MAHARAJA SUHEL DEV UNIVERSITY AZAMGARH

BACHELOR OF ENGINEERING (B.E.) DEGREE PROGRAMME

(CHOICE BASED CREDIT SYSTEM)

COURSE STRUCTURE AND EVALUATION SCHEME

B.E. COMPUTER SCIENCE ENGINEERING
(4 YEARS UG PROGRAMME)

SYLLABI

For
B.E. 3rd Year
(CSE)

Effective from the Session: 2026-27

Maharaja Suhel Dev University, Azamgarh

B.E. Third Year Semester - V

SN	Subject Code	Subject	L	T	P	CT	TA	CT+TA	TE/PE	Total	Credit
1	BCS501	Database Management System	3	1	0	15	10	25	75	100	4
2	BCS502	Web Technology	3	1	0	15	10	25	75	100	4
3	BCS503	Design and Analysis of Algorithm	3	1	0	15	10	25	75	100	4
4	Deptt-Elective-I	Departmental Elective-I	3	0	0	15	10	25	75	100	3
5	Deptt-Elective-II	Departmental Elective-II	3	0	0	15	10	25	75	100	3
6	BCS551	Database Management System Lab	0	0	2	0	25	25	75	100	1
7	BCS552	Web Technology Lab	0	0	2	0	25	25	75	100	1
8	BCS553	Design and Analysis of Algorithm Lab	0	0	2	0	25	25	75	100	1
9	BCS554	Mini Project / Internship Assessment	0	0	2	0	100	100	-	100	1
10	BNC501	Constitution of India	2	0	0	15	10	25	75	100	0
		Total	17	3	8						22

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

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B.E. Third Year Semester - VI

SN.	Subject Code	Subject	L	T	P	CT	TA	CT+TA	TE/PE	Total	Credit
1	BCS601	Software Engineering	3	1	0	15	10	25	75	100	4
2	BCS602	Compiler Design	3	1	0	15	10	25	75	100	4
3	BCS603	Computer Networks	3	1	0	15	10	25	75	100	4
4	Deptt-Elective-III	Departmental Elective-III	3	0	0	15	10	25	75	100	3
5	Open Elective-I	Open Elective-I	3	0	0	15	10	25	75	100	4
6	BCS651	Software Engineering Lab	0	0	2	0	25	25	75	100	1
7	BCS652	Compiler Design Lab	0	0	2	0	25	25	75	100	1
8	BCS653	Computer Networks Lab	0	0	2	0	25	25	75	100	1
9	BNC602	Essence of Indian Traditional Knowledge	2	0	0	15	10	25	75	100	0
		Total	**17**	**3**	**6**					**900**	**22**

Departmental Electives

Departmental Elective-I

- BCS-051 Statistical Computing
- BCS-052 Data Analytics
- BCS-053 Computer Graphics
- BCS-054 Object Oriented System Design with C++

Departmental Elective-II

-BCS-055 Machine Learning Techniques
-BCS-056 Application of Soft Computing
-BCS-057 Image Processing
-BCS-058 Data Warehousing & Data Mining

Departmental Elective-III

- BCS-061 Big Data
- BCS-062 Augmented & Virtual Reality
- BCS-063 Blockchain Architecture Design
- BCS-064 Data Compression

Database Management System (BCS501)

Unit I: Introduction to Database Systems

Overview of Database Management Systems, Difference between Database System and File System, Database System Concepts and Architecture, Data Models, Schema and Instances, Data Independence, Database Languages and Interfaces, Data Definition Language (DDL), Data Manipulation Language (DML), Overall Database Structure.

Unit II: Entity Relationship Model and Relational Model

ER Model Concepts, ER Diagram Notations, Mapping Constraints, Keys (Super Key, Candidate Key, Primary Key), Generalization and Aggregation, Conversion of ER Diagrams into Tables, Extended ER Model, Higher Degree Relationships.

Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Domain Constraints, Relational Algebra, Relational Calculus, Tuple Relational Calculus and Domain Relational Calculus.

Unit III: SQL and PL/SQL

Introduction to SQL, Characteristics and Advantages of SQL, SQL Data Types and Literals, Types of SQL Commands, SQL Operators, Tables, Views and Indexes, Queries and Subqueries, Aggregate Functions, Insert, Update and Delete Operations, Joins, Union, Intersection and Minus Operations, Cursors, Triggers and Procedures in SQL/PL SQL.

Unit IV: Database Design and Transaction Processing

Functional Dependency and Normalization, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), BCNF, Inclusion Dependency, Lossless Join Decomposition, Normalization using Functional Dependency (FD), Multivalued Dependency (MVD) and Join Dependency (JD), Alternative Approaches to Database Design.

Transaction Processing Concepts, Transaction Systems, Serializability of Schedules, Conflict and View Serializable Schedules, Recoverability, Recovery from Transaction Failures, Log-Based Recovery, Checkpoints and Deadlock Handling.

Unit V: Distributed Database and Concurrency Control

Distributed Database Concepts, Distributed Data Storage, Concurrency Control in Distributed Databases, Directory Systems.

Concurrency Control Techniques, Locking Techniques, Time Stamping Protocols, Validation-Based Protocols, Multiple Granularity, Multi-Version Schemes, Recovery with Concurrent Transactions, Case Study of Oracle Database.

Text Books

1. Database System Concepts — Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGraw Hill.
2. An Introduction to Database Systems — C. J. Date, Addison Wesley.
3. Fundamentals of Database Systems — Ramez Elmasri and Shamkant B. Navathe, Addison Wesley.
4. Databases — Patrick O'Neil, Elsevier Publications.
5. Database Management Systems — Raghu Ramakrishnan, McGraw Hill.
6. Database Management Systems — Alexis Leon and Mathews Leon, Vikas Publishing House.
7. An Introduction to Database Systems — Bipin C. Desai, Gagotia Publications.
8. Database Management System — Nilanjan Majumdar and Pritimoy Bhattacharya, Tata McGraw Hill (TMH).

Web Technology (BCS502)

Unit I: Introduction to Web Technology and HTML (08 Hours)

Introduction to Web Technology and Web Development Strategies, History of Web and Internet, Protocols Governing the Web, Writing Web Projects, Connecting to the Internet, Internet Services and Tools, Client-Server Computing.
HTML: Lists, Tables, Images, Frames, Forms.
XML: Document Type Definition (DTD), XML Schemas, Object Models, Presenting and Using XML, XML Processors — DOM and SAX.

Unit II: CSS and Web Page Designing (08 Hours)

Introduction to CSS, Creating Style Sheets, CSS Properties, Background and Text Formatting, Font Control, Working with Block Elements and Objects, Lists and Tables, CSS ID and Class.
Box Model: Introduction, Border Properties, Padding Properties, Margin Properties.
Advanced CSS: Grouping, Dimensions, Display, Positioning, Floating, Alignment, Pseudo Classes, Navigation Bar, Image Sprites, Attribute Selectors, CSS Colors, Creating Page Layouts and Website Designs.

Unit III: JavaScript and Networking (08 Hours)

JavaScript: Introduction, Documents, Forms, Statements, Functions, Objects, Introduction to AJAX.
Networking Concepts: Internet Addressing, InetAddress, Factory Methods, Instance Methods, TCP/IP Client Sockets, URL and URL Connection, TCP/IP Server Sockets, Datagram.

Unit IV: Enterprise Java Beans and Node.js (08 Hours)

Enterprise Java Beans (EJB): Creating JavaBeans, JavaBeans Properties, Types of Beans, Stateful Session Bean, Stateless Session Bean, Entity Bean.
Node.js: Introduction, Environment Setup, REPL Terminal, NPM (Node Package Manager), Callback Concepts, Events, Packaging, Express Framework, RESTful API.
Node.js with MongoDB: Creating Database and Collections, Insert, Delete, Update, Join, Sort and Query Operations.

