication, inverse transpose and division operations using vector concept in R.
4. To perform statistical operations (Mean, Median, Mode and Standard deviation) using R.
5. To perform data pre-processing operations i) Handling Missing data ii) Min-Max normalization
6. To perform dimensionality reduction operation using PCA for Houses Data Set
7. To perform Simple Linear Regression with R.
8. To perform K-Means clustering operation and visualize for iris data set
9. Learn how to collect data via web-scraping, APIs and data connectors from suitable sources as specified by the instructor.
10. Perform association analysis on a given dataset and evaluate its accuracy.
11. Build a recommendation system on a given dataset and evaluate its accuracy.
12. Build a time-series model on a given dataset and evaluate its accuracy.
13. Build cartographic visualization for multiple datasets involving various countries of the world; states and districts in India etc.
14. Perform text mining on a set of documents and visualize the most important words in a visualization such as word cloud.

Note: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner
It is also suggested that open source tools should be preferred to conduct the lab (R, Python etc.)

BCS553	DESIGN AND ANALYSIS OF ALGORITHM LAB	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Implement algorithm to solve problems by iterative approach.	K_2, K_4
CO 2	Implement algorithm to solve problems by divide and conquer approach	K_3, K_5
CO 3	Implement algorithm to solve problems by Greedy algorithm approach.	K_4, K_5
CO 4	Implement algorithm to solve problems by Dynamic programming, backtracking, branch and bound approach.	K_4, K_5
CO 5	Implement algorithm to solve problems by branch and bound approach.	K_3, K_4

DETAILED SYLLABUS

1. Program for Recursive Binary & Linear Search.
2. Program for Heap Sort.
3. Program for Merge Sort.
4. Program for Selection Sort.
5. Program for Insertion Sort.
6. Program for Quick Sort.
7. Knapsack Problem using Greedy Solution
8. Perform Travelling Salesman Problem
9. Find Minimum Spanning Tree using Kruskal's Algorithm
10. Implement N Queen Problem using Backtracking
11. Sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus non graph sheet. The elements can be read from a file or can be generated using the random number generator. Demonstrate using Java how the divide and- conquer method works along with its time complexity analysis: worst case, average case and best case.
12. Sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. Plot a graph of the time taken versus non graph sheet. The elements can be read from a file or can be generated using the random number generator. Demonstrate how the divide and-conquer method works along with its time complexity analysis: worst case, average case and best case.
13. Implement, the 0/1 Knapsack problem using

(a) Dynamic Programming method

(b) Greedy method.

14. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
15. Find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm. Use Union-Find algorithms in your program.
16. Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.
17. Write programs to:
    (a). Implement All-Pairs Shortest Paths problem using Floyd's algorithm.
    (b). Implement Travelling Sales Person problem using Dynamic programming.
18. Design and implement to find a subset of a given set S = {Sl, S2,. ...,Sn} of n positive integers whose SUM is equal to a given positive integer d. For example, if S ={1, 2, 5, 6, 8} and d= 9, there are two solutions {1,2,6}and {1,8}. Display a suitable message, if the given problem instance doesn't have a solution.

10. Design and implement to find all Hamiltonian Cycles in a connected undirected Graph G of n vertices using backtracking principle.
Note: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner **It is also suggested that open source tools should be preferred to conduct the lab (C, C++ etc)**

