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DEPARTMENT OF COMPUTER SCIENCE

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DEPARTMENT OF COMPUTER SCIENCE
[UG Programme for Bachelor in Computer Science (Honours)]

DISCIPLINE SPECIFIC CORE COURSE - 10 (DSC-10) : Design and Analysis of Algorithms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC 10 Design and Analysis of Algorithms	4	3	0	1	Pass in Class XII	DSC 07 Data Structures with C++

Learning Objectives

The course is designed to develop understanding of different algorithm design techniques and use them for problem solving. The course shall also enable the students to verify correctness of algorithms and analyze their time complexity.

Learning outcomes

On successful completion of the course, students will be able to:
- Compute and compare the asymptotic time complexity of algorithms.
- Prove correctness of algorithms.
- Use appropriate algorithm design technique(s) for solving a given problem.
- Distinguish between tractable and intractable problems.

Unit 1 (10 hours)

Searching, Sorting, Selection: Linear Search, Binary Search, Insertion Sort, Selection Sort, Bubble Sort, Heapsort, Linear Time Sorting, Selection Problem, running time analysis and correctness.

Unit 2 (5 hours)

Graphs: Review of graph traversals, graph connectivity, testing bipartiteness, Directed Acyclic Graphs and Topological Ordering.

Unit 3 (10 hours)

Divide and Conquer: Introduction to divide and conquer technique, Merge Sort, Quick Sort, Maximum-subarray problem, Strassen's algorithm for matrix multiplication.

Unit 4 (5 hours)

Greedy algorithms: Introduction to the Greedy algorithm design approach, application to minimum spanning trees, fractional knapsack problem, etc. with correctness, and analysis of time complexity.

Unit 5 (5 hours)

Dynamic Programming: Introduction to the Dynamic Programming approach, application to subset sum, integer knapsack problem etc., correctness, and analysis of time complexity.

Unit 6 (5 hours)

Intractability: Concept of polynomial time computation, polynomial time reductions, decision vs optimization problems, Introduction to NP, NP-hard and NP-Complete classes.

Unit 7 (5 hours)

Advanced Analysis of Algorithms: Amortized Analysis.

Essential/recommended readings

1. Cormen, T.H., Leiserson, C.E., Rivest, R. L., Stein C. *Introduction to Algorithms*, 4th edition, Prentice Hall of India, 2022.
2. Kleinberg, J., Tardos, E. *Algorithm Design,* 1st edition, Pearson, 2013.

Additional references

1. Basse, S., Gelder, A. V., *Computer Algorithms: Introduction to Design and Analysis,* 3rd edition, Pearson, 1999.

Practical List (If any): (30 Hours)

1. i. Write a program to sort the elements of an array using Insertion Sort (The program should report the number of comparisons).
   ii. Write a program to sort the elements of an array using Merge Sort (The program should report the number of comparisons).
2. Write a program to sort the elements of an array using Heap Sort (The program should report the number of comparisons).
3. Write a program to multiply two matrices using the Strassen's algorithm for matrix multiplication.

4. Write a program to sort the elements of an array using Radix Sort.
5. Write a program to sort the elements of an array using Bucket Sort.
6. Display the data stored in a given graph using the Breadth-First Search algorithm.
7. Display the data stored in a given graph using the Depth-First Search algorithm.
8. Write a program to determine a minimum spanning tree of a graph using the Prim's algorithm.
9. Write a program to implement Dijkstra's algorithm to find the shortest paths from a given source node to all other nodes in a graph.
10. Write a program to solve the weighted interval scheduling problem.
11. Write a program to solve the 0-1 knapsack problem.

For the algorithms at S.No 1 and 2, test run the algorithm on 100 different input sizes varying from 30 to 1000. For each size find the number of comparisons averaged on 10 different input instances; plot a graph for the average number of comparisons against each input size. Compare it with a graph of nlogn.

| DISCIPLINE SPECIFIC CORE COURSE – 11 (DSC11): Database Management Systems |

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC 11 Database Management Systems	**4**	**3**	**0**	**1**		DSC01 Programming using Python / A course in Python at plus 2 level, DSC08

Learning Objectives

The course introduces the students to the fundamentals of database management system and its architecture. Emphasis is given on the popular relational database system including data models and data manipulation. Students will learn about the importance of database structure and its designing using conceptual approach using Entity Relationship Model and formal approach using Normalization. The importance of file indexing and controlled execution of transactions will be taught. The course would give students hands-on practice of structured query language in a relational database management system and glimpse of basic database administration commands.

Learning outcomes

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

- Use database management system software to create and manipulate the database.

- Create conceptual data models using entity relationship diagrams for modeling real-life situations and designing the database schema.

- Use the concept of functional dependencies to remove redundancy and update anomalies.

- Apply normalization theory to get a normalized database scheme.

- Write queries using relational algebra, a procedural language.

SYLLABUS OF DSC11

Unit 1 (5 hours)

Introduction to Database: Purpose of database system, Characteristics of database approach, data models, database management system, database system architecture, three-schema architecture, components of DBMS, data independence, and file system approach vs database system approach.

Unit 2 (7 hours)

Entity Relationship Modeling: Conceptual data modeling - motivation, entities, entity types, attributes, relationships, relationship types, constraints on relationship, Entity Relationship diagram notation.

Unit 3 (7 hours)

Relational Data Model: Update anomalies, Relational Data Model - Concept of relations, schema-instance distinction, keys, relational integrity constraints, referential integrity and foreign keys, relational algebra operators and queries.

Unit 4 (10 hours)

Structured Query Language (SQL): Querying in SQL, DDL to create database and tables, table constraints, update database-update behaviors, DML, aggregation functions group by

and having clauses, retrieve data from the database, generate and query views. Access and manipulate databases using ODBC. Basic Database administration SQL commands.

Unit 5 (8 hours)

Database Design: Mapping an Entity Relationship model to relational database, functional dependencies and Normal forms, 1NF, 2NF, 3NF and BCNF decompositions and desirable properties of them.

Unit 6 (8 hours)

File indexing and Transaction Processing: Data Storage and Indexes- Need of file indexes, file organizations, index structures, single- and multi-level indexing, concurrent execution of transactions, ACID properties, need of data recovery and log file.

Essential/recommended readings

1. Elmasri, R., Navathe, B. S. *Fundamentals of Database Systems*, 7th Edition, Pearson Education, 2015.
2. Krogh, J. W. *MySQL Connector/Python Revealed: SQL and NoSQL Data Storage Using MySQL for Python Programmers*, Apress, 2018.
3. Murach J. *Murach's MySQL,* 3rd edition, Pearson, 2019.

Additional References

1. Ramakrishnan, R., Gehrke J. *Database Management Systems*, 3rd Edition, McGraw-Hill, 2014.
2. Silberschatz, A., Korth, H. F., Sudarshan S. *Database System Concepts*, 7th Edition, McGraw Hill, 2019.
3. Connolly, T. M., Begg, C. E. *Database Systems: A Practical Approach to Design, Implementation, and Management*, 6th edition, Pearson, 2019.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

It has three components.

   I.   Create and use the following student-society database schema for a college to answer the given (sample) queries using the standalone SQL editor.

STUDENT	Roll No	StudentName	Course	DOB
	Char(6)	Varchar(20)	Varchar(10)	Date

SOCIETY	SID	SocName	MentorName	TotalSeats
	Char(6)	Varchar(20)	Varchar(15)	Unsigned int

ENROLLMENT	Roll No	SID	DateOfEnrollment
	Char(6)	Char(6)	Date

Here Rollno (ENROLLMENT) and SID (ENROLLMENT) are foreign keys.