Unit V: Servlets and Java Server Pages (08 Hours)

Servlets: Servlet Overview and Architecture, Servlet Interface and Life Cycle, Handling HTTP GET and POST Requests, Redirecting Requests, Session Tracking, Cookies, HttpSession.
Java Server Pages (JSP): Introduction and Overview, Basic JSP Example, Implicit Objects, Scripting, Standard Actions, Directives, Custom Tag Libraries.

Text Books

1. Collaborative Web Development — Jessica Burdman, Addison Wesley.
2. Web Technology and Design — C. Xavier, New Age International.
3. HTML, DHTML, JavaScript, Perl and CGI — Ivan Bayross, BPB Publications.
4. Java Server Pages — Hans Bergsten, SPD O'Reilly.
5. The Complete Reference Internet — Margaret Levine Young, McGraw Hill.
6. Beginning Node.js, Express and MongoDB Development — Greg Lim, Greg Lim Publications, 2020.
7. MongoDB: The Definitive Guide — Shannon Bradshaw, Eoin Brazil and Kristina Chodorow, O'Reilly Media, 3rd Edition, 2019.

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Design and Analysis of Algorithm (BCS503)

Unit I: Introduction and Sorting Algorithms

Introduction to Algorithms, Analysis of Algorithms, Time and Space Complexity, Growth of Functions, Performance Measurement of Algorithms.

Sorting and Order Statistics: Shell Sort, Quick Sort, Merge Sort, Heap Sort, Comparison of Sorting Algorithms, Linear Time Sorting Techniques.

Unit II: Advanced Data Structures and Divide & Conquer

Advanced Data Structures: Red-Black Trees, B-Trees, Binomial Heaps, Fibonacci Heaps, Tries and Skip Lists.

Divide and Conquer Technique: Concept and Applications in Sorting, Matrix Multiplication, Convex Hull and Searching Problems.

Unit III: Greedy and Dynamic Programming Techniques

Greedy Method: Knapsack Problem, Optimal Reliability Allocation, Minimum Spanning Trees using Prim's and Kruskal's Algorithms, Single Source Shortest Path using Dijkstra's and Bellman-Ford Algorithms.

Dynamic Programming: Knapsack Problem, All-Pairs Shortest Paths using Warshall's and Floyd's Algorithms, Resource Allocation Problems.

Unit IV: Backtracking and Branch & Bound

Backtracking Technique: Travelling Salesman Problem, Graph Coloring, N-Queen Problem, Hamiltonian Cycles and Sum of Subsets Problem.

Branch and Bound Method: Concept and Applications in Optimization Problems.

Unit V: Advanced Algorithm Topics

Algebraic Computation, Fast Fourier Transform (FFT), String Matching Algorithms, Theory of NP-Completeness, Approximation Algorithms and Randomized Algorithms.

Text Books

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

Database Management Systems Lab (BCS551)

Detailed Syllabus

Experiment 1: Installation of Database Software

Installation and Configuration of Oracle/MySQL Database Server.

Experiment 2: Entity Relationship Diagram

Creating Entity-Relationship (ER) Diagrams using CASE Tools.

Experiment 3: SQL Programming using Oracle/MySQL

- Writing Basic SQL SELECT Statements
- Restricting and Sorting Data
- Retrieving Data from Multiple Tables
- Using Group Functions and Aggregate Functions
- Data Manipulation Operations (INSERT, UPDATE, DELETE)
- Creating and Managing Tables

Experiment 4: Database Normalization

Normalization Techniques: 1NF, 2NF, 3NF and BCNF.

Experiment 5: Cursors

Creating and Using Cursors in PL/SQL.

Experiment 6: Procedures and Functions

Creating Stored Procedures and Functions.

Experiment 7: Packages and Triggers

Creating and Managing Packages and Database Triggers.

Experiment 8: Payroll Processing System

Design and Implementation of Payroll Processing System.

Experiment 9: Library Information System

Design and Implementation of Library Information System.

Experiment 10: Student Information System

Design and Implementation of Student Information System.

Experiment 11: Backup and Recovery

Automatic Backup and Recovery of Database Files.

Experiment 12: Mini Project

Design and Development of Database Applications for any one of the following:

- Inventory Control System
- Material Requirement Processing System
- Hospital Management System
- Railway Reservation System
- Personal Information System
- Web-Based User Identification System
- Timetable Management System
- Hotel Management System

Note: The instructor may add, delete or modify experiments as required. Open-source database tools such as MySQL, SQL Server, Oracle, MongoDB, Cubrid and MariaDB are recommended for conducting the lab.

Web Technology Lab (BCS552)

Detailed Syllabus

Experiment 1: Institute Website using HTML

Design a basic website for the institute using HTML and display departmental information on the website.

Experiment 2: Student/Employee Information Form

Create an HTML form for entering student details, employee information or faculty details.

Experiment 3: Responsive Website Design

Develop a responsive website using HTML and CSS for tutorials, blogs or commercial applications.

Experiment 4: Form Validation using JavaScript

Write programs using HTML and JavaScript for validation of user input data.

Experiment 5: XML and DTD

Create XML documents with DTD rules. Design Style Sheets using CSS/XSL and display XML documents in a web browser.

Experiment 6: Java Bean Application

Create a Java Bean for Employee Information including Employee ID, Name, Salary, Designation and Department.

Experiment 7: Node.js Command-Line Utility

Develop a command-line utility using Node.js for tasks such as:

- Text conversion to uppercase
- Factorial calculation
- Random password generation

Experiment 8: MongoDB Aggregation Framework

Develop MongoDB programs using aggregation operations such as grouping, filtering and sorting. Example: Finding average age of users from different cities.

Experiment 9: Servlet using Cookies

Create a Servlet application to:

- Create cookies for predefined users and passwords
- Authenticate users using Login Form data and stored cookies

Experiment 10: Servlet/JSP Database Connectivity

Create a database table containing fields such as Name, Password, Email ID and Phone Number. Develop Servlet/JSP programs to:

- Connect to the database
- Retrieve and display records
- Insert user registration details into the database

Experiment 11: JSP User Authentication

Create a JSP application to:

- Insert details of registered users using a registration form
- Authenticate users using username and password from the database

Experiment 12: Shopping Cart using Session Tracking

Design and implement a simple Shopping Cart application using Session Tracking API.

Note

The instructor may add, delete or modify experiments as required. Open-source tools such as Servlet, JSP, Node.js and MongoDB are recommended for conducting the lab sessions.

Design and Analysis of Algorithms Lab (BCS553)

Detailed Syllabus

1. Write programs for Recursive Linear Search and Binary Search.
2. Implement Heap Sort.
3. Implement Merge Sort.
4. Implement Selection Sort.
5. Implement Insertion Sort.
6. Implement Quick Sort.
7. Solve the Knapsack Problem using Greedy Method.
8. Implement Travelling Salesman Problem (TSP).
9. Find Minimum Spanning Tree using Kruskal's Algorithm.
10. Implement N-Queen Problem using Backtracking.
11. Analyze Quick Sort by computing time complexity for different input sizes and plot graph of execution time versus number of elements.
12. Analyze Merge Sort by computing time complexity for different input sizes and plot graph of execution time versus number of elements.
13. Implement 0/1 Knapsack Problem using:
    - Dynamic Programming Method
    - Greedy Method
14. Find Shortest Path using Dijkstra's Algorithm.
15. Find Minimum Cost Spanning Tree using Kruskal's Algorithm with Union-Find Method.
16. Find Minimum Cost Spanning Tree using Prim's Algorithm.
17. Implement:
    - All-Pairs Shortest Path using Floyd's Algorithm
    - Travelling Salesman Problem using Dynamic Programming
18. Design and implement Sum of Subsets Problem using Backtracking.
19. Find all Hamiltonian Cycles in a Connected Undirected Graph using Backtracking.