BCDS601	BIG DATA AND ANALYTICS	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to		
CO 1	Demonstrate knowledge of Big Data Analytics concepts and its applications in business.	K_1, K_2
CO 2	Demonstrate functions and components of Map Reduce Framework and HDFS.	K_1, K_2
CO 3	Discuss Data Management concepts in NoSQL environment.	K_6
CO 4	Explain process of developing Map Reduce based distributed processing applications.	K_2, K_5
CO 5	Explain process of developing applications using HBASE, Hive, Pig etc.	K_2, K_5
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lectures
I	**Introduction to Big Data**: Types of digital data, history of Big Data innovation, introduction to Big Data platform, drivers for Big Data, Big Data architecture and characteristics, 5 Vs of Big Data, Big Data technology components, Big Data importance and applications. Big Data features – security, compliance, auditing and protection, Big Data privacy and ethics, Big Data Analytics, Challenges of conventional systems, intelligent data analysis, nature of data, analytic processes and tools, analysis vs reporting, modern data analytic tools.	**06**
II	**Hadoop:** History of Hadoop, Apache Hadoop, the Hadoop Distributed File System, components of Hadoop, data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, Hadoop Echo System. **Map Reduce:** Map Reduce framework and basics, how Map Reduce works, developing a Map Reduce application, unit tests with MR unit, test data and local tests, anatomy of a Map Reduce job run, failures, job scheduling, shuffle and sort, task execution, Map Reduce types, input formats, output formats, Map Reduce features, Real-world Map Reduce	**08**
III	**HDFS (Hadoop Distributed File System):** Design of HDFS, HDFS concepts, benefits and challenges, file sizes, block sizes and block abstraction in HDFS, data replication, how does HDFS store, read, and write files, Java interfaces to HDFS, command line interface. Hadoop file system interfaces, data flow, data ingest with Flume and Scoop, Hadoop archives, Hadoop I/O: compression, serialization, Avro and file-based data structures. **Hadoop Environment:** Setting up a Hadoop cluster, cluster specification, cluster setup and installation, Hadoop configuration, security in Hadoop, administering Hadoop, HDFS monitoring & maintenance, Hadoop benchmarks, Hadoop in the cloud	**08**
IV	**Hadoop Eco System and YARN**: Hadoop ecosystem components, schedulers, fair and capacity, Hadoop 2.0 New Features - NameNode high availability, HDFS federation, MRv2, YARN, Running MRv1 in YARN. **NoSQL Databases:** Introduction to NoSQL **MongoDB:** Introduction, data types, creating, updating and deleing documents, querying, introduction to indexing, capped collections **Spark:** Installing spark, spark applications, jobs, stages and tasks, Resilient Distributed Databases, anatomy of a Spark job run, Spark on YARN **SCALA:** Introduction, classes and objects, basic types and operators, built-in control structures, functions and closures, inheritance.	**09**

V	**Hadoop Eco System Frameworks**: Applications on Big Data using Pig, Hive and HBase **Pig -** Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators,	**09**
	Hive - Apache Hive architecture and installation, Hive shell, Hive services, Hive metastore, comparison with traditional databases, HiveQL, tables, querying data and userdefined functions, sorting and aggregating, Map Reduce scripts, joins & subqueries. **HBase** – Hbase concepts, clients, example, Hbase vs RDBMS, advanced usage, schema design, advance indexing, Zookeeper – how it helps in monitoring a cluster, how to build applications with Zookeeper. IBM Big Data strategy, introduction to Infosphere, BigInsights and Big Sheets, introduction to Big SQL.	

Text books and References:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
2. Big-Data Black Book, DT Editorial Services, Wiley
3. Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos, Tom Deutsch, “Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill.
4. Thomas Erl, Wajid Khattak, Paul Buhler, “Big Data Fundamentals: Concepts, Drivers and Techniques”, Prentice Hall.
5. Raj Kamal, Preeti Saxena, “Big Data Analytics”, McGraw Hill Education
6. Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)”, John Wiley & Sons
7. ArshdeepBahga, Vijay Madisetti, “Big Data Science & Analytics: A HandsOn Approach “, VPT
8. Anil Maheshwari, “Big Data”, Second Edition, McGraw Hill
9. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP
10. Tom White, "Hadoop: The Definitive Guide", O'Reilly.
11. Eric Sammer, "Hadoop Operations", O'Reilly.
12. Chuck Lam, “Hadoop in Action”, MANNING Publishers
13. Deepak Vohra, “Practical Hadoop Ecosystem: A Definitive Guide to Hadoop-Related Frameworks and Tools”, Apress
14. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly
15. Lars George, "HBase: The Definitive Guide", O'Reilly.
16. Alan Gates, "Programming Pig", O'Reilly.
17. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer
18. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons
19. Glenn J. Myatt, “Making Sense of Data”, John Wiley & Sons
20. Pete Warden, “Big Data Glossary”, O’Reilly