1. Retrieve names of students enrolled in any society.
2. Retrieve all society names.
3. Retrieve students' names starting with letter 'A'.
4. Retrieve students' details studying in courses 'computer science' or 'chemistry'.
5. Retrieve students' names whose roll no either starts with 'X' or 'Z' and ends with '9'
6. Find society details with more than N TotalSeats where N is to be input by the user
7. Update society table for mentor name of a specific society
8. Find society names in which more than five students have enrolled
9. Find the name of youngest student enrolled in society 'NSS'
10. Find the name of most popular society (on the basis of enrolled students)
11. Find the name of two least popular societies (on the basis of enrolled students)
12. Find the student names who are not enrolled in any society
13. Find the student names enrolled in at least two societies
14. Find society names in which maximum students are enrolled
15. Find names of all students who have enrolled in any society and society names in which at least one student has enrolled
16. Find names of students who are enrolled in any of the three societies 'Debating', 'Dancing' and 'Sashakt'.
17. Find society names such that its mentor has a name with 'Gupta' in it.
18. Find the society names in which the number of enrolled students is only 10% of its capacity.
19. Display the vacant seats for each society.
20. Increment Total Seats of each society by 10%
21. Add enrollment fees paid ('yes'/'No') field in the enrollment table.
22. Update date of enrollment of society id 's1' to '2018-01-15', 's2' to current date and 's3' to '2018-01-02'.
23. Create a view to keep track of society names with the total number of students enrolled in it.
24. Find student names enrolled in all the societies.
25. Count number of societies with more than 5 student enrolled in it
26. Add column Mobile number in student table with default value '9999999999'
27. Find the total number of students whose age is > 20 years.
28. Find names of students who are born in 2001 and are enrolled in at least one society.
29. Count all societies whose name starts with 'S' and ends with 't' and at least 5 students are enrolled in the society.
30. Display the following information:

Society name   Mentor name   Total Capacity   Total Enrolled   Unfilled Seats

II. Do the following database administration commands:

create user, create role, grant privileges to a role, revoke privileges from a role, create index

     II.   Execute queries given in part I through a high-level language using ODBC connection.

DISCIPLINE SPECIFIC CORE COURSE– 12 (DSC-12): Computer Networks

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Lecture	Tutorial	Practical/ Practice	Eligibility criteria	Pre-requisite of the course (if any)
DSC12 Computer Networks	4	3	0	1	Pass in Class XII	DSC 04 Object Oriented Programming with C++/ GE 1a Programming using C++ / GE1b Programming with Python/ DSC 01 Programming using Python/ GE 3b: Java Programming

Learning Objectives

The course objectives of this paper are to:

- Understand the concepts behind computer networks and data communication.
- Learn the different types of networks, network topologies and their characteristics.
- Learn the working of protocols used at various layers.
- Understand the utility of different networking devices.

Learning outcomes

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

- differentiate between various types of computer networks and their topologies.
- understand the difference between the OSI and TCP/IP protocol suit.

- distinguish between different types of network devices and their functions.
- design/implement data link and network layer protocols in a simulated networking environment.

SYLLABUS OF DSC06

Unit 1 (8 hours)
Introduction: Types of computer networks, Internet, Intranet, network topologies (bus, star, ring, mesh, tree, hybrid topologies), network classifications. layered architecture approach, OSI Reference Model, TCP/IP Reference Model. Transmission Modes: simplex, half duplex and full duplex.

Unit 2 (9 hours)
Physical Layer: Analog signal, digital signal, the maximum data rate of a channel, transmission media (guided transmission media, wireless transmission, satellite communication), multiplexing (frequency division multiplexing, time-division multiplexing, wavelength division multiplexing). Guided Media (Wired) (Twisted pair, Coaxial Cable, Fiber Optics. Unguided Media (Radio Waves, Infrared, Micro-wave, Satellite).

Unit 3 (10 hours)
Data Link and MAC Layer: Data link layer services, error detection and correction techniques, error recovery protocols (stop and wait, go back n, selective repeat), multiple access protocols with collision detection, MAC addressing, Ethernet, data link layer switching, point-to-point protocol.

Unit 4 (8 hours)
Network layer: Networks and Internetworks, virtual circuits and datagrams, addressing, subnetting, Dijkstra Routing algorithm, Distance vector routing, Network Layer protocol-(ARP, IPV4, ICMP).

Unit 5 (10 hours)
Transport and Application Layer: Process to process Delivery- (client-server paradigm, connectionless versus connection-oriented service); User Datagram Protocols, TCP/IP protocol, Flow Control. FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), Telnet (Remote login protocol), WWW (World Wide Web), HTTP (HyperText Transfer Protocol), URL (Uniform Resource Locator).

Essential/recommended readings

1. Tanenbaum, A.S. & Wethrall, D.J.. *Computer Networks*, 5th edition, Pearson Education, 2012.

2. Forouzan, B. A.. *Data Communication and Networking*, 4th edition, McGraw-Hill Education, 2017.

Additional References

1. Comer, D. E.. *Computer Networks and Internet,* 6th edition*,* Pearson education, 2015.

2. Stallings, W., *Data and Computer Communications,* 10th edition, Pearson education India, 2017.

Suggested Practical List :

Practical exercises such as

Introduce students to any network simulator tool and do the following:

1. To Study basic network command and Network configuration commands.
2. To study and perform PC to PC communication.
3. To create Star topology using Hub and Switch.
4. To create Bus, Ring, Tree, Hybrid, Mesh topologies.
5. Perform an initial Switch configuration.
6. Perform an initial Router configuration.
7. To implement Client Server Network.
8. To implement connection between devices using router.
9. To perform remote desktop sharing within LAN connection.

Computer Science Courses for Undergraduate Programme of study with Computer Science discipline Elective

DISCIPLINE SPECIFIC ELECTIVE COURSE: Data Mining - I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Data Mining - I	4	3	0	1	Pass in Class XII	DSC01 Programming using Python / GE1b Programming with Python

Learning Objectives

This course aims to introduce data mining techniques and their application on real-life datasets. The students will learn to pre-process the dataset and make it ready for application of data mining techniques. The course will focus on three main techniques of data mining i.e. Classification, Clustering and Association Rule Mining. Different algorithms for these techniques will be discussed along with appropriate evaluation metrics to judge the performance of the results delivered.

Learning outcomes

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

1. Pre-process the data for subsequent data mining tasks
2. Apply a suitable classification algorithm to train the classifier and evaluate its performance.
3. Apply appropriate clustering algorithm to cluster the data and evaluate clustering quality
4. Use association rule mining algorithms and generate frequent item-sets and association rules

SYLLABUS OF DSE

Unit 1 (5 hours)

Introduction to Data Mining: Motivation and challenges for data mining, Types of data mining tasks, Applications of data mining, Data measurements, Data quality, Supervised vs. unsupervised techniques

Unit 2 (10 hours)

Data Pre-processing: Data aggregation, sampling, dimensionality reduction, feature subset selection, feature creation, variable transformation.

Unit 3 (10 hours)

Cluster Analysis: Basic concepts of clustering, measure of similarity, types of clusters and clustering methods, K-means algorithm, measures for cluster validation, determine optimal number of clusters

Unit 4 (10 hours)

Association Rule mining: Transaction data-set, frequent itemset, support measure, rule generation, confidence of association rule, Apriori algorithm, Apriori principle

Unit 5 (10 hours)

Classification: Naive Bayes classifier, Nearest Neighbour classifier, decision tree, overfitting, confusion matrix, evaluation metrics and model evaluation.

Essential/recommended readings

1. Tan P.N., Steinbach M, Karpatne A. and Kumar V. *Introduction to Data Mining,*2nd edition, Pearson, 2021.
2. Han J., Kamber M. and Pei J. *Data Mining: Concepts and Techniques*, 3rd edition, 2011, Morgan Kaufmann Publishers.
3. Zaki M. J. and Meira J. Jr. *Data Mining and Machine Learning: Fundamental Concepts and Algorithms*, 2nd edition, Cambridge University Press, 2020.

Additional References

1. Aggarwal C. C. *Data Mining: The Textbook*, Springer, 2015.
2. Dunham M. *Data Mining: Introductory and Advanced Topics,* 1st edition, Pearson Education India, 2006.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

All topics covered in theory will be implemented using Python. The operations may be performed on the datasets loaded through scikit, seaborn libraries or can be downloaded from from Open Data Portal (https:// data.gov.in/, UCI repository http://archive.ics.uci.edu/ml/).

Recommended Datasets for :

Classification: Abalone, Artificial Characters, Breast Cancer Wisconsin (Diagnostic)

Clustering: Grammatical Facial Expressions, HTRU2, Perfume data

Association Rule Mining: MovieLens, Titanics

Additional Suggested Practicals List

1. Apply data cleaning techniques on any dataset (e,g, wine dataset). Techniques may include handling missing values, outliers, inconsistent values. A set of validation rules can be prepared based on the dataset and validations can be performed.
2. Apply data pre-processing techniques such as standardization / normalization, transformation, aggregation, discretization/binarization, sampling etc. on any dataset
3. Run Apriori algorithm to find frequent itemsets and association rules on 2 real datasets and use appropriate evaluation measures to compute correctness of obtained patterns
   a) Use minimum support as 50% and minimum confidence as 75%
   b) Use minimum support as 60% and minimum confidence as 60 %

4. Use Naive bayes, K-nearest, and Decision tree classification algorithms and build classifiers on any two datasets. Divide the data set into training and test set. Compare the accuracy of the different classifiers under the following situations:
   I. a) Training set = 75% Test set = 25% b) Training set = 66.6% (2/3rd of total), Test set = 33.3%
   II. Training set is chosen by i) hold out method ii) Random subsampling iii) Cross-Validation. Compare the accuracy of the classifiers obtained.
   Data is scaled to standard format.
5. Use Simple K-means algorithm for clustering on any dataset. Compare the performance of clusters by changing the parameters involved in the algorithm. Plot MSE computed after each iteration using a line plot for any set of parameters.