Note

The instructor may add, delete or modify experiments as required. Open-source tools such as C and C++ are recommended for conducting the lab sessions.

Statistical Computing (BCS051)

Unit I: Descriptive Statistics and Probability (08 Hours)

Descriptive Statistics: Diagrammatic Representation of Data, Measures of Central Tendency, Measures of Dispersion, Skewness and Kurtosis, Correlation, Inference for Correlation Coefficient, Bivariate and Multiple Correlation, Linear and Multiple Regression.

Probability: Basic Probability Concepts, Conditional Probability, Independent Events, Bayes' Theorem, Random Variables, Discrete and Continuous Probability Distributions, Expectation and Variance, Markov Inequality, Chebyshev's Inequality and Central Limit Theorem.

Unit II: Inferential Statistics and Regression Analysis (08 Hours)

Sampling and Confidence Intervals, Statistical Inference and Significance Testing, Estimation and Hypothesis Testing, Goodness of Fit Test, Test of Independence, Permutation and Randomization Tests, t-test, z-test (One Sample, Independent and Paired), ANOVA and Chi-Square Test.

Regression Analysis: Multiple Regression Analysis, Orthogonalization using Householder Transformations (QR Method), Singular Value Decomposition (SVD), Principal Component Analysis (PCA) for Dimension Reduction.

Unit III: Random Number Generation and Monte Carlo Methods (08 Hours)

Pseudo-Random Number Generation, Inverse Transform Method, Acceptance-Rejection Method, Transformations and Multivariate Probability Calculations.

Monte Carlo Methods: Simulation and Monte Carlo Integration, Variance Reduction Techniques, Monte Carlo Hypothesis Testing, Antithetic Variables, Control Variates, Importance Sampling, Stratified Sampling.

Markov Chain Monte Carlo (MCMC): Markov Chains, Metropolis-Hastings Algorithm, Gibbs Sampling and Convergence Analysis.

Unit IV: Resampling, Density Estimation and Numerical Methods (08 Hours)

Resampling Methods: Cross Validation, Bootstrapping, Jackknife Resampling, Percentile Confidence Intervals and Permutation Tests.

Density Estimation: Univariate and Multivariate Density Estimation, Kernel Smoothing Techniques.

Numerical Methods: Root Finding Methods, Numerical Integration, Numerical Maximization and Minimization, Constrained and Unconstrained Optimization, Expectation-Maximization (EM) Algorithm and Simplex Algorithm.

Unit V: R Programming and Statistical Analysis using R (08 Hours)

Introduction to R Programming: History of R, Starting and Exiting R, R as a Scientific Calculator, Package Handling, Workspace Management, Variables, Operators and Expressions, Data Types and Objects, Vectors, Matrices, Arrays, Lists and Data Frames, Built-in and User-Defined Functions, Strings and Factors, Flow Control, Loops, Advanced Looping, Date and Time Functions.

Using R for Statistical Analysis: Importing and Exporting Data, Outputting Results, Graphical Representation in R, Interactive Plotting, Data Analysis Techniques, Commands for Descriptive Statistics, Data Aggregation, Representation of Multivariate Data, Code Optimization and Statistical Libraries in R.

Reference Books

1. Fundamentals of Mathematical Statistics — S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons.
2. Introduction to Probability and Statistics for Engineers and Scientists — Sheldon M. Ross, Academic Press.
3. Modern Mathematical Statistics — Edward J. Dudewicz and S. N. Mishra, Wiley.
4. Statistics Using R — Narosa Publications.
5. Statistical Computing with R — Maria L. Rizzo, Chapman & Hall/CRC Press.
6. The Art of R Programming — Norman Matloff.
7. Introductory Statistics with R — Peter Dalgaard, Springer.
8. Probability and Statistics with R — CRC Press.
9. Statistical Computing – Existing Methods and Recent Developments — Narosa Publications.
10. Handbook of Computational Statistics — Springer.

Data Analytics (BCS052)

Unit I: Introduction to Data Analytics

Introduction to Data Analytics, Sources and Types of Data (Structured, Semi-Structured and Unstructured), Characteristics of Data, Big Data Platforms, Need and Applications of Data Analytics, Analytics Process and Tools, Reporting vs Analytics, Modern Data Analytics Tools.

Unit II: Data Analytics Lifecycle and Data Analysis

Phases of Data Analytics Lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results and Operationalization.

Data Analysis Techniques: Regression Modeling, Multivariate Analysis, Bayesian Modeling, Time Series Analysis, Support Vector Machines, Neural Networks, Principal Component Analysis (PCA), Fuzzy Logic and Decision Trees.

Unit III: Mining Data Streams

Introduction to Data Streams, Stream Data Models and Architecture, Stream Computing, Sampling and Filtering Data Streams, Counting and Estimation Methods, Window Models, Real-Time Analytics Platforms (RTAP), Applications in Sentiment Analysis and Stock Market Prediction.

Unit IV: Frequent Itemsets and Clustering

Mining Frequent Itemsets, Apriori Algorithm, Market Basket Analysis, Handling Large Data Sets, Stream Data Mining.

Clustering Techniques: Hierarchical Clustering, K-Means Clustering, High Dimensional Data Clustering, CLIQUE, ProCLUS, Frequent Pattern-Based Clustering, Clustering in Non-Euclidean Space and Stream Clustering.

Unit V: Big Data Frameworks, Visualization and R Programming

Introduction to Big Data Frameworks: MapReduce, Hadoop, Pig, Hive, HBase, MapR, NoSQL Databases, Hadoop Distributed File System (HDFS) and Sharding.

Data Visualization: Visual Data Analysis Techniques, Interaction Techniques and Applications.

Introduction to R Programming: R GUI, Data Import and Export, Data Types, Descriptive Statistics, Exploratory Data Analysis, Data Visualization and Analytics for Unstructured Data.

Text Books and References

1. Intelligent Data Analysis — Springer.
2. Mining of Massive Datasets — Cambridge University Press.
3. Taming the Big Data Tidal Wave — John Wiley & Sons.
4. Data Analytics for IT Networks — Pearson Education.
5. Big Data, Big Analytics — Wiley.
6. Data Science and Big Data Analytics — EMC Education Series, John Wiley.
7. Big Data Analytics: Turning Big Data into Big Money — Wiley and SAS Business Series.
8. Data Mining and Predictive Analysis — Elsevier.
9. Intelligent Data Analysis — Springer.

Computer Graphics (BCS053)

Unit I: Introduction and Line Drawing

Introduction to Computer Graphics, Types of Graphics Displays, Raster Scan and Random Scan Displays, Frame Buffer and Video Controller, Points and Lines, Line Drawing Algorithms, Circle Drawing Algorithms and Midpoint Circle Algorithm.

Unit II: Transformations and Clipping

2D Transformations, Matrix Representation, Homogeneous Coordinates, Composite Transformations, Reflection and Shearing.
Windowing and Clipping: Viewing Pipeline, Viewing Transformations, Line Clipping Algorithms (Cohen-Sutherland and Liang-Barsky), Polygon Clipping, Curve Clipping and Text Clipping.

Unit III: Three-Dimensional Graphics

3D Geometric Primitives, 3D Object Representation, 3D Transformations, 3D Viewing, Projections and 3D Clipping.

Unit IV: Curves and Surfaces

Quadric Surfaces, Sphere and Ellipsoid, Bezier Curves, B-Spline Curves, Surfaces and Introductory Concepts of Splines.