BCS601	SOFTWARE ENGINEERING	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
	At the end of course, the student will be able to	
CO 1	Explain various software characteristics and analyze different software Development Models.	K_1, K_2
CO 2	Demonstrate the contents of a SRS and apply basic software quality assurance practices to ensure that design, development meet or exceed applicable standards.	K_1, K_2
CO 3	Compare and contrast various methods for software design	K_2, K_3
CO 4	Formulate testing strategy for software systems, employ techniques such as unit testing, Test driven development and functional testing.	K_3
CO 5	Manage software development process independently as well as in teams and make use of Various software management tools for development, maintenance and analysis.	K_5
	DETAILED SYLLABUS	**3-1-0**
Unit	**Topic**	**Proposed Lecture**
I	**Introduction:** Introduction to Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Similarity and Differences from Conventional Engineering Processes, Software Quality Attributes. Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models.	**08**
II	**Software Requirement Specifications (SRS):** Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modelling, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS. Software Quality Assurance (SQA): Verification and Validation, SQA Plans, Software Quality Frameworks, ISO 9000 Models, SEI-CMM Model.	**08**
III	**Software Design:** Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design. Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs.	**08**
IV	**Software Testing:** Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, TopDown and BottomUp Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards.	**08**

V	**Software Maintenance and Software Project Management:** Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re- Engineering, Reverse Engineering. Software Configuration Management Activities, Change Control Process, Software Version Control, An Overview of CASE Tools. Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management.	**08**

Text books:

1. RS Pressman, Software Engineering: A Practitioners Approach, McGraw Hill.
2. Pankaj Jalote, Software Engineering, Wiley
3. Rajib Mall, Fundamentals of Software Engineering, PHI Publication.
4. KK Aggarwal and Yogesh Singh, Software Engineering, New Age International Publishers.
5. Ghezzi, M. Jarayeri, D. Manodrioli, Fundamentals of Software Engineering, PHI Publication.
6. Ian Sommerville, Software Engineering, Addison Wesley.
7. Kassem Saleh, "Software Engineering", Cengage Learning.
8. P fleeger, Software Engineering, Macmillan Publication

BCS603	COMPUTER NETWORKS	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to		
CO1	Explain basic concepts, OSI reference model, services and role of each layer of OSI model and TCP/IP, networks devices and transmission media, Analog and digital data transmission	K_1, K_2
CO2	Apply channel allocation, framing, error and flow control techniques.	K_3
CO3	Describe the functions of Network Layer i.e. Logical addressing, subnetting & Routing Mechanism.	K_2, K_3
CO4	Explain the different Transport Layer function i.e. Port addressing, Connection Management, Error control and Flow control mechanism.	K_2, K_3
CO5	Explain the functions offered by session and presentation layer and their Implementation.	K_2, K_3
CO6	Explain the different protocols used at application layer i.e. HTTP, SNMP, SMTP, FTP, TELNET and VPN.	K_2
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**Introductory Concepts**: Goals and applications of networks, Categories of networks, Organization of the Internet, ISP, Network structure and architecture (layering principles, services, protocols and standards), The OSI reference model, TCP/IP protocol suite, Network devices and components. **Physical Layer:** Network topology design, Types of connections, Transmission media, Signal transmission and encoding, Network performance and transmission impairments, Switching techniques and multiplexing.	**08**
II	**Link layer:** Framing, Error Detection and Correction, Flow control (Elementary Data Link Protocols, Sliding Window protocols). Medium Access Control and Local Area Networks: Channel allocation, Multiple access protocols,	**08**
	LAN standards, Link layer switches & bridges (learning bridge and spanning tree algorithms).	
III	**Network Layer:** Point-to-point networks, Logical addressing, Basic internetworking (IP, CIDR, ARP, RARP, DHCP, ICMP), Routing, forwarding and delivery, Static and dynamic routing, Routing algorithms and protocols, Congestion control algorithms, IPv6.	**08**
IV	**Transport Layer:** Process-to-process delivery, Transport layer protocols (UDP and TCP), Multiplexing, Connection management, Flow control and retransmission, Window management, TCP Congestion control, Quality of service.	**08**
V	**Application Layer:** Domain Name System, World Wide Web and Hyper Text Transfer Protocol, Electronic mail, File Transfer Protocol, Remote login, Network management, Data compression, Cryptography – basic concepts.	**08**