Project: Students should be promoted to take up one project on any UCI/kaggle/data.gov.in or a dataset verified by the teacher. Preprocessing steps and at least one data mining technique should be shown on the selected dataset. This will allow the students to have a practical knowledge of how to apply the various skills learnt in the subject for a single problem/project.

DISCIPLINE SPECIFIC ELECTIVE COURSE: Combinatorial Optimization

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Combinatorial Optimization	4	3	1	0	Pass in Class XII	NIL

Learning Objectives

This course is designed to introduce the fundamentals of combinatorial optimization to the students in terms of both theory and applications, so as to equip them to explore the more advanced areas of convex and non-convex optimizations.

Learning outcomes

On successful completion of the course, students will be able to:
- Model problems using linear and integer programs
- Apply polyhedral analysis to develop algorithms for optimization problems
- Use the concept of duality for design of algorithms

SYLLABUS OF DSE

Unit 1 (9 hours)

Introduction: Introduction to Combinatorial Optimization Problems, Linear and Integer Programs- LP Formulation, understanding integer programs, computational complexities of IP vs LP, using LP to find optimal or approximate integral solutions, concept of integrality gap.

Unit 2 (14 hours)

Theory of Linear Programming and Algorithmic Perspective to Simplex Method: standard vs. equational form, basic feasible solutions, convexity and convex polyhedra, correspondence between vertices and basic feasible solutions, geometry of Simplex algorithm, exception handling (unboundedness, degeneracy, infeasibility), Simplex algorithm, avoiding cycles.

Unit 3 (12 hours)

Primal-Dual Algorithms: interpretation of dual, optimality conditions for primal and dual, weak and strong duality, complementary slackness, primal-dual algorithm for the shortest path problem.

Unit 4 (10 hours)

Network Flows: linear programming formulations for network flows and bipartite matching, totally unimodular matrices.

Essential/recommended readings

2. Papadimitriou, C.H. & Steiglitz, K. *Combinatorial Optimization: Algorithms and complexity*, New edition, Dover Publications inc., 2000.

Additional References

(i) Bazaraa, M.S., Jarvis, J.J., & and Sherali, H.D. *Linear Programming and Network Flows*, 4th edition, Wiley, 2010.
(ii) Korte, B., & Vygen, J. *Combinatorial Optimization,* 6th edition, Springer, 2018.

Tutorials

Tutorials based on Theory

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Network Security		3	1	0	Pass in Class XII	DSC 04 Object Oriented Programming with C++/ GE 1a Programming using C++ / GE1b Programming with Python/ DSC 01 Programming using Python/ GE 3b: Java Programming

Learning Objectives

This course will provide students with an understanding of the fundamental concepts, principles, and techniques of network security. Students will learn how to assess, design, and implement secure networks using various tools and technologies.

Learning outcomes
On successful completion of the course, students will be able to:

- Describe the importance of network security and the principles of the CIA triad (confidentiality, integrity, and availability), types of security threats and attacks
- Describe the basics of cryptography, including symmetric and asymmetric encryption, hash functions, digital signatures, and public key infrastructure (PKI).
- Apply authentication and access control techniques, including password-based, token-based, and biometric authentication, as well as authorization models and single sign-on (SSO).
- Design and implement secure networks using network segmentation, security zones, and VPNs for remote access.

- Implement and manage firewalls, intrusion detection systems (IDS), and intrusion prevention systems (IPS) to protect network resources, secure wireless networks,
- Implement endpoint security and malware protection measures, including antivirus, patch management, and host-based firewalls.

SYLLABUS OF DSE

Unit 1 (10 hours)

Introduction to Network Security and Network Fundamentals: Importance of network security, Confidentiality, integrity, and availability (CIA) triad, Types of security threats and attacks. OSI and TCP/IP models. IP addressing and subnetting. Networking devices (hubs, switches, routers, firewalls). Network protocols and services (HTTP, HTTPS, FTP, SSH, etc.).

Unit 2 (12 hours)

Cryptography Basics, Authentication and Access Control, Secure Network Design: Symmetric and asymmetric encryption, Hash functions and digital signatures, Public key infrastructure (PKI), Common cryptographic algorithms (AES, RSA, SHA, etc.). Authentication techniques (passwords, tokens, biometrics), Authorization and access control models (RBAC, ABAC, MAC, DAC), Single sign-on (SSO) and multi-factor authentication (MFA). Defense-in-depth strategy, Network segmentation and isolation, Security zones and DMZ, VPNs and secure remote access.

Unit 3 (12 hours)

Firewalls and Intrusion Detection/Prevention Systems, Wireless Network Security: Types of firewalls (packet filtering, stateful inspection, application layer), IDS and IPS concepts and deployment, Signature-based and anomaly-based detection, Honeypots and honeynets. Wireless standards and technologies (802.11, Bluetooth, RFID), Wireless security protocols (WEP, WPA, WPA2, WPA3), Rogue access points and wireless attacks, Securing wireless networks.

Unit 4 (8 hours)

Endpoint Security and Malware Protection, Security Monitoring and Incident Response: Antivirus and antimalware solutions, Patch management and software updates, Host-based firewalls and intrusion detection, Mobile device management (MDM). Security Information and Event Management (SIEM) systems, Log management and analysis, Incident response process and procedures, Forensic analysis and evidence handling.

Unit 5 (3 hours)

Network Security Best Practices and Compliance: Security policies and procedures, Risk assessment and management, Security awareness training, Regulatory compliance (HIPAA, GDPR, PCI-DSS, etc.).

Essential/recommended readings

1. Behrouz Forouzan, Cryptography and network security. 3rd edition (2015), McGraw Hill Education.

2. Stallings, W. (2021). Cryptography and Network Security: Principles and Practice (8th Edition). Pearson.
3. Harris, S. (2018). All-in-One CISSP Exam Guide (8th Edition). McGraw-Hill Education.
4. Atul Kahate, Cryptography and Network Security, McGraw-Hill; Fourth edition (8 May 2019); McGraw Hill Education (India).

Additional References

i. Conklin, W. A., White, G., Williams, D., Davis, R., & Cothren, C. (2021). Principles of Computer Security: CompTIA Security+ and Beyond (6th Edition). McGraw-Hill Education.
ii. Chapple, M., & Seidl, D. (2020). Network Security For Dummies. Wiley.
iii. Gibson, D. (2021). CompTIA Security+ Get Certified Get Ahead: SY0-601 Study Guide. YCDA Publishing.

Online Additional Reference Materials:

1. NIST Special Publications: https://csrc.nist.gov/publications/sp
   a. SP 800-53: Security and Privacy Controls for Federal Information Systems and Organizations
   b. SP 800-82: Guide to Industrial Control Systems (ICS) Security
   c. SP 800-115: Technical Guide to Information Security Testing and Assessment
2. ISO/IEC 27000 series: Information Security Management Systems (ISMS)
   a. ISO/IEC 27001: Information Security Management
   b. ISO/IEC 27002: Code of Practice for Information Security Controls
   c. ISO/IEC 27005: Information Security Risk Management
3. Center for Internet Security (CIS) Critical Security Controls: https://www.cisecurity.org/controls/
   a. A prioritized set of actions to improve network security.
4. OWASP Top Ten Project: https://owasp.org/www-project-top-ten/
   a. A list of the most critical web application security risks.
5. SANS Institute Reading Room: https://www.sans.org/reading-room/
   a. A collection of whitepapers and articles on various network security topics.
6. Vendor documentation and best practices guides (Cisco, Juniper, Palo Alto Networks, etc.)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
	4	3	0	1	Pass in Class XII	NIL

Learning Objectives

The course aims at introducing the basic concepts and techniques of client side web programming. The student shall be able to develop simple websites using HTML, CSS and Javascript.

Learning outcomes

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

- Build websites using the elements of HTML.
- Build dynamic websites using the client side programming techniques with CSS, Javascript and jQuery.
- Learn to validate client-side data.

SYLLABUS OF DSE

Unit 1 (5 hours)
Introduction: Introduction to Internet and web design. Basic concepts of web architecture.

Unit 2 (12 hours)
HTML: Introduction to hypertext mark-up language (html), creating web pages, lists, hyperlinks, tables, web forms, inserting images, frames.

Unit 3 (8 hours)
Cascading style sheet (CSS): Concept of CSS, creating style sheet, Importing style sheets, CSS properties, CSS styling (background, text format, controlling fonts), CSS rules, Style Types, CSS Selectors, CSS cascade, working with block elements and objects, working with lists and tables, CSS id and class, box model (introduction, border properties, padding

properties, margin properties).