Unit V: Hidden Surface Removal and Illumination

Hidden Line and Surface Removal Techniques: Back Face Detection, Depth Buffer Method, A-Buffer and Scan Line Method.
Illumination Models: Ambient, Diffuse and Specular Reflection, Phong Model, Intensity Attenuation, Transparency, Shadows and Color Models.
Text Books

- Computer Graphics C Version
- Computer Graphics: Principles and Practice
- Procedural Elements of Computer Graphics
- Principles of Interactive Computer Graphics
- Computer Graphics
- Computer Graphics
- Fundamentals of Computer Graphics and Multimedia
- Computer Graphics with OpenGL

Object Oriented System Design with C++ (BCS054)

Unit I: Introduction to Object Oriented Concepts

Object Oriented Concepts: Object Identity, Encapsulation, Information Hiding, Polymorphism and Object Oriented Modeling. Importance and Principles of Modeling, Introduction to UML, Conceptual Model and Architecture of UML.

Unit II: UML Structural and Behavioral Modeling

Structural Modeling: Classes, Relationships, Common Mechanisms, Class and Object Diagrams.
Interaction Modeling: Collaboration Diagrams, Sequence Diagrams, Message Passing and Polymorphism in Interaction Diagrams.
Behavioral Modeling: Use Case Diagrams, Activity Diagrams, State Machine Diagrams, Events, Signals, Interaction and Package Diagrams.
Architectural Modeling: Component and Deployment Diagrams.

Unit III: Object Oriented Analysis and Design

Object Oriented Analysis and Design, Object Design, Design Optimization, Algorithm Design, Inheritance Adjustment, Object Representation and Documentation.
Structured Analysis and Design (SA/SD), Jackson Structured Development (JSD), Mapping Object Oriented Concepts to Non-Object Oriented Languages, Reusability, Extensibility, Robustness, Procedural vs Object Oriented Programming, Abstraction and Encapsulation.

Unit IV: Basics of C++ and Functions

Introduction to C++, Program Structure, Namespace, Variables, Constants, Enumerations, Operators, Type Casting and Control Structures.
Functions in C++: Call by Reference, Inline Functions, Macro vs Inline Functions, Function Overloading, Default Arguments, Friend Functions and Virtual Functions.

Unit V: Classes, Inheritance and Polymorphism

Objects and Classes in C++, Public and Private Members, Static Members, Constructors, Destructors, Operator Overloading and Type Conversion.
Inheritance: Single, Multiple, Multilevel, Hierarchical and Hybrid Inheritance, Overriding and Virtual Base Class.
Polymorphism: Pointers and Objects, This Pointer, Virtual and Pure Virtual Functions, Runtime Polymorphism.

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
   The Compete Reference C++, Herbert Schlitz, McGraw-Hill Education

Machine Learning Techniques (BCS055)

Unit I: Introduction to Machine Learning

Introduction to Learning, Types of Learning, Well-Defined Learning Problems, Designing a Learning System, History of Machine Learning.
Overview of Machine Learning Approaches: Artificial Neural Networks, Clustering, Reinforcement Learning, Decision Tree Learning, Bayesian Networks, Support Vector Machines and Genetic Algorithms.
Issues in Machine Learning, Difference between Data Science and Machine Learning.
Regression Techniques: Linear Regression and Logistic Regression.

Unit II: Bayesian Learning and Support Vector Machine

Bayesian Learning: Bayes' Theorem, Concept Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks and Expectation-Maximization (EM) Algorithm.
Support Vector Machine (SVM): Introduction to SVM, Types of Kernels (Linear, Polynomial and Gaussian Kernel), Hyperplane and Decision Surface, Properties of SVM and Issues in SVM.

Unit III: Decision Tree and Instance-Based Learning

Decision Tree Learning: Decision Tree Learning Algorithm, Inductive Bias, Inductive Inference with Decision Trees, Entropy and Information Theory, Information Gain, ID3 Algorithm and Issues in Decision Tree Learning.
Instance-Based Learning: k-Nearest Neighbour (k-NN) Learning, Locally Weighted Regression, Radial Basis Function Networks and Case-Based Learning.

Unit IV: Artificial Neural Networks and Deep Learning

Artificial Neural Networks: Perceptron, Multilayer Perceptron, Gradient Descent and Delta Rule, Multilayer Networks, Backpropagation Algorithm, Generalization, Unsupervised Learning, Self-Organizing Map (SOM) Algorithm and its Variants.
Deep Learning: Introduction to Deep Learning, Convolutional Neural Networks (CNN), Types of Layers (Convolutional Layer, Activation Function, Pooling Layer and Fully Connected Layer), Concept of 1D and 2D Convolution, Training of Neural Networks.
Applications and Case Studies: Diabetic Retinopathy Detection, Smart Speakers and Self-Driving Cars.

Unit V: Reinforcement Learning and Genetic Algorithms

Reinforcement Learning: Introduction, Learning Tasks, Applications of Reinforcement Learning, Markov Decision Process (MDP), Q-Learning Function, Q-Learning Algorithm and Introduction to Deep Q-Learning.
Genetic Algorithms: Introduction, Components of Genetic Algorithms, GA Reproduction Cycle, Crossover, Mutation, Genetic Programming, Models of Evolution and Learning, Applications of Genetic Algorithms.

Text books:

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

Application of Soft Computing (BCS056)

Unit I: Neural Networks – I (Introduction and Architecture) (08 Hours)

Introduction to Neural Networks, Biological Neuron, Nerve Structure and Synapse, Artificial Neuron Model, Activation Functions.

Neural Network Architectures: Single Layer and Multilayer Feed Forward Networks, Recurrent Networks. Learning Techniques: Perceptron Learning Rule, Convergence Rule, Auto-Associative Memory and Hetero-Associative Memory.

Unit II: Neural Networks – II (Backpropagation Networks) (08 Hours)

Perceptron Model and its Solution, Single Layer Artificial Neural Networks, Multilayer Perceptron Model. Backpropagation Networks: Learning Methods, Learning Rule Coefficient, Backpropagation Algorithm, Factors Affecting Backpropagation Training and Applications of Neural Networks.

Unit III: Fuzzy Logic – I (Introduction) (08 Hours)

Basic Concepts of Fuzzy Logic, Fuzzy Sets and Crisp Sets, Fuzzy Set Theory and Operations, Properties of Fuzzy Sets.

Fuzzy Relations and Crisp Relations, Conversion of Fuzzy Data to Crisp Data.

Unit IV: Fuzzy Logic – II (Membership Functions and Rules) (08 Hours)

Membership Functions, Inference Mechanism in Fuzzy Logic, Fuzzy IF-THEN Rules, Fuzzy Implications and Fuzzy Algorithms.

Fuzzification and Defuzzification Techniques, Fuzzy Controllers and Industrial Applications of Fuzzy Logic.

Unit V: Genetic Algorithms (GA) (08 Hours)

Introduction to Genetic Algorithms, Basic Concepts and Working Principle of GA, Flowchart and Procedure of Genetic Algorithms.

Genetic Representation and Encoding, Initialization and Selection Process, Genetic Operators, Mutation, Generational Cycle and Applications of Genetic Algorithms.

Text Books

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications — S. Rajasekaran and G. A. Vijayalakshmi Pai, Prentice Hall of India.
2. Artificial Intelligence and Intelligent Systems — N. P. Padhy, Oxford University Press.
   Reference Books
3. Neural Networks — Simon Haykin, Pearson Education.
4. Fuzzy Logic with Engineering Applications — Timothy J. Ross, Wiley India.
5. Neural Networks — Satish Kumar, McGraw Hill.

Image Processing (BCS057)

Unit I: Digital Image Fundamentals

Introduction to Digital Image Processing, Steps in Digital Image Processing, Components of Image Processing Systems, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationship between Pixels.