Text books and References:

1. Behrouz Forouzan, "Data Communication and Networking", McGraw Hill
2. Andrew Tanenbaum "Computer Networks", Prentice Hall.
3. William Stallings, "Data and Computer Communication", Pearson.
4. Kurose and Ross, "Computer Networking- A Top-Down Approach", Pearson.
5. Peterson and Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann
6. W. A. Shay, "Understanding Communications and Networks", Cengage Learning.
7. D. Comer, "Computer Networks and Internets", Pearson.
8. Behrouz Forouzan, "TCP/IP Protocol Suite", McGraw Hill.

BCAI061	CYBER FORENSIC ANALYTICS	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Outline the Cyber Crime and its types.	K_1, K_2
CO 2	Explore the Cyber Forensics Techniques	K_1, K_2
CO 3	Use the Cyber Investigation Techniques	K_3, K_4
CO 4	Explore the Cyber Evidence Management Techniques	K_3, K_4
CO 5	Outline the Cyber Laws in India	K_1, K_2
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**Cyber Crime:** Cyber Space – Cyber Crime – Criminal Behaviour – Jurisdictional Concerns - Jurisprudential Inconsistency – eCash Security – Prepaid Cards – Stored Values Cards – Mobile Payments – Internet Payment Services -Cyber stalking - Cyber extortion – Cyber terrorism - Cyber warfare –Cyber weapons -ATM frauds – Phreaking – Internet Gambling **Practical Component:** 1. Key logger 2. Email Fraud	**08**
II	**Cyber Forensics:** Digital device – Hard disk –Disk characteristics - Disk imaging - Data Carving – Techniques – commercial piracy - soft lifting – Steganography – Network components - Port scans - Wireshark - pcap analysis - Trojans and Backdoors – Botnets - DoS – DDoS Attacks - Honey Pots – Malware – Virus and Worms **Practical Component:** 1. Pcab file Analysis – Case Study 2. Network Port Scan – Forensics	**08**
III	**Cyber Investigation** Concepts of Investigation - cyber investigation, Network Investigation - Investigating audit logs -Investigating Web attacks - Investigating Computer Intrusions - Profiling – Cyber Criminal profiling – Stylometric Techniques – Warranted searches – Warrantless searches – Undercover Techniques **Practical Component:** 1. Investigating Audit Logs 2. Investigating Web attacks	**08**
IV	**Evidence Management:** Evidence – Digital Evidence - Types – physical evidence – Real evidence – Circumstantial evidence –network evidence - Evidence collection – Evidence Analysis - Contextual Information –Evidence Management – pre search activities – On Scene activities – Report Preparations **Practical Component:** 1. Digital Evidence Analysis 2. Network Analysis	**08**

V	**Cyber Laws and Authorities** Information Technology Act 2000 – Digital signature - Electronic Governance - Secure electronic records - Regulation of certifying authorities – CERNTin - Electronic signature certificates - Penalties compensation - Future Trends and Emerging Concerns **Practical Component:** 1. Digital Signature	**08**

Text Books:

1. Marjie T. Britz, "Computer Forensics and Cyber Crime", Pearson, 2013.
2. Garima Tiwari, "Understanding Laws– Cyber Laws And Cyber Crimes", Lexis Nexis, 2014.
3. Chuck Easttom, Jeff Taylor, "Computer Crime, Investigation, and the Law", Course Technology, 2018.
4. Eoghan Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet", Eoghan Casey, 2018.