Unit 4 (10 hours)

Javascript: Document object model, data types and variables, functions, methods and events, controlling program flow, JavaScript object model, built-in objects and operators, validations.

Unit 5 (10 hours)

jQuery and JSON: Introduction to jQuery, syntax, selectors, events. JSON file format for storing and transporting data.

Essential/recommended readings

1. Nixon, R. *Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5*, O'Rielly*, 2018.*
2. Powell, T.A. *HTML & CSS: The Complete Reference, 5th edition*, Tata McGrawHill, 2010.
3. Duckett, J. *JavaScript and JQuery: Interactive Front-End Web Development*, Wiley, 2014.

Additional References

1. Minnick, J. *Web Design with HTML5 and CSS3*, 8th edition, Cengage Learning, 2015.
2. Boehm, A., & Ruvalcaba, Z. *Munarch's HTML5 and CCS,* 4th edition, Mike Murach & Associates, 2018.
3. J. A. Ramalho *Learn Advanced HTML 4.0 with DHTML*, BPB Publications, 2007.
4. Ivan Bayross *Web Enabled Commercial Application Development Using Html, Dhtml, Javascript, Perl CGI*, BPB Publications, 2009.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

HTML

1. Create an HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.
2. Create an HTML document with Ordered and Unordered lists, Inserting Images, Internal and External linking
3. Create an HTML displaying this semester's time table.
4. Create a website with horizontal and vertical frames. Top horizontal frame showing your college's name and logo. Bottom horizontal frame split into two vertical frames. The left frame with hyperlinks to pages related to faculty, courses, student activities, etc. The right frame showing corresponding pages based on the link clicked on the left frame.
5. Create a student registration form using HTML which has the following controls:

      I.   Text Box
      II.   Dropdown box
      III.   Option/radio buttons
      IV.   Check boxes
      V.   Reset and Submit button

CSS

Create a webpage for your department with drop down navigation menu for faculty, courses, activities, etc.. Implement the webpage using styles, rules, selectors, ID, class.

Javascript

1. Create event driven programs for the following:
   a. Enter a number and on click of a button print its multiplication table.
   b. Print the largest of three numbers entered by the user.
   c. Find the factorial of a number entered by the user.
   d. Enter a list of positive numbers using the prompt terminated by a zero. Find the sum and average of these numbers.
2. Create a student registration form using text, radio button, check box, drop down box, text field and all other required HTML elements. Customise the CSS and javascript to input and validate all data. Create functions to perform validation of each element, example:
   a. Roll number is a 7-digit numeric value
   b. Name should be an alphabetical value(String)
   c. Non-empty and valid fields like DOB

jQuery and JSON

1. Change text color and contents using button click events using jQuery
2. Select elements using ID, class, elements name, attribute name
3. Run code on click events in jQuery
4. Handle HTML form, store the data in JSON object, pass them to another page and display it there using jQuery/Javascript

(For all the Generic Elective courses offered by your department, please put it in the format provided below)

GENERIC ELECTIVES (GE-4a): Data Structures using C++

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GE4a Data Structures using C++	4	3	0	1	Pass in Class XII	NIL

Learning Objectives

The course aims at developing the ability to use basic data structures like arrays, stacks, queues, lists, trees to solve problems. C++ is chosen as the language to understand implementation of these data structures.

Learning outcomes

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

- Compare two functions for their rates of growth.
- Understand abstract specification of data-structures and their implementation.
- Compute time and space complexity of operations on a data-structure.
- Identify the appropriate data structure(s) for a given application and understand the trade-offs involved in terms of time and space complexity.
- Apply recursive techniques to solve problems.

SYLLABUS OF GE-4a

Unit 1 (7 hours)

Growth of Functions, Recurrence Relations: Functions used in analysis, asymptotic notations, asymptotic analysis, solving recurrences using recursion tree, Master Theorem.

Unit 2 (14 hours)

Arrays, Linked Lists, Stacks, Queues, Deques: Arrays: array operations, applications, sorting, two-dimensional arrays, dynamic allocation of arrays; Linked Lists: singly linked lists, doubly linked lists, circularly linked lists, Stacks: stack as an ADT, implementing stacks using arrays, implementing stacks using linked lists, applications of stacks; Queues: queue as an ADT, implementing queues using arrays, implementing queues using linked lists, double-ended queue as an ADT. Time complexity analysis of operations on all data structures.

Unit 3 (4 hours)

Sorting: Insertion Sort, Count Sort and their complexity analysis.

Unit 4 (4 hours)

Recursion: Recursive functions, linear recursion, binary recursion.

Unit 5 (10 hours)

Trees, Binary Trees: Trees: definition and properties, binary trees: definition and properties, traversal of binary trees and their time complexity analysis. Binary Search Trees: insert, delete (by copying), search operations, time complexity analysis of these operation.

Unit 6 (6 hours)

Binary Heap, Priority Queue: Binary Heaps: motivation and introduction, application of heaps - Priority Queues.

Essential/recommended readings

1. Goodrich, M.T, Tamassia, R., & Mount, D., *Data Structures and Algorithms Analysis in C++,* 2nd edition, Wiley, 2011.
2. Cormen, T.H., Leiserson, C.E., Rivest, R. L., Stein C., Introduction to Algorithms. 4th edition. Prentice Hall of India. 2022.
3. Drozdek, A., *Data Structures and Algorithms in C++*, 4th edition, Cengage Learning, 2012.

Additional References

1. Sahni, S. *Data Structures, Algorithms and applications in C++*, 2nd edition. Universities Press, 2011.
2. Langsam Y., Augenstein, M. J., & Tanenbaum, A. M. *Data Structures Using C and C++*, 2nd edition, Pearson, 2009.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

1. Perform matrix addition and multiplication.
2. Implement following recursive functions:
   a. Factorialof a number
   b. Nth fibonacci number
   c. Power function: x^y
3. Implement singly linked lists.
3. Implement doubly linked lists.

4. Implement circular linked lists.
5. Implement stack data structure and its operations using arrays.
6. Implement stack data structure and its operations using linked lists.
7. Convert Prefix expression to Infix and Postfix expressions, and evaluate.
8. Implement queue data structure and its operations using arrays.
9. Implement queue data structure and its operations using linked lists.
10. Implement Binary Trees and its traversals.

GENERIC ELECTIVES (GE-4b): Introduction to Web Programming

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GE4b: Introduction to Programming	**4**	**3**	**0**	**1**	Pass in Class XII	NIL

Learning Objectives

The course aims at introducing the basic concepts and techniques of client side web programming. The student shall be able to develop simple websites using HTML, CSS and Javascript.

Learning outcomes

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

- Build websites using the elements of HTML.
- Build dynamic websites using the client side programming techniques with CSS, Javascript and jQuery.
- Learn to validate client-side data.

SYLLABUS OF GE4b

Unit 1 (5 hours)
Introduction: Introduction to Internet and web design. Basic concepts of web architecture.

Unit 2 (12 hours)
HTML: Introduction to hypertext mark-up language (html), creating web pages, lists,

hyperlinks, tables, web forms, inserting images, frames.

Unit 3 (8 hours)

Cascading style sheet (CSS): Concept of CSS, creating style sheet, Importing style sheets, CSS properties, CSS styling (background, text format, controlling fonts), CSS rules, Style Types, CSS Selectors, CSS cascade, working with block elements and objects, working with lists and tables, CSS id and class, box model (introduction, border properties, padding properties, margin properties).

Unit 4 (10 hours)

Javascript: Document object model, data types and variables, functions, methods and events, controlling program flow, JavaScript object model, built-in objects and operators, validations.

Unit 5 (10 hours)

jQuery and JSON: Introduction to jQuery, syntax, selectors, events. JSON file format for storing and transporting data.

Essential/recommended readings

1. Nixon, R. *Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5*, O'Rielly, 2018.
2. Powell, T.A. *HTML & CSS: The Complete Reference, 5th edition*, Tata McGrawHill, 2010.
3. Duckett, J. *JavaScript and JQuery: Interactive Front-End Web Development*, Wiley, 2014.

Additional References

1. Minnick, J. *Web Design with HTML5 and CSS3*, 8th edition, Cengage Learning, 2015.
2. Boehm, A., & Ruvalcaba, Z. *Munarch's HTML5 and CCS,* 4th edition, Mike Murach & Associates, 2018.
3. J. A. Ramalho *Learn Advanced HTML 4.0 with DHTML*, BPB Publications, 2007.
4. Ivan Bayross *Web Enabled Commercial Application Development Using Html, Dhtml, Javascript, Perl CGI*, BPB Publications, 2009.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

HTML

1. Create an HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.
2. Create an HTML document with Ordered and Unordered lists, Inserting Images, Internal and External linking
3. Create an HTML displaying this semester's time table.
4. Create a website with horizontal and vertical frames. Top horizontal frame showing

your college's name and logo. Bottom horizontal frame split into two vertical frames. The left frame with hyperlinks to pages related to faculty, courses, student activities, etc. The right frame showing corresponding pages based on the link clicked on the left frame.