Color Image Fundamentals: RGB and HSI Color Models.

Two-Dimensional Mathematical Transforms: Discrete Fourier Transform (DFT) and Discrete Cosine Transform (DCT).

Unit II: Image Enhancement

Spatial Domain Enhancement

Gray Level Transformations, Histogram Processing, Basics of Spatial Filtering, Smoothing and Sharpening Filters.

Frequency Domain Enhancement

Introduction to Fourier Transform, Frequency Domain Smoothing and Sharpening Filters, Ideal Filters, Butterworth Filters and Gaussian Filters, Homomorphic Filtering and Color Image Enhancement Techniques.

Unit III: Image Restoration

Image Degradation and Restoration Model, Noise Models, Mean Filters, Order Statistics Filters, Adaptive Filters.

Frequency Domain Restoration: Band Reject Filters, Band Pass Filters, Notch Filters, Optimum Notch Filtering.

Image Restoration Techniques: Inverse Filtering and Wiener Filtering.

Unit IV: Image Segmentation

Edge Detection Techniques, Edge Linking using Hough Transform, Thresholding Methods.

Region-Based Segmentation: Region Growing, Region Splitting and Merging.

Morphological Processing: Erosion and Dilation.

Watershed Segmentation: Basic Concepts, Dam Construction and Watershed Segmentation Algorithm.

Unit V: Image Compression and Recognition

Need for Image Compression, Huffman Coding, Run Length Encoding, Shift Codes, Arithmetic Coding, JPEG and MPEG Standards.

Image Representation and Recognition: Boundary Representation, Boundary Description, Fourier Descriptors, Regional Descriptors, Topological Features, Texture Analysis, Pattern Recognition and Recognition based on Matching Techniques.

Text Books

1. Digital Image Processing — Rafael C. Gonzalez and Richard E. Woods, Pearson, 2010.
2. Fundamentals of Digital Image Processing — Anil K. Jain, Pearson, 2002.
3. Digital Image Processing — Kenneth R. Castleman, Pearson, 2006.
4. Digital Image Processing Using MATLAB — Steven Eddins, Pearson Education, 2011.
5. Multidimensional Digital Signal Processing — Dan E. Dudgeon and Russell M. Mersereau, Prentice Hall, 1990.
6. Digital Image Processing — William K. Pratt, John Wiley & Sons, 2002.

Data Warehousing and Data Mining

Unit I: Introduction to Data Warehousing

Overview and Definition of Data Warehousing, Components of Data Warehouse, Building a Data Warehouse, Warehouse Database, Mapping Data Warehouse to Multiprocessor Architecture.
Difference between Database Systems and Data Warehouses.
Multidimensional Data Model: Data Cubes, Star Schema, Snowflake Schema, Fact Constellation and Concept Hierarchies.

Unit 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, Parallel Processors and Cluster Systems, Distributed DBMS Implementation, Warehousing Software and Warehouse Schema Design.

Unit III: Data Mining and Data Preprocessing

Introduction to Data Mining, Motivation, Definition and Functionalities of Data Mining.
Data Preprocessing Techniques: Data Cleaning, Handling Missing Values, Noisy Data Processing (Binning, Clustering, Regression, Computer and Human Inspection), Inconsistent Data, Data Integration and Data Transformation.
Data Reduction Techniques: Data Cube Aggregation, Dimensionality Reduction, Data Compression, Numerosity Reduction, Discretization and Concept Hierarchy Generation.
Decision Tree Concepts.

Unit IV: Classification and Clustering

Classification: Data Generalization, Analytical Characterization, Attribute Relevance Analysis, Mining Class Comparisons, Statistical Measures in Large Databases.
Classification Algorithms: Statistical-Based Algorithms, Distance-Based Algorithms and Decision Tree-Based Algorithms.
Clustering: Introduction, Similarity and Distance Measures, Hierarchical and Partitional Clustering Algorithms.
Advanced Clustering Methods:
Hierarchical Clustering: CURE and Chameleon, Density-Based Methods: DBSCAN and OPTICS,
Grid-Based Methods: STING and CLIQUE, Model-Based Methods: Statistical Approaches
Association Rule Mining: Large Item Sets, Basic Algorithms, Parallel and Distributed Algorithms, Neural Network Approach.

Unit V: OLAP, Visualization and Applications

Data Visualization and Aggregation, Historical Information Analysis, Query Facilities, OLAP Functions and Tools.
Types of OLAP Servers: ROLAP, MOLAP and HOLAP.
Data Mining Interface, Security, Backup and Recovery, Tuning and Testing of Data Warehouse.
Applications and Recent Trends in Data Warehousing and Data Mining:
Web Mining, Spatial Mining and Temporal Mining.

Text Books

1. Data Warehousing, Data Mining and OLAP — Alex Berson and Stephen J. Smith, Tata McGraw Hill (TMH).
2. Data Warehousing: Architecture and Implementation — Pearson Education.
3. Data Mining: Introductory and Advanced Topics — Margaret H. Dunham and S. Sridhar, Pearson Education.
4. Data Mining Techniques — Arun K. Pujari, Universities Press.
5. Data Mining — Pieter Adriaans and Dolf Zantinge, Pearson Education.

Software Engineering (BCS601)

Unit I: Introduction to Software Engineering

Introduction to Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Comparison between Software Engineering and Conventional Engineering Processes, Software Quality Attributes.Software Development Life Cycle (SDLC) Models:
Waterfall Model, Prototype Model, Spiral Model, Evolutionary Development Model and Iterative Enhancement Model.

Unit II: Software Requirement Specification and Quality Assurance

Software Requirement Specification (SRS): Requirement Engineering Process, Requirement Elicitation, Analysis, Documentation, Review and Management of User Requirements.
Feasibility Study, Information Modeling, Data Flow Diagrams (DFD), Entity Relationship Diagrams (ERD), Decision Tables, SRS Documentation and IEEE Standards for SRS.
Software Quality Assurance (SQA): Verification and Validation, SQA Plans, Software Quality Frameworks, ISO 9000 Models and SEI-CMM Model.

Unit III: Software Design and Software Metrics

Basic Concepts of Software Design, Architectural Design and Low-Level Design.
Modularization, Structure Charts, Pseudo Code, Flowcharts, Coupling and Cohesion.
Design Strategies:
Function-Oriented Design, Object-Oriented Design, Top-Down Design and Bottom-Up Design.
Software Measurement and Metrics:
Halstead's Software Science, Function Point (FP) Metrics, Cyclomatic Complexity and Control Flow Graphs.

Unit IV: Software Testing

Software Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing and Regression Testing.
Testing for Functionality and Performance, Top-Down and Bottom-Up Testing Strategies, Test Drivers and Test Stubs.
White Box Testing and Black Box Testing, Test Data Preparation, Alpha Testing and Beta Testing.
Static Testing Techniques:
Formal Technical Reviews, Peer Reviews, Walkthroughs, Code Inspection and Compliance with Design and Coding Standards.

Unit V: Software Maintenance and Project Management

Software Maintenance: Software Evolution, Need for Maintenance, Types of Maintenance – Preventive, Corrective and Perfective Maintenance, Cost of Maintenance.
Software Re-engineering and Reverse Engineering.
Software Configuration Management: Configuration Management Activities, Change Control Process, Software Version Control and CASE Tools.
Software Project Management:
Cost Estimation, Effort Estimation, Scheduling and Duration Estimation, COCOMO Model, Resource Allocation Models, Software Risk Analysis and Risk Management.