BCDS061	IMAGE ANALYTICS	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Infer the basics and fundamentals of digital image processing and Apply the various techniques for intensity transformations functions. Implement Color image Smoothing and Sharpening.	K_1, K_2
CO 2	Illustrate Morphological operation and Apply Some Basic Morphological Algorithms.	K_2, K_3
CO 3	Apply image segmentation techniques such as Optimum Global Thresholding using Otsu's Method, Active Contours: Snakes and Level Sets for various real-time applications.	K_3, K_4
CO 4	Analysis various Feature Extraction methods and Implement for various real-time applications.	K_3, K_4
CO 5	Apply and Analysis various Image Pattern Classification methods such as MinimumDistance Classification, Optimum (Bayes) Statistical Classification, and Deep Convolutional Neural Network.	K_3, K_4
DETAILED SYLLABUS		**3-0-0**

Unit	Topic	Proposed Lecture
I	**Fundamentals:** Introduction – Fundamental steps in Image Processing Systems – Image Acquisition – Sampling and Quantization – Pixel Relationships – Mathematical Tools Used in Digital Image Processing. Some Basic Intensity Transformation Functions: Image Negatives, Log Transformations, Power-Law Transformations – Histogram Processing. Color Fundamentals – Fundamentals of Spatial Filtering – Smoothing Spatial Filters – Sharpening Spatial Filters. **Practical Component:** Use Python/ MATLAB 1. Apply various intensity transformations functions. 2. Computing and plotting image histograms and use standard image processing toolbox Spatial filters. 3. Implement color image Smoothing and Sharpening.	**08**
II	**Morphological Image Processing:** Morphological Image Processing: Fundamentals – Erosion and Dilation – Opening and Closing – Hit or Miss Transform – Some Basic Morphological Algorithms – Morphological Reconstruction – Grayscale Morphology **Practical Component:** Use Python/ MATLAB 1. Implement Morphological operations. 2. Implement Morphological Reconstruction. 3. Implement Grayscale Morphology.	**08**
III	**Colour Image Processing:** Colour fundamentals, colour models, pseudo colour image processing, basics of full colour image processing, colour transformation, smoothing and sharpening. Image Segmentation based on colour, Active Contours: Snakes and Level Sets, noise in colour images, colour image compressions. **Thresholding:** Foundation, Basic Global thresholding, Optimum Global Thresholding using Otsu's Method, Multiple Thresholds, Variable Thresholding –Segmentation by Region Growing and by Region Splitting and Merging. Practical Component: Use Python/ MATLAB 1. Implement Optimum Global Thresholding using Otsu's Method. 2. Implement Image smoothing and sharpening. 3. Implement Image Segmentation by Active Contours using anyone method Snakes and Level Sets	**08**

IV	**Feature Extraction** Background – Representation – Boundary Preprocessing – Boundary Feature Descriptors: Some Basic Boundary Descriptors, Shape Numbers, Fourier Descriptors, Statistical Moments – Regional Feature Descriptors: Some Basic Descriptors, Topological and Texture Descriptors, Moment Invariants – Principal Components as Feature Descriptors – Whole-image Features Object – Scale-Invariant Feature Transform (SIFT). **Practical Component:** Use Python/ MATLAB 1. Implement Boundary Feature Descriptors 2. Implement Topological and Texture Descriptors 3. Implement Scale-Invariant Feature Transform (SIFT)	**08**
V	**Image Pattern Classification** Background –Patterns and Pattern Classes – Pattern Classification by Prototype Matching: Minimum-Distance Classifier, Using Correlation for 2-D prototype matching, Matching SIFT Features, Matching Structural Prototypes – Optimum (Bayes) Statistical Classifiers – Neural Networks and Deep Learning: Background – The Perceptron – Multilayer Feedforward Neural Networks – Deep Convolutional Neural Networks **Practical** **Component:** Use Python/ MATLAB 1. Implement Minimum-Distance Classification Algorithm. 2. Implement Optimum (Bayes) Statistical Classification Algorithm. 3. Implement Deep Convolutional Neural Network.	**08**

Text Books:

1. Rafael C Gonzalez, Richard E Woods, "Digital Image Processing", 4th Edition, Pearson, 2018.
2. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
3. Anil K.Jain, "Fundamentals of Digital Image Processing", Person Education, 2003.