5. Create a student registration form using HTML which has the following controls:

   I.   Text Box
   II.   Dropdown box
   III.   Option/radio buttons
   IV.   Check boxes
   V.   Reset and Submit button

CSS

Create a webpage for your department with drop down navigation menu for faculty, courses, activities, etc.. Implement the webpage using styles, rules, selectors, ID, class.

Javascript

1. Create event driven programs for the following:
   e. Enter a number and on click of a button print its multiplication table.
   f. Print the largest of three numbers entered by the user.
   g. Find the factorial of a number entered by the user.
   h. Enter a list of positive numbers using the prompt terminated by a zero. Find the sum and average of these numbers.
2. Create a student registration form using text, radio button, check box, drop down box, text field and all other required HTML elements. Customise the CSS and javascript to input and validate all data. Create functions to perform validation of each element, example:
   d. Roll number is a 7-digit numeric value
   e. Name should be an alphabetical value(String)
   f. Non-empty and valid fields like DOB

jQuery and JSON

1. Change text color and contents using button click events using jQuery
2. Select elements using ID, class, elements name, attribute name
3. Run code on click events in jQuery

(Computer Science Courses for Undergraduate Programme of study with Computer Science discipline as one of the three Core Disciplines)

<div style="background:blue">

DISCIPLINE SPECIFIC CORE COURSE (DSC04): Operating Systems

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CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC04: Operating Systems	4	3	0	1	Pass in Class XII	DSC 01 Programming using Python/ A course in C/C++/Python at plus 2 level.

Learning Objectives

This course introduces the students to Operating Systems and its importance in computer systems. The focus is to explain the common services provided by an operating system like process management, memory (primary, secondary & virtual) management, I/O management, file management. The course talks about the various functional components of the operating and their design.

Learning outcomes

On successful completion of the course, students will be able to

- gain knowledge of different concepts of the operating System and its components.
- learn about shell scripts and would be able to use the system in an efficient manner.

SYLLABUS OF DSC04

Unit 1 (4 hours)

Introduction: Operating Systems (OS) definition and its purpose, Multiprogrammed and Time Sharing Systems, OS Structure, OS Operations: Dual and Multi-mode, OS as resource manager.

Unit 2 (10 hours)

Operating System Structures: OS Services, System Calls: Process Control, File Management, Device Management, and Information Maintenance, Inter-process Communication, and Protection, System programs, OS structure- Simple, Layered, Microkernel, and Modular.

Unit 3 (9 hours)

Process Management: Process Concept, States. Process Control Block, Context Switch, Process scheduling, Schedulers, Overview of threads and Scheduling Algorithms: First Come First Served, Shortest-Job-First, Priority & Round-Robin.

Unit 4 (9 hours)

Memory Management: Physical and Logical address space, Swapping Contiguous memory allocation strategies - fixed and variable partitions, Segmentation, Paging, virtual memory: Demand Paging.

Unit 5 (8 hours)

File and Input / Output Device Management: File Concepts, File Attributes, File Access Methods, Directory Structure: Single-Level, Two-Level, Tree-Structured, and Acyclic-Graph Directories, Magnetic Disks, Solid-State Disks, Magnetic Tapes.

Unit 6 (5 hours)

Shell Scripting: Shell variables, parameter passing conditional statements, iterative statements, writing and executing shell scripts, utility programs (cut, paste, grep, echo, pipe, filter etc.)

Essential/recommended readings

1. Galvin, S. P. B., Gagne, G., *Operating System Concepts*, 9th edition, John Wiley Publications, 2016.
2. G. Nutt, Operating Systems, Pearson, 2009
3. Das, S., *Unix: Concepts and Applications*, 4th edition, TMH, 2009.

Additional References

1. Dhamdhere, D. M., *Operating Systems: A Concept-based Approach,* 2nd edition, Tata McGraw-Hill Education, 2017.

2. Kernighan, B. W., Pike, R., *The Unix Programming Environment*, Englewood Cliffs, NJ: Prentice-Hall, 1984.

3. Stallings, W., *Operating Systems: Internals and Design Principles*, 9th edition, Pearson Education, 2018.

4. Tanenbaum, A. S., *Modern Operating Systems.* 3rd edition, Pearson Education, 2007.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

1. Execute various LINUX commands for:

    i. Information Maintenance: wc, clear, cal, who, date, pwd

    ii. File Management: cat, cp, rm, mv, cmp, comm, diff, find, grep

    iii. Directory Management : cd, mkdir, rmdir, ls

2. Execute various LINUX commands for:

    i. Process Control: fork, getpid, ps

    ii. Communication: Input-output redirection, Pipe

    iii. Protection Management: chmod, chown, chgrp

3. Write a program(using fork() and/or exec() commands) where parent and child execute:

    i. same program, same code.

    ii. same program, different code.

    iii. before terminating, the parent waits for the child to finish its task.

4. Write a program to calculate sum of n numbers using Pthreads.

5. Write a program to generate a Fibonacci Series of numbers using Pthreads.

6. Write a program to implement best-fit and worst-fit allocation strategies

7. Write a program to copy files using system calls and using pthreads and compare timings.

8. Write a program to implement FCFS scheduling algorithm.

9. Write a program to implement SJF scheduling algorithm.

10. Write a program to implement non-preemptive priority based scheduling algorithm.

Computer Science Courses for Undergraduate Programme of study with Computer Science discipline as one of the two Core Disciplines
(For e.g. courses for B.A. Programmes with Computer Science as Major discipline)

Computer Science Major

DISCIPLINE SPECIFIC CORE COURSE (DSC04): Operating Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC04: Operating Systems	4	3	0	1	Pass in Class XII	DSC 01 Programming using Python/ A course in C/C++/Python at plus 2 level

Learning Objectives

This course introduces the students to Operating Systems and its importance in computer systems. The focus is to explain the common services provided by an operating system like process management, memory (primary, secondary & virtual) management, I/O management, file management. The course talks about the various functional components of the operating and their design.

Learning outcomes

On successful completion of the course, students will be able to

- gain knowledge of different concepts of the operating System and its components.
- learn about shell scripts and would be able to use the system in an efficient manner.

SYLLABUS OF DSC04

Unit 1 (4 hours)

Introduction: Operating Systems (OS) definition and its purpose, Multiprogrammed and Time Sharing Systems, OS Structure, OS Operations: Dual and Multi-mode, OS as resource manager.

Unit 2 (10 hours)

Operating System Structures: OS Services, System Calls: Process Control, File Management, Device Management, and Information Maintenance, Inter-process Communication, and Protection, System programs, OS structure- Simple, Layered, Microkernel, and Modular.

Unit 3 (9 hours)

Process Management: Process Concept, States. Process Control Block, Context Switch, Process scheduling, Schedulers, Overview of threads and Scheduling Algorithms: First Come First Served, Shortest-Job-First, Priority & Round-Robin.

Unit 4 (9 hours)

Memory Management: Physical and Logical address space, Swapping Contiguous memory allocation strategies - fixed and variable partitions, Segmentation, Paging, virtual memory: Demand Paging.

Unit 5 (8 hours)

File and Input / Output Device Management: File Concepts, File Attributes, File Access Methods, Directory Structure: Single-Level, Two-Level, Tree-Structured, and Acyclic-Graph Directories, Magnetic Disks, Solid-State Disks, Magnetic Tapes.

Unit 6 (5 hours)

Shell Scripting: Shell variables, parameter passing conditional statements, iterative statements, writing and executing shell scripts, utility programs (cut, paste, grep, echo, pipe, filter etc.)

Essential/recommended readings

1. Galvin, S. P. B., Gagne, G., *Operating System Concepts*, 9th edition, John Wiley Publications, 2016.
2. G. Nutt, Operating Systems, Pearson, 2009
3. Das, S., *Unix: Concepts and Applications*, 4th edition, TMH, 2009.