Text books:

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

Compiler Design (BCS602)

Unit I: Introduction to Compiler Design (08 Hours)

Introduction to Compiler, Phases of Compiler, Passes, Bootstrapping.
Finite State Machines and Regular Expressions, Applications of Regular Expressions in Lexical Analysis, DFA-Based Pattern Matching, Implementation of Lexical Analyzers, Lexical Analyzer Generator, LEX Compiler. Formal Grammars and their Applications in Syntax Analysis, BNF Notation, Ambiguity, YACC. Context Free Grammars (CFG), Derivation and Parse Trees, Capabilities of CFG.

Unit II: Parsing Techniques (08 Hours)

Basic Parsing Techniques: Parsers, Shift Reduce Parsing, Operator Precedence Parsing, Top-Down Parsing and Predictive Parsing.
Automatic Construction of Efficient Parsers:
LR Parsers, Canonical Collection of LR(0) Items, Construction of SLR Parsing Tables, Canonical LR Parsing Tables and LALR Parsing Tables.
Use of Ambiguous Grammars, Automatic Parser Generators and Implementation of LR Parsing Tables.

Unit III: Syntax-Directed Translation and Intermediate Code Generation (08 Hours)

Syntax-Directed Translation Schemes, Implementation of Syntax-Directed Translators.
Intermediate Code Generation: Postfix Notation, Parse Trees, Syntax Trees, Three Address Code, Quadruples and Triples.
Translation of Assignment Statements, Boolean Expressions and Control Flow Statements.
Postfix Translation and Translation using Top-Down Parsers.
Advanced Translation Topics:
Array References in Arithmetic Expressions, Procedure Calls, Declarations and Case Statements.

Unit IV: Symbol Tables, Runtime Environment and Error Handling (08 Hours)

Symbol Tables: Data Structures for Symbol Tables and Representation of Scope Information.
Run-Time Environment: Stack Allocation Scheme and Storage Allocation in Block Structured Languages.
Error Detection and Recovery:
Lexical Errors, Syntax Errors and Semantic Errors.

Unit V: Code Generation and Code Optimization (08 Hours)

Code Generation: Design Issues, Target Language, Addressing in Target Code, Basic Blocks and Flow Graphs, Optimization of Basic Blocks and Code Generators.
Code Optimization Techniques:
Machine Independent Optimization, Loop Optimization, DAG Representation of Basic Blocks, Value Numbering, Algebraic Transformations and Global Data Flow Analysis.

Text Books

1. Compilers: Principles, Techniques and Tools — Alfred V. Aho, Ravi Sethi and Jeffrey Ullman, Pearson Education.
2. Compiler Design — K. Muneeswaran, Oxford University Press.
3. Introduction to Compiler Techniques — J. P. Bennett, McGraw-Hill, 2003.
4. Practice and Principles of Compiler Building with C — Henk Alblas and Albert Nymeyer, PHI, 2001.
5. Principles of Compiler Design — V. Raghavan, McGraw-Hill.
6. Compiler Construction — Kenneth C. Louden, Cengage Learning.
7. Crafting a Compiler with C — Charles N. Fischer and Richard LeBlanc, Pearson Education.

Computer Networks (BCS603)

Unit I: Introduction to Computer Networks

Introduction to Computer Networks, Goals and Applications of Networks, Categories of Networks, Organization of the Internet and Internet Service Providers (ISP).
Network Architecture: Layering Principles, Services, Protocols and Standards, OSI Reference Model, TCP/IP Protocol Suite.
Network Devices and Components.

Unit II: Physical Layer and Data Link Layer

Physical Layer:
Network Topology Design, Types of Connections, Transmission Media, Signal Transmission and Encoding, Network Performance, Transmission Impairments, Switching Techniques and Multiplexing.
Data Link Layer:
Framing, Error Detection and Correction, Flow Control Techniques, Elementary Data Link Protocols and Sliding Window Protocols.

Unit III: Medium Access Control and Network Layer

Medium Access Control (MAC) and Local Area Networks:
Channel Allocation, Multiple Access Protocols, LAN Standards, Link Layer Switches and Bridges, Learning Bridge and Spanning Tree Algorithms.
Network Layer:
Point-to-Point Networks, Logical Addressing, Internetworking Concepts, IP Addressing, CIDR, ARP, RARP, DHCP and ICMP.
Routing, Forwarding and Delivery, Static and Dynamic Routing, Routing Algorithms and Protocols, Congestion Control Algorithms and IPv6.

Unit 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 and Quality of Service (QoS).
Domain Name System (DNS), World Wide Web (WWW), Hyper Text Transfer Protocol (HTTP), Electronic Mail, File Transfer Protocol (FTP), Remote Login and Network Management.
Data Compression and Cryptography: Basic Concepts.

Text Books and References

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

Big Data (BCS061)

Unit 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, importance and applications of Big Data, Big Data features including 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.

Unit II Hadoop

History of Hadoop, Apache Hadoop, Hadoop Distributed File System (HDFS), components of Hadoop, data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, Hadoop ecosystem.
Map Reduce: Map Reduce framework and basics, working of Map Reduce, 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.

Unit 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, storing, reading and writing files in HDFS, 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 and maintenance, Hadoop benchmarks, Hadoop in the cloud.

Unit IV Hadoop Ecosystem and YARN

Hadoop ecosystem components, schedulers, fair and capacity scheduling, 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 deleting 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.

Unit V Hadoop Ecosystem 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.
Hive: Apache Hive architecture and installation, Hive shell, Hive services, Hive metastore, comparison with traditional databases, HiveQL, tables, querying data and user defined functions, sorting and aggregating, Map Reduce scripts, joins and subqueries.
HBase: HBase concepts, clients, examples, HBase vs RDBMS, advanced usage, schema design, advanced indexing.
Zookeeper: Role in cluster monitoring and application development using Zookeeper.
IBM Big Data Strategy: Introduction to Infosphere, BigInsights, Big Sheets and Big SQL.
Proposed

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. DT Editorial Services, "Big-Data Black Book", Wiley.

3. Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos and Tom Deutsch, "Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill.
4. Thomas Erl, Wajid Khattak and Paul Buhler, "Big Data Fundamentals: Concepts, Drivers and Techniques", Prentice Hall.
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley.
6. Arshdeep Bahga and Vijay Madisetti, "Big Data Science & Analytics: A Hands-On Approach", VPT.
7. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", CUP.
8. Tom White, "Hadoop: The Definitive Guide", O'Reilly.
9. Eric Sammer, "Hadoop Operations", O'Reilly.
10. Chuck Lam, "Hadoop in Action", Manning Publishers.
11. Deepak Vohra, "Practical Hadoop Ecosystem: A Definitive Guide to Hadoop-Related Frameworks and Tools", Apress.
12. E. Capriolo, D. Wampler and J. Rutherglen, "Programming Hive", O'Reilly.
13. Lars George, "HBase: The Definitive Guide", O'Reilly.
14. Alan Gates, "Programming Pig", O'Reilly.
15. Michael Berthold and David J. Hand, "Intelligent Data Analysis", Springer.
16. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & Sons.
17. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons.
18. Pete Warden, "Big Data Glossary", O'Reilly.

Augmented & Virtual Reality (BCS062)

Unit I: Introduction to Virtual Reality and Hardware Technologies (08 Hours)

Introduction to Virtual Reality (VR) and Virtual Environments, Historical Development of VR, Scientific Landmarks, Computer Graphics, Real-Time Computer Graphics, Flight Simulation and Virtual Environments. Requirements and Benefits of Virtual Reality. Hardware Technologies for 3D User Interfaces: Visual Displays, Auditory Displays, Haptic Displays and Selection of Output Devices for 3D User Interfaces.

Unit II: 3D User Interface Input Hardware (08 Hours)

Characteristics of Input Devices, Desktop Input Devices, Tracking Devices and 3D Mice. Special Purpose Input Devices, Direct Human Input, Home-Built Input Devices and Selection of Input Devices for 3D Interfaces.