BCAM061	Social Media Analytics and Data Analysis	
	Course Outcome (CO)	**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	Understand basic concepts and need of social media analysis	
CO 2	Understand the fundamental of graphs and matrices in social media analysis	
CO 3	Understand networking fundamentals of social media analysis	
CO 4	Understand social networking and modelling concepts and methods	
CO 5	Understand processing and visualizing social media data	

DETAILED SYLLABUS

Unit	Topic	Proposed Lecture
I	**Introduction to Social Media** Introduction to Social Media, Social Media Landscape, Social Media Analytics & its Need. SMA in Small and Large Organisations; Application of SMA in Different Social Media Platforms. Types of Social Networks, friend, user-generated content, affiliation, etc., sociograms, sociometric studies Basics of Social Media and Business Models, Basics of Web Search Engines and Digital Advertising, Application of SMA in different areas.	**08**
II	**Graphs and Matrices** The adjacency matrix, paths, connectivity, Distance and Breadth First Search, Network Datasets: An Overview Nodes, ties, and influencers, Making connections, Link analysis. Random graphs and network evolution. Weighted Networks, Hypergraphs	**08**
III	**Network Fundamentals** Network Structures, equivalence, homophile, clustering, snowball sampling, contact tracing and random walks, Ego-ceneterd networks, dominance hierarchies, Third Party Records, affiliation Network Citation Networks, Peer to Peer Networks, Recommender Networks, Biological Networks	**08**
IV	**Social Network and Modelling** Social Contexts: Affiliation and Identity, social capital, structural holes, structural balance, Predictive Modeling, Descriptive Modeling, community/ anomaly detection **Facebook Analytics:** Introduction, parameters, demographics, Analyzing page audience. Reach and Engagement analysis **Google Analytics**: Brief Implementation Technology, Limitations, Performance Concerns, Privacy Issues. Introduction and Working, Google Website Optimizer	**08**

V	**Processing, Visualizing and Social Media Data Analytics** Processing and Visualizing Data, Influence Maximization,Link Prediction, Collective Classification, Applications in Advertising and Game Analytics, collecting and visualizing social media data, visualization and exploration. Social Network and Web Data Analytics Methods, Clickstream analysis, A/B testing, online surveys, Web crawling and Indexing. Natural Language ProcessingTechniques for Micro-text Analysis, Trend, social influencers on judgements, opinion spread, judgement	**08**

Text and Reference Books:

1. Matthew Ganis, Avinash Kohirkar, Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media Pearson 2016
2. Jim Sterne, Social Media Metrics: How to Measure and Optimize Your Marketing Investment Wiley Latest edition
3. Brian Clifton, Advanced Web Metrics with Google Analytics, John Wiley & Sons; 3rd Edition edition (30 Mar 2012)
4. Ganis/Kohirka, SOCIAL MEDIA ANALYTICS Paperback – 29 September 2016 by Pearson.