Additional References

1. Dhamdhere, D. M., *Operating Systems: A Concept-based Approach,* 2nd edition, Tata McGraw-Hill Education, 2017.

2. Kernighan, B. W., Pike, R., *The Unix Programming Environment*, Englewood Cliffs, NJ: Prentice-Hall, 1984.

3. Stallings, W., *Operating Systems: Internals and Design Principles*, 9th edition, Pearson Education, 2018.

4. Tanenbaum, A. S., *Modern Operating Systems.* 3rd edition, Pearson Education, 2007.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

1. Execute various LINUX commands for:

    i. Information Maintenance: wc, clear, cal, who, date, pwd

    iv. File Management: cat, cp, rm, mv, cmp, comm, diff, find, grep

    v. Directory Management : cd, mkdir, rmdir, ls

2. Execute various LINUX commands for:

    iv. Process Control: fork, getpid, ps

    v. Communication: Input-output redirection, Pipe

    vi. Protection Management: chmod, chown, chgrp

3. Write a program(using fork() and/or exec() commands) where parent and child execute:

    iv. same program, same code.

    v. same program, different code.

    vi. before terminating, the parent waits for the child to finish its task.

4. Write a program to calculate sum of n numbers using Pthreads.

5. Write a program to generate a Fibonacci Series of numbers using Pthreads.

6. Write a program to implement best-fit and worst-fit allocation strategies

7. Write a program to copy files using system calls and using pthreads and compare timings.

8. Write a program to implement FCFS scheduling algorithm.

9. Write a program to implement SJF scheduling algorithm.

10. Write a program to implement non-preemptive priority based scheduling algorithm.

DISCIPLINE SPECIFIC CORE COURSE (A4): Data Mining-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
A4: Data Mining - II	4	3	0	1	Pass in Class XII	DSC01 Programming using Python, / GE1b

						Programming with Python / A1 Programming Fundamentals using Python ,Data Mining-I

Learning Objectives

The course introduces the students to the supervised and unsupervised learning techniques. Students will learn about the importance of ensemble methods, cluster analysis, anomaly detection and their applicability in mining patterns in real applications. At the end students will be exposed to two advanced topics: text mining and time-series mining. Students will use the learned topics in solving real applications using open-source software.

Learning outcomes

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

- Differentiate between partition-based, density-based and hierarchical clustering
- Build ensemble models to improve predictive performance of the classifier
- Identify anomalies and outliers using supervised and unsupervised techniques
- Analyze time-series data and extract patterns from the stamped data
- Mine textual data and do topic modeling

SYLLABUS OF A4

Unit 1 (9 hours)

Clustering: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Comparison of different methods

Unit 2 (8 hours)

Ensemble Methods: Need of ensemble, Random Forests, Bagging and Boosting

Unit 3 (10 hours)

Anomaly Detection: Outliers and Outlier Analysis, Outlier Detection Methods, Statistical Approaches, Proximity-based and density-based outlier detection, Clustering-based approaches

Unit 4 (8 hours)

Mining Text Data: Document Preparation and Similarity, Clustering Methods for Text, Topic Modeling

Unit 5 (10 hours)

Stream Mining: Time series basics, Date Ranges, Frequencies, and Shifting, Resampling and moving windows functions, Decay function, Clustering stamped data: STREAM and CluStream

Essential/recommended readings

1. Tan P.N., Steinbach M, Karpatne A. and Kumar V. *Introduction to Data Mining,* 2nd edition, Pearson, 2019.
2. Zaki M. J. and Meira J. Jr. *Data Mining and Machine Learning: Fundamental Concepts and Algorithms*, 2nd edition, Cambridge University Press, 2020.
3. Aggarwal C. C. *Data Mining: The Textbook*, Springer, 2015.

Additional References

1. Han J. Kamber M. and Pei J. *Data Mining: Concepts and Techniques*, Morgan Kaufmann Publishers, 2011.
2. Dunham M. *Data Mining: Introductory and Advanced Topics*, Pearson, 2006.

Suggested Practicals List (If any): (30 Hours)

Practical exercise such as

1. Apply Partitioning Methods, Hierarchical Methods, Density-Based Methods for clustering on a data set and compare the performance of the obtained results using different metrics
2. Create an ensemble using Random Forest and show the impact of bagging and boosting on the performance
3. Apply different outlier-detection methods on a noisy dataset and compare their effectiveness in terms of outliers reported
4. Compute similarity between two documents after required document preparation
5. Considering a time-stamped data (sales data/weather data), compare the aggregate values visually using different moving windows function
6. Write a program to find the latent topics in a document using any topic modeling method and display top 5 terms that contribute to each topic along with their strength. Also, visualize the distribution of terms contributing to the topics.

Project: Students should be promoted to take up one project covering at least one unit of the syllabus on any UCI/kaggle/data.gov.in or a dataset verified by the teacher. This will allow the students to have a practical knowledge of how to apply the various skills learnt in the subject for a single problem/project.

Computer Science Courses for Undergraduate Programme of study with Computer Science discipline as one of the two Core Disciplines
(For e.g. courses for B.A. Programmes with Computer Science as Non-major discipline)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC04: Operating Systems	4	3	0	1	Pass in Class XII	DSC 01 Programming using Python/ A course in C/C++/Python at plus 2 level

Learning Objectives

This course introduces the students to Operating Systems and its importance in computer systems. The focus is to explain the common services provided by an operating system like process management, memory (primary, secondary & virtual) management, I/O management, file management. The course talks about the various functional components of the operating and their design.

Learning outcomes

On successful completion of the course, students will be able to

- gain knowledge of different concepts of the operating System and its components.
- learn about shell scripts and would be able to use the system in an efficient manner.

SYLLABUS OF DSC04

Unit 1 (4 hours)

Introduction: Operating Systems (OS) definition and its purpose, Multiprogrammed and Time Sharing Systems, OS Structure, OS Operations: Dual and Multi-mode, OS as resource manager.

Unit 2 (10 hours)

Operating System Structures: OS Services, System Calls: Process Control, File Management, Device Management, and Information Maintenance, Inter-process Communication, and Protection, System programs, OS structure- Simple, Layered, Microkernel, and Modular.

Unit 3 (9 hours)

Process Management: Process Concept, States. Process Control Block, Context Switch, Process scheduling, Schedulers, Overview of threads and Scheduling Algorithms: First Come First Served, Shortest-Job-First, Priority & Round-Robin.

Unit 4 (9 hours)

Memory Management: Physical and Logical address space, Swapping Contiguous memory allocation strategies - fixed and variable partitions, Segmentation, Paging, virtual memory: Demand Paging.

Unit 5 (8 hours)

File and Input / Output Device Management: File Concepts, File Attributes, File Access Methods, Directory Structure: Single-Level, Two-Level, Tree-Structured, and Acyclic-Graph Directories, Magnetic Disks, Solid-State Disks, Magnetic Tapes.

Unit 6 (5 hours)

Shell Scripting: Shell variables, parameter passing conditional statements, iterative statements, writing and executing shell scripts, utility programs (cut, paste, grep, echo, pipe, filter etc.)

Essential/recommended readings

1. Galvin, S. P. B., Gagne, G., *Operating System Concepts*, 9th edition, John Wiley Publications, 2016.
2. G. Nutt, Operating Systems, Pearson, 2009
3. Das, S., *Unix: Concepts and Applications*, 4th edition, TMH, 2009.

Additional References

1. Dhamdhere, D. M., *Operating Systems: A Concept-based Approach,* 2nd edition, Tata McGraw-Hill Education, 2017.

2. Kernighan, B. W., Pike, R., *The Unix Programming Environment*, Englewood Cliffs, NJ: Prentice-Hall, 1984.

3. Stallings, W., *Operating Systems: Internals and Design Principles*, 9th edition, Pearson Education, 2018.

4. Tanenbaum, A. S., *Modern Operating Systems.* 3rd edition, Pearson Education, 2007.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

1. Execute various LINUX commands for:

    i. Information Maintenance: wc, clear, cal, who, date, pwd

    vi. File Management: cat, cp, rm, mv, cmp, comm, diff, find, grep

    vii. Directory Management : cd, mkdir, rmdir, ls

2. Execute various LINUX commands for:

   vii. Process Control: fork, getpid, ps

   viii. Communication: Input-output redirection, Pipe

   ix. Protection Management: chmod, chown, chgrp

3. Write a program(using fork() and/or exec() commands) where parent and child execute:

  vii. same program, same code.

viii. same program, different code.

  ix. before terminating, the parent waits for the child to finish its task.

4. Write a program to calculate sum of n numbers using Pthreads.

5. Write a program to generate a Fibonacci Series of numbers using Pthreads.

6. Write a program to implement best-fit and worst-fit allocation strategies

7. Write a program to copy files using system calls and using pthreads and compare timings.

8. Write a program to implement FCFS scheduling algorithm.

9. Write a program to implement SJF scheduling algorithm.

10. Write a program to implement non-preemptive priority based scheduling algorithm.

DEPARTMENT OF COMPUTER SCIENCE
[UG Programme for Bachelor in Computer Science (Honours)]

DISCIPLINE SPECIFIC CORE COURSE - 13 (DSC-13) : Algorithms and Advanced Data Structures

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSC 13 Algorithms and Advanced Data Structures	4	3	0	1	Pass in Class XII	DSC 07 Data Structures with C++, DSC 10 Design and Analysis of Algorithms

Learning Objectives

This course is designed to build upon the fundamentals in data structures and algorithm design and gain exposure to more data structures and algorithms for new problems.