Unit III: Software Technologies for Virtual Reality (08 Hours)

VR Database Concepts: World Space, World Coordinates, World Environment.
Objects and Attributes: Geometry, Position and Orientation, Hierarchy, Bounding Volume, Scripts and Other Attributes. VR Environment Components: VR Databases, Tessellated Data, Levels of Detail (LOD), Cullers and Occluders, Lights, Cameras and Scripts. Interaction Techniques: Graphical User Interface (GUI), Control Panels, 2D Controls, Hardware Controls, Room and Stage Descriptions.
World Authoring and Playback, VR Toolkits and Available VR Software Technologies.

Unit IV: 3D Interaction Techniques and VR Applications (08 Hours)

3D Interaction Techniques: 3D Manipulation Tasks, Manipulation Techniques, Input Devices, Travel Techniques and Design Guidelines.
Wayfinding Support: Theoretical Foundations, User-Centered and Environment-Centered Wayfinding Support, Evaluation of Wayfinding Aids.
System Control Techniques: Graphical Menus, Voice Commands, Gestural Commands, Multimodal System Control Techniques and Symbolic Input Techniques.
Designing and Developing 3D User Interfaces: Design Strategies, Development Guidelines and Evaluation Methods. Applications of Virtual Reality: Engineering, Architecture, Education, Medicine, Entertainment, Science and Training.

Unit V: Augmented and Mixed Reality (08 Hours)

Introduction to Augmented Reality (AR) and Mixed Reality (MR), Taxonomy, Features and Technologies of AR. Difference between Augmented Reality and Virtual Reality, Challenges in AR Systems.
AR Systems and Functionalities, Augmented Reality Methods and Visualization Techniques.
Wireless Displays in Educational AR Applications, Mobile Projection Interfaces, Marker-less Tracking, Enhancing Interactivity in AR Environments and Evaluation of AR Systems.

Text Books

1. Developing Virtual Reality Applications: Foundations of Effective Design — Alan B. Craig, William R. Sherman and Jeffrey D. Will, Morgan Kaufmann, 2009.
2. Designing Virtual Systems: The Structured Approach — Gerard Jounghyun Kim, 2005.
3. 3D User Interfaces: Theory and Practice — Doug A. Bowman, Joseph J. LaViola Jr. and Ivan Poupyrev, Addison Wesley, 2005.
4. Spatial Augmented Reality: Merging Real and Virtual Worlds — Oliver Bimber and Ramesh Raskar, 2005.
5. Virtual Reality Technology — Grigore C. Burdea and Philippe Coiffet, Wiley Interscience, 2003.
6. Virtual Reality Systems — John Vince, Addison Wesley, 1995.
7. Virtual Reality: The Revolutionary Technology and How it Promises to Transform Society — Howard Rheingold, Simon & Schuster, 1991.
8. Understanding Virtual Reality: Interface, Application and Design — Morgan Kaufmann Publishers, 2002.
9. Understanding Augmented Reality: Concepts and Applications — Alan B. Craig, Morgan Kaufmann, 2013.

Blockchain Architecture Design (BCS063)

Unit I: Introduction to Blockchain

Introduction to Blockchain, Evolution from Digital Money to Distributed Ledgers.
Blockchain Design Primitives:
Protocols, Security, Consensus Mechanisms, Permissions and Privacy.
Blockchain Architecture and Design:
Basic Cryptographic Primitives such as Hash Functions and Digital Signatures, Hash Chain and Blockchain Concepts, Basic Consensus Mechanisms.

Unit II: Consensus Mechanisms and Permissioned Blockchains

Requirements of Consensus Protocols, Proof of Work (PoW), Scalability Issues in Blockchain Consensus Protocols.
Permissioned Blockchains:
Design Goals and Consensus Protocols used in Permissioned Blockchain Systems.

Unit III: Hyperledger Fabric

Hyperledger Fabric – I
Consensus Process in Hyperledger Fabric, Components of Hyperledger Fabric, Chaincode Design and Implementation.
Hyperledger Fabric – II
Fabric SDK and Front-End Development, Hyperledger Composer Tool and Applications.

Unit IV: Applications of Blockchain Technology

Blockchain in Financial Software and Systems (FSS):
Settlements, Know Your Customer (KYC), Capital Markets and Insurance Applications.
Blockchain in Trade and Supply Chain:
Provenance of Goods, Supply Chain Visibility, Supply Chain Finance, Invoice Management and Discounting.
Blockchain for Government Applications:
Digital Identity, Land Records Management, Public Distribution Systems and Social Welfare Systems.

Unit V: Blockchain Security and Privacy

Blockchain Cryptography, Privacy and Security Mechanisms in Blockchain Systems.
Security Challenges and Privacy Preservation Techniques in Blockchain Technology.

Text Books

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies — Andreas M. Antonopoulos.
2. Blockchain — Melanie Swan, O'Reilly Media.
3. Hyperledger Fabric Documentation
4. Zero to Blockchain – IBM Redbooks Course

Data Compression (BCS064)

Unit I: Introduction to Compression Techniques

Introduction to Data Compression, Lossless Compression and Lossy Compression, Performance Measures of Compression Techniques.
Modeling and Coding: Mathematical Foundations of Lossless Compression, Introduction to Information Theory.
Types of Models: Physical Models, Probability Models, Markov Models and Composite Source Models.
Coding Techniques: Uniquely Decodable Codes and Prefix Codes.

Unit II: Huffman Coding and Related Techniques

Huffman Coding Algorithm, Minimum Variance Huffman Codes.
Adaptive Huffman Coding: Update Procedure, Encoding Procedure and Decoding Procedure.
Golomb Codes, Rice Codes and Tunstall Codes.
Applications of Huffman Coding: Lossless Image Compression, Text Compression and Audio Compression.
Binary Coding and Huffman Coding: Coding a Sequence, Generating Binary Codes and Comparison between Binary and Huffman Coding.
Applications: Bi-level Image Compression, JBIG Standard, JBIG2 and Image Compression Techniques.

Unit III: Dictionary-Based Compression Techniques

Introduction to Dictionary Techniques, Static Dictionary and Adaptive Dictionary Methods.
LZ Compression Techniques: LZ77 and LZ78 Algorithms.
Applications: UNIX Compress Utility, GIF (Graphics Interchange Format) Image Compression and V.42 bis Compression over Modems.
Predictive Coding: Prediction by Partial Matching (PPM), Escape Symbol, Context Length and Exclusion Principle.
Burrows-Wheeler Transform, Move-to-Front Coding, CALIC, JPEG-LS, Multi-Resolution Approaches, Facsimile Encoding and Dynamic Markov Compression.

Unit IV: Quantization Techniques

Distortion Criteria and Source Models.
Scalar Quantization: Quantization Problem, Uniform Quantization, Adaptive Quantization and Non-Uniform Quantization.

Unit v: Vector Quantization: Advantages of Vector Quantization over Scalar Quantization, Linde-Buzo-Gray (LBG) Algorithm, Tree Structured Vector Quantizers and Structured Vector Quantizers.

Text Books

1. Introduction to Data Compression — Khalid Sayood, Morgan Kaufmann Publishers.
2. Elements of Data Compression — Adam Drozdek, Cengage Learning.
3. Introduction to Data Compression, Second Edition — Khalid Sayood, Morgan Kaufmann Series.
4. Data Compression: The Complete Reference — David Salomon, Springer.
5. Text Compression — Timothy C. Bell, Prentice Hall.