BCDS062	MACHINE LEARNING TECHNIQUES	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to:		
CO 1	To understand the need for machine learning for various problem solving.	K_1, K_2
CO 2	To understand a wide variety of learning algorithms and how to evaluate models generated from data.	K_1, K_3
CO 3	To understand the latest trends in machine learning.	K_2, K_3
CO 4	To design appropriate machine learning algorithms and apply the algorithms to a real-world problem.	K_4, K_6
CO 5	To optimize the models learned and report on the expected accuracy that can be achieved by applying the models,	K_4, K_5

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	**INTRODUCTION –** Learning, Types of Learning, Well defined learning problems, Designing a Learning System, History of ML, Introduction of Machine Learning Approaches – (Artificial Neural Network, Clustering, Reinforcement Learning, Decision Tree Learning, Bayesian networks, Support Vector Machine, Genetic Algorithm), Issues in Machine Learning and Data Science Vs Machine Learning.	**08**
II	**REGRESSION**: Linear Regression and Logistic Regression **BAYESIAN LEARNING -** Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm. **SUPPORT VECTOR MACHINE:** Introduction, Types of support vector kernel – (Linear kernel, polynomial kernel and Gaussian kernel), Hyperplane – (Decision surface), Properties of SVM, and Issues in SVM**.**	**08**
III	**DECISION TREE LEARNING** - Decision tree learning algorithm, Inductive bias, Inductive inference with decision trees, Entropy and information theory, Information gain, ID-3 Algorithm, Issues in Decision tree learning. **INSTANCE-BASED LEARNING** – k-Nearest Neighbour Learning, Locally Weighted Regression, Radial basis function networks, Case-based learning**.**	**08**
IV	**ARTIFICIAL NEURAL NETWORKS –** Perceptron's, Multilayer perceptron, Gradient descent and the Delta rule, Multilayer networks, Derivation of Backpropagation Algorithm, Generalization, Unsupervised Learning – SOM Algorithm and its variant. **DEEP LEARNING -** Introduction, concept of convolutional neural network, Types of layers – (Convolutional Layers, Activation function, pooling, fully connected), Concept of Convolution (1D and 2D) layers, Training of network, Case study of CNN for eg on Diabetic Retinopathy, Building a smart speaker, Self-deriving car etc.	**08**

V	**REINFORCEMENT LEARNING–**Introduction to Reinforcement Learning, Learning Task, Example of Reinforcement Learning in Practice, Learning Models for Reinforcement – (Markov Decision process, Q Learning - Q Learning function, Q Learning Algorithm), Application of Reinforcement Learning, Introduction to Deep Q Learning. **GENETIC ALGORITHMS:** Introduction, Components, GA cycle of reproduction, Crossover, Mutation, Genetic Programming, Models of Evolution and Learning, Applications.	**08**

Text books:

1. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin, ―Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
3. Stephen Marsland, ―Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
4. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.

BCDS651	BIG DATA AND ANALYTICS LAB	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to		
CO 1	Optimize business decisions and create competitive advantage with Big data analytics	K_3, K_5
CO 2	Practice java concepts required for developing map reduce programs	K_4, K_5
CO 3	Impart the architectural concepts of Hadoop and introducing map reduce paradigm.	K_4, K_5
CO 4	Practice programming tools PIG and HIVE in Hadoop eco system.	K_5
CO 5	Implement best practices for Hadoop development.	K_5, K_6

DETAILED SYLLABUS

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Implement the following file management tasks in Hadoop:
   i. Adding files and directories
   ii. Retrieving files
   iii. Deleting files Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command line utilities
3. Implement of Matrix Multiplication with Hadoop Map Reduce
4. Write a Map Reduce program that mines weather data. Hint: Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce, since it is semi structured and record-oriented
5. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. 6. Implementation of K-means clustering using Map Reduce
7. Installation of Hive along with practice examples.
8. Installation of HBase, Installing thrift along with Practice examples
9. Patrice importing and exporting data from various data bases .
10. Write PIG Commands: Write Pig Latin scripts sort, group, join, project, and filter your data.
11. Run the Pig Latin Scripts to find Word Count .
12. Run the Pig Latin Scripts to find a max temp for each and every year.