Learning outcomes

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

- Comprehend and use data structures for lists.
- Use hash tables for dictionaries.
- Comprehend and use data structures and algorithms for string matching.
- Apply disk based data structures.
- Implement and analyze advanced data structures and algorithms for graphs.
- Describe the purpose of randomization in data structures and algorithms.

Unit 1 (4 hours)

List and Iterator ADTs: Vectors, Lists, Sequences

Unit 2 (6 hours)

Hash Tables, Dictionaries: Hash Functions, Collision resolution schemes.

Unit 3 (8 hours)

Strings: String Matching: KMP algorithm; Tries: Standard Tries, Compressed Tries, Suffix Tries, Search Engines

Unit 4 (8 hours)

More on Trees: 2-4 Trees, B Trees

Unit 5 (8 hours)

More on Graphs: Bellman Ford Algorithm, Union Find Data Structures - application Kruskal's algorithm

Unit 6 (6 hours)

Randomization: Randomized Quicksort, Randomized Select, Skip lists

Unit 7 (5 hours)

Network Flows: Ford Fulkerson algorithm for max flow problem.

Essential/recommended readings

1. Goodrich, M.T, Tamassia, R., & Mount, D. *Data Structures and Algorithms Analysis in C++*, 2nd edition, Wiley, 2011.
2. Cormen, T.H., Leiserson, C.E., Rivest, R. L., Stein C. *Introduction to Algorithms*, 4th edition, Prentice Hall of India, 2022.
3. Kleinberg, J., Tardos, E. *Algorithm Design*, 1st edition, Pearson, 2013.
4. Drozdek, A. *Data Structures and Algorithms in C++*, 4th edition, Cengage Learning. 2012.

Practical List : (30 Hours)

Practical exercises such as

1. Write a program to sort the elements of an array using Randomized Quick sort (the program should report the number of comparisons).
2. Write a program to find the ith smallest element of an array using Randomized Select.
3. Write a program to determine the minimum spanning tree of a graph using Kruskal's algorithm.
4. Write a program to implement the Bellman Ford algorithm to find the shortest paths from a given source node to all other nodes in a graph.

5. Write a program to implement a B-Tree.
6. Write a program to implement the Tree Data structure, which supports the following operations:
   I.   Insert
   II.   Search
7. Write a program to search a pattern in a given text using the KMP algorithm.
8. Write a program to implement a Suffix tree.

DISCIPLINE SPECIFIC CORE COURSE – 14 (DSC-14): Theory of Computation

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSC 14 Theory of Computati on	4	3	0	1	Pass in Class XII	DSC04 Object Oriented Programming with C++ / GE1a Programming using C++ /A course in C/C++ at plus 2 level

Learning Objectives

This course introduces formal models of computation, namely, finite automaton, pushdown automaton, and Turing machine; and their relationships with formal languages. make students aware of the notion of computation using abstract computing devices. Students will also learn about the limitations of computing machines as this course addresses the issue of which problems can be solved by computational means (decidability vs undecidability

Learning outcomes

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

● design a finite automaton, pushdown automaton or a Turing machine for a problem at hand.

- apply pumping lemma to prove that a language is non-regular/non-context-free.
- describe limitations of a computing machines and
- recognize what can be solved and what cannot be solved using these machines.

SYLLABUS OF DSC 14

Unit 1 (7 hours)

Introduction: Alphabets, string, language, basic operations on language, concatenation, union, Kleene star.

Unit 2 (15 hours)

Finite Automata and Regular: Regular expressions, Deterministic Finite Automata (DFA), Non-deterministic Finite Automata (NFA), relationship between NFA and DFA, Transition Graphs (TG), properties of regular languages, the relationship between regular languages and finite automata, pumping lemma, Kleene's theorem.

Unit 3 (15 hours)

Context-Free Languages (CFL): Context-Free Grammars (CFG), deterministic and non-deterministic Pushdown Automata (PDA), relationship between CFG and PDA, parse trees, leftmost derivation, Ambiguities in grammars, pumping lemma for CFL, properties of CFL, Chomsky Normal Form.

Unit 4 (8 hours)

Turing Machines and Models of Computations: Turing machine as a model of computation, configuration of Turing machine, Recursive and recursively enumerable languages, Church Turing Thesis, Universal Turing Machine, decidability, Halting problem.

Essential/recommended readings
1. Harry R. Lewis and Christos H. Papadimitriou, *Elements of the Theory of Computation*, 2nd Edition, Prentice Hall of India (PHI), 2002
2. Daniel I.A. Cohen, *Introduction to Computer Theory*, 2nd Edition, Wiley India Pvt. Ltd., 2011.

Additional References

1. J.E. Hopcroft, R. Motwani, and J.D. Ullman, *Introduction to Automata Theory, Languages and Computation*, 3rd edition, Addison Wesley, 2006.
2. Peter Linz, *An Introduction to Formal Languages and Automata*, 6th edition, Jones & Bartlett Learning, 2017.

3. Michael Sipser, *Introduction to the Theory of Computation*, Cengage, 2014

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	**Tutorial**	**Practical/ Practice**		
DSC 15 Software Engineering		3	0	1	Pass in Class XII	DSC01 Programming using Python/ DSC04 Object Oriented Programming with C++/A course in C/C++ or Python at plus 2 level

Learning Objectives

This course will acquaint the student with different approaches and techniques used to develop good quality software. The course includes learning of various software development process frameworks, requirement analysis, design modeling, qualitative and quantitative software metrics, risk management, and testing techniques.

Learning outcomes

On successful completion of the course, a student will be able to:

- describe the software development models.
- analyse and model customer requirements and build design models.
- estimate and prepare schedule for software projects.
- analyse the impact of risks involved in software development.
- design and build test cases, and perform software testing.

SYLLABUS OF DSC 15

Unit 1 (9 hours)

Introduction: Software Engineering - A Layered Approach; Software Process – Process Framework, Umbrella Activities; Process Models – Waterfall Model, Incremental Model, and Evolutionary process Model (Prototyping, Spiral Model); Introduction to Agile, Agile Model – Scrum.

Unit 2 (6 hours)

Software Requirements Analysis and Specification: Use Case Approach, Software Requirement Specification Document, Flow-oriented Model, Data Flow Model

Unit 3 (8 hours)

Design Modeling: Translating the Requirements model into the Design Model, The Design Process, Design Concepts - Abstraction, Modularity and Functional Independence; Structure Charts.

Unit 4 (7 hours)

Software Metrics and Project Estimation: Function based Metrics, Software Measurement, Metrics for Software Quality; Software Project Estimation (FP based estimations); Project Scheduling (Timeline charts, tracking the schedule).

Unit 5 (5 hours)

Quality Control and Risk Management: Quality Control and Quality Assurance, Software Process Assessment and Improvement; Software Risks, Risk Identification, Risk Projection, Risk Mitigation, Monitoring and Management.

Unit 6 (10 hours)

Software Testing: Strategic Approach to Software Testing, Unit Testing, Integration Testing, Validation Testing, System Testing; Black-Box and White Box Testing, Basis Path Testing.

Essential/recommended readings

1. Pressman, R.S. *Software Engineering: A Practitioner's Approach*, 9th edition, McGraw-Hill, 2020.
2. Aggarwal, K.K., Singh, Y. *Software Engineering*, 3rd edition, New Age International Publishers, 2007.
3. Jalote, P. An Integrated Approach to Software Engineering, 3rd Edition, Narosa Publishing House, 2005.

Additional References

1. Sommerville, I. *Software Engineering*, 9th edition, Addison Wesley, 2011.
2. *The Definitive Guide to Scrum: The Rules of the Game*, Ken Schwaber, Jeff Sutherland, July 2016.

Suggested Practical List :(30 Hours)

Practical exercises such as

The students document, design and code a module of a Software Project using an appropriate Software Process model. The Software Project should include the use of software engineering tools and include.

1. Problem Statement, Process Model

2. Requirement Analysis: Create Data Flow, Data Dictionary, Use Cases, Sequence Diagram, Software Requirement Specification Document

3. Project Management: Timeline Chart, Compute FP, Effort, Cost, Risk Table.

4. Design Engineering: Architectural Design, Pseudocode of a small module.

5. Coding: Develop at least a single module using any programming Language

6. Testing: Compute Basic path set for at least one module from a project, Generate test cases.

Some of the sample projects are given below:

1. Criminal Record Management: Implement a criminal record management system for jailers, police officers and CBI officers

2. DTC Route Information: Online information about the bus routes and their frequency and fares.

3. Car Pooling: To maintain a web-based intranet application that enables the corporate employees within an organization to avail the facility of carpooling effectively.