Software Engineering Lab (BCS651)

Detailed Syllabus

For a given case study or problem statement, perform the following experiments:

1. Prepare a Software Requirement Specification (SRS) document based on IEEE standards.
2. Draw the Use Case Diagram and identify the role of each actor, along with preconditions, postconditions and functions of each use case.
3. Draw the Activity Diagram.
4. Identify weak and strong classes and draw the Class Diagram.
5. Draw Sequence Diagrams 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 or modify experiments as required. Open-source tools such as OpenOffice, LibreOffice, JUnit, OpenProj, GanttProject, dotProject, ArgoUML and StarUML are recommended for conducting the lab sessions.

Compiler Design Lab (BCS652)

Detailed Syllabus

1. Design and implement a Lexical Analyzer in C that ignores spaces, tabs and new lines.
2. Implement a Lexical Analyzer using LEX Tool.
3. Generate YACC specifications for different syntactic categories:
   - Recognize valid arithmetic expressions using +, –, * and / operators
   - Recognize valid variables starting with letters followed by letters or digits
   - Implement a Calculator using LEX and YACC
   - Convert BNF rules into YACC form and generate Abstract Syntax Tree (AST)
4. Write a program to find ε-closure of all states in an NFA with ε-transitions.
5. Convert NFA with ε-transitions into NFA without ε-transitions.
6. Convert NFA to DFA.
7. Minimize a given DFA.
8. Develop an Operator Precedence Parser.
9. Write a program to compute First and Follow sets of a grammar.
10. Construct a Recursive Descent Parser for arithmetic expressions.
11. Construct a Shift Reduce Parser for a given grammar.
12. Write a program to perform Loop Unrolling optimization.
13. Write a program to perform Constant Propagation optimization.
14. Implement Intermediate Code Generation for simple expressions.
15. Implement the Back-End of a Compiler to convert Three Address Code into 8086 Assembly Language Instructions such as MOV, ADD, SUB and JUMP.

Note

The instructor may add, delete or modify experiments as required. Open-source tools such as R, Python, LEX, YACC and C are recommended for conducting the lab sessions.

Computer Networks Lab (BCS653)

Detailed Syllabus

1. Implement Stop-and-Wait Protocol and Sliding Window Protocol.
2. Study Socket Programming and Client-Server Model.
3. Write programs to simulate ARP and RARP protocols.
4. Write programs to simulate PING and TRACEROUTE commands.
5. Create HTTP Socket programs for web page upload and download.
6. Implement Remote Procedure Call (RPC).
7. Perform Subnetting and IP Address Calculations.
8. Develop TCP Socket Applications:
   - Echo Client and Echo Server
   - Chat Application
   - File Transfer Application
9. Develop TCP and UDP Socket Applications:
   - DNS
   - SNMP
   - File Transfer
10. Study Network Simulator (NS) and simulate Congestion Control Algorithms.
11. Perform case studies on Routing Algorithms:
    - Link State Routing
    - Flooding
    - Distance Vector Routing
12. Learn handling and configuration of networking hardware such as RJ-45 connectors, CAT-6 cables and crimping tools.
13. Configure networking devices such as Routers, Hubs and Switches using real devices or simulators.
14. Practice networking commands and services:
    - ping
    - traceroute
    - nslookup
    - arp
    - telnet
    - ftp
15. Perform Network Packet Analysis using tools like Wireshark and tcpdump.
16. Perform Network Simulation using Cisco Packet Tracer, NetSim, OMNeT++, NS2 and NS3.
17. Implement Socket Programming using TCP and UDP:
    - DNS Application
    - Date and Time Client/Server
    - Echo Client/Server
    - Iterative and Concurrent Servers

Note

The instructor may add, delete or modify experiments as required. Open-source tools such as C, C++, Java, NS3, Mininet, OPNET, TCPDump and Wireshark are recommended for conducting the lab sessions.

Semester IV

Open Elective- 01

IDEA TO BUSINESS MODEL (MOE-060)

Course Objectives

1. To motivate students to understand the fundamentals of establishing and sustaining a business enterprise.
2. To provide students with knowledge about identifying, evaluating, and selecting innovative business ideas and business models.
3. To develop entrepreneurial competencies through entrepreneurship development, production planning and control, and communication systems for effective business management.

Unit I – Introduction

Search for a business idea. Methods of choosing a business idea. Product idea and product selection. Product adoption process. Product innovation. Production planning and development strategy. Development of new product ideas.

Unit II – Introduction to Entrepreneurship

Meaning and concept of entrepreneurship. Difference between entrepreneurship and wage employment. Functions of an entrepreneur. Entrepreneur vs. manager. Role of entrepreneurship in economic development. Barriers to entrepreneurship.

Unit III – Entrepreneurial Development

Types of entrepreneurs. Competencies required for entrepreneurship. Creative and design thinking. Entrepreneurial decision-making process. Entrepreneurship Development Programme (EDP). Evaluation of EDP. Entrepreneurial development training.

Unit IV – Production Planning and Control

Production system and design of production systems. Types of production systems. Production Planning and Control (PPC). Steps involved in PPC.

Unit V – Communication and Negotiation Skills

Importance of communication systems. Barriers to communication. Effective listening skills. Power of communication and presentation. Personal selling. Risk-taking and resilience. Negotiation skills.

Text Books

1. Entrepreneurship Development – Sangeeta Sharma, Kindle Edition.
2. Production and Operations Management – Kanishka Bedi.
3. Marketing Management – Philip Kotler.
4. The Business Model Book: Design, Build and Adapt Business Ideas that Drive Business Growth – Adam Bock and Gerard George.

Software Project Management (MOE-068)

Unit I: Project Evaluation and Project Planning

Introduction to Software Project Management, Importance of Software Project Management and Project Management Activities.
Software Project Methodologies and Categorization of Software Projects.
Project Planning:
Setting Objectives, Management Principles, Management Control and Project Portfolio Management.
Cost-Benefit Evaluation, Risk Evaluation, Strategic Program Management and Stepwise Project Planning.

Unit II: Project Life Cycle and Effort Estimation

Software Process and Process Models, Selection of Process Models.
Rapid Application Development (RAD), Agile Methods, Dynamic System Development Method (DSDM) and Extreme Programming (XP).
Managing Iterative Processes.
Software Estimation:
Basics of Software Estimation, Effort Estimation and Cost Estimation Techniques.
COSMIC Full Function Points, COCOMO II and Parametric Productivity Models.

Unit III: Activity Planning and Risk Management

Objectives of Activity Planning, Project Scheduling, Activity Sequencing and Scheduling.
Network Planning Models:
Formulation of Network Models, Forward Pass and Backward Pass Techniques, Critical Path Method (CPM) and PERT Technique.
Risk Management:
Risk Identification, Risk Assessment, Risk Planning and Risk Management.
Monte Carlo Simulation, Resource Allocation, Creation of Critical Paths and Cost Scheduling.

Unit IV: Project Management and Control

Framework for Project Management and Control.
Data Collection and Progress Visualization.
Cost Monitoring and Earned Value Analysis (EVA).
Project Tracking, Prioritizing Monitoring and Change Control.
Software Configuration Management (SCM), Contract Management and Managing Contracts.

Unit V: Staffing in Software Projects

Managing People and Organizational Behavior.
Staff Selection Methods, Motivation Techniques and the Oldham-Hackman Job Characteristic Model.
Stress Management, Health and Safety Issues, Ethical and Professional Concerns.
Team Work and Decision Making.
Organizational Structures, Distributed and Virtual Teams, Communication Plans and Leadership Skills.

Text Books

1. Software Project Management — Bob Hughes, Mike Cotterell and Rajib Mall, Fifth Edition, McGraw Hill, 2012.
2. Effective Software Project Management — Robert K. Wysocki, Wiley Publication, 2011.
3. Software Project Management — Walker Royce, Addison-Wesley, 1998.
4. Managing Global Software Projects — Gopalaswamy Ramesh, McGraw Hill Education (India), 2013.