Note: The Instructor may add/delete/modify/tune experiments

BCS651	SOFTWARE ENGINEERING LAB	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to		
CO 1	Identify ambiguities, inconsistencies and incompleteness from a requirements specification and state functional and non-functional requirement	K_2, K_4
CO 2	Identify different actors and use cases from a given problem statement and draw use case diagram to associate use cases with different types of relationship	K_3, K_5
CO 3	Draw a class diagram after identifying classes and association among them	K_4, K_5
CO 4	Graphically represent various UML diagrams, and associations among them and identify the logical sequence of activities undergoing in a system, and represent them pictorially	K_4, K_5
CO 5	Able to use modern engineering tools for specification, design, implementation and testing	K_3, K_4

DETAILED SYLLABUS

For any given case/ problem statement do the following;

1. Prepare a SRS document in line with the IEEE recommended standards.
2. Draw the use case diagram and specify the role of each of the actors. Also state the precondition, post condition and function of each use case.
3. Draw the activity diagram.
4. Identify the classes. Classify them as weak and strong classes and draw the class diagram.
5. Draw the sequence diagram for any two scenarios.
6. Draw the collaboration diagram.
7. Draw the state chart diagram.
8. Draw the component diagram.
9. Perform forward engineering in java.(Model to code conversion)
10. Perform reverse engineering in java.(Code to Model conversion)
11. Draw the deployment diagram.

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

It is also suggested that open source tools should be preferred to conduct the lab (Java , JSP , Bootstrap Firebug , WampServer , MongoDB, etc)

Software Engineering Lab (BCS651): Mapping with Virtual Lab

Name of the Lab	Name of the Experiment
Software Engineering Lab (BCS-651)	Identifying the Requirements from Problem Statements
	Estimation of Project Metrics
	Modeling UML Use Case Diagrams and Capturing Use Case Scenarios
	E-R Modeling from the Problem Statements
	Identifying Domain Classes from the Problem Statements
	Statechart and Activity Modeling
	Modeling UML Class Diagrams and Sequence diagrams
	Modeling Data Flow Diagrams
	Estimation of Test Coverage Metrics and Structural Complexity
	Designing Test Suites

BCS653	COMPUTER NETWORKS LAB	
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to		
CO 1	Simulate different network topologies.	K_3, K_4
CO 2	Implement various framing methods of Data Link Layer.	K_3, K_4
CO 3	Implement various Error and flow control techniques.	K_3, K_4
CO 4	Implement network routing and addressing techniques.	K_3, K_4
CO 5	Implement transport and security mechanisms	K_3, K_4

DETAILED SYLLABUS

1. Implementation of Stop and Wait Protocol and Sliding Window Protocol.
2. Study of Socket Programming and Client – Server model 3. Write a code simulating ARP /RARP protocols.
4. Write a code simulating PING and TRACEROUTE commands
5. Create a socket for HTTP for web page upload and download. 6. Write a program to implement RPC (Remote Procedure Call)
7. Implementation of Subnetting.
8. Applications using TCP Sockets like
   a. Echo client and echo server b. Chat c. File Transfer
9. Applications using TCP and UDP Sockets like; d. DNS e. SNMP f. File Transfer
10. Study of Network simulator (NS).and Simulation of Congestion Control Algorithms using NS
11. Perform a case study about the different routing algorithms to select the network path with its optimum and economical during data transfer. i. Link State routing ii. Flooding iii. Distance vector.
12. To learn handling and configuration of networking hardware like RJ-45 connector, CAT-6 cables, crimping tool, etc.
13. Configuration of router, hub, switch etc. (using real devices or simulators)
14. Running and using services/commands like ping, traceroute, nslookup, arp, telnet, ftp, etc.
15. Network packet analysis using tools like Wireshark, tcpdump, etc.
16. Network simulation using tools like Cisco Packet Tracer, NetSim, OMNeT++, NS2, NS3, etc.
17. Socket programming using UDP and TCP (e.g., simple DNS, data & time client/server, echo client/server, iterative & concurrent servers)

Note: The Instructor may add/delete/modify/tune experiments, wherever he/she feels in a justified manner
It is also suggested that open source tools should be preferred to conduct the lab (C , C++ , Java , NS3, Mininet, Opnet, TCP Dump, Wireshark etc.

.