4. Patient Appointment and Prescription Management System

5. Organized Retail Shopping Management Software

6. Online Hotel Reservation Service System

7. Examination and Result computation System

8. Automatic Internal Assessment System

9. Parking Allocation System

Computer Science Courses for Undergraduate Programme of study with Computer Science discipline Elective

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Data Mining-II	4	3	0	1	Pass in Class XII	DSC01 Programming using Python, / GE1b Programming with Python / A1 Programming Fundamentals using Python ,Data Mining-I

Learning Objectives

The course introduces the students to the important supervised and unsupervised learning techniques. Students will learn about the importance of ensemble methods, cluster analysis, anomaly detection and their applicability in mining patterns in real applications. At the end students will be exposed to two advanced topics: text mining and time-series mining. Students will use the learned topics in solving real applications using Open-source software.

Learning outcomes

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

- Differentiate between partition-based, density-based and hierarchical clustering.
- Build ensemble models to improve predictive performance of the classifier.
- Identify anomalies and outliers using supervised and unsupervised techniques.
- Analyze time-series data and extract patterns from the stamped data.
- Mine textual data and do topic modelling.

SYLLABUS OF DSE

Unit 1 (10 hours)

Clustering: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Comparison of different methods

Unit 2 (8 hours)

Ensemble Methods: Need of ensemble, Random Forests, Bagging and Boosting

Unit 3 (10 hours)

Anomaly Detection: Outliers and Outlier Analysis, Outlier Detection Methods, Statistical Approaches, Proximity-based and density-based outlier detection, Clustering-based approaches

Unit 4 (7 hours)

Mining Text Data: Document Preparation and Similarity, Clustering Methods for Text, Topic Modeling

Unit 5 (10 hours)

Stream Mining: Time series basics, Date Ranges, Frequencies, and Shifting, Resampling and moving windows functions, Decay function, Clustering stamped data**:** STREAM and CluStream

Essential/recommended readings

1. Tan P.N., Steinbach M, Karpatne A. and Kumar V. *Introduction to Data Mining,* 2nd edition, Pearson, 2019.
2. Zaki M. J. and Meira J. Jr. *Data Mining and Machine Learning: Fundamental Concepts and Algorithms*, 2nd edition, Cambridge University Press, 2020.
3. Aggarwal C. C. *Data Mining: The Textbook*, Springer, 2015.

Additional References

1. Han J. Kamber M. and Pei J. *Data Mining: Concepts and Techniques*, Morgan Kaufmann Publishers, 2011.
2. Dunham M. *Data Mining: Introductory and Advanced Topics*, Pearson, 2006.

Suggested Practical List : (30 Hours)

Practical exercises such as

Use a dataset of your choice from Open Data Portal (https:// data.gov.in/, UCI repository or a dataset verified by the teacher) or load from scikit, seaborn library for the following exercises to practice the concepts learnt.

1. Apply Partitioning Methods, Hierarchical Methods, Density-Based Methods for clustering on a data set and compare the performance of the obtained results using different metrics.
2. Create an ensemble using Random Forest and show the impact of bagging and boosting on the performance.

3. Apply different outlier-detection methods on a noisy dataset and compare their effectiveness in terms of outliers reported.
4. Compute similarity between two documents after required document preparation.
5. Considering a time-stamped data (sales data/weather data), compare the aggregate values visually using different moving windows function.
6. Write a program to find the latent topics in a document using any topic modeling method and display top 5 terms that contribute to each topic along with their strength. Also, visualize the distribution of terms contributing to the topics.

Project: Students are encouraged to work on a good dataset in consultation with their faculty and apply the concepts learned in the course.

DISCIPLINE SPECIFIC ELECTIVE COURSE: Data Privacy

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	**Tutorial**	**Practical/ Practice**		
Data Privacy	4	3	0	1	Pass in Class XII	NIL

Learning Objectives

This course aims to provide students with an ability to identify privacy related aspects of data uses(including attacks on data privacy), evaluate proposed mechanisms for privacy protection and relate to ethical issues related to data privacy.

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

- Understand the basic principles of data privacy and the implications of data breaches.
- Identify and evaluate different methods of protecting sensitive data.
- Explain the role of privacy regulations in safeguarding personal information.
- Implement basic cryptographic techniques to secure data.
- Apply data anonymization techniques to protect personal information.
- Analyze the ethical considerations in data privacy

Unit 1 (10 hours)

Introduction to Data Privacy and Privacy Regulations: Notion of data privacy, Historical context of data privacy, Types of sensitive data, Privacy laws and regulations.

Unit 2 (15 hours)

Data Privacy Attacks, Cryptography and Data Protection: Type of Attacks/ Data Breaches on Data Privacy, Impact of Data Breaches / Attacks, Introduction to cryptography, Symmetric and asymmetric encryption, Hashing and digital signatures.

Unit 3 (10 hours)

Data Collection, Use and Reuse: Harms Associated with Data collections, use and reuse, Introduction to data anonymization, Data Anonymization Techniques for anonymizing data, Challenges in anonymizing data

Unit 4 (10 hours)

Ethical considerations in Data Privacy: Privacy and Surveillance, Ethics of Data Collection and Use, Bias and discrimination in data analysis

Essential/recommended readings

1. Ronald Leenes, Rosamunde van Brakel, and Serge Gutwirth: *Data Protection and Privacy: The Age of Intelligent Machines*, Hart Publishing, 2017.
2. Naavi: *Personal Data Protection Act of India (PDPA 2020)*: Be Aware, Be Ready and Be Compliant, Notion Press, 2020.
3. Ravinder Kumar Gaurav Goyal, *The Right to Privacy in India: Concept and Evolution*, Publisher: Lightning Source, 2016.

Additional References

1. https://onlinecourses.nptel.ac.in/noc22_cs37/preview
2. https://www.coursera.org/learn/northeastern-data-privacy/home/info

Suggested Practical List : (30 Hours)

Practical exercises such as

1. Data Privacy Audit: Students can conduct a data privacy audit of a company or organization to identify potential vulnerabilities and risks in their data privacy practices.

2. Privacy Impact Assessment: Students can conduct a privacy impact assessment (PIA) of a new technology or system to identify potential privacy risks and develop strategies to mitigate them.
3. Regulation Compliance: Students can explore the requirements of the Data Protection Regulations and develop a plan for ensuring compliance with the regulation.
4. Cryptography: Students can learn about different cryptographic techniques and tools, such as encryption, hashing, and digital signatures, and implement them in practice.
5. Anonymization Techniques: Students can learn about data anonymization techniques, such as k-anonymity, differential privacy, and data masking, and apply them to a real-world dataset.
6. Privacy Policy Analysis: Students can analyze the privacy policies of different companies and identify gaps or areas for improvement.
7. Privacy-Enhancing Technologies: Students can explore privacy-enhancing technologies (PETs), such as virtual private networks (VPNs), Tor, and secure messaging apps, and evaluate their effectiveness in protecting privacy.
8. Privacy Breach Response Plan: Students can develop a privacy breach response plan for a company or organization, including steps to take in the event of a data breach and strategies for communicating with affected parties.
9. Ethical Considerations: Students can explore ethical considerations in data privacy, such as the balance between privacy and security, the impact of data collection and analysis on marginalized communities, and the role of data ethics in technology development.
10. Case Studies: Students can analyze case studies of privacy breaches or successful privacy protection strategies, and identify key lessons and takeaways.

DISCIPLINE SPECIFIC ELECTIVE COURSE: Unix Network Programming

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	
		Lecture	Tutorial	Practical/ Practice		
Unix Network Programming	4	3	0	1	Pass in Class XII	DSC 04 Object Oriented Programming with C++/ GE 1a Programming using C++ / GE1b Programming with Python/ DSC 01 Programming using Python/ GE 3b: Java Programming

Learning Objectives

This course introduces the concepts of Internet protocols, ports used during communication, Client/Server concepts and various transport protocols used in computer network applications and services. The objective is to equip the students with technical knowledge of it comprises of the study of the sockets used with TCP and UDP.

Learning outcomes

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

- Describe and analyze the various Internet Transport layer protocols used in TCP AND UDP.
- Comprehend the concepts and structures of both TCP based connection-oriented and UDP based connectionless client server applications.
- Write various real-life client-server applications using socket programming.
- Modify, maintain and extend the present internet client-server applications and write any new type of internet applications to suit the current needs of Internet users.

SYLLABUS OF DSE

Unit 1 (6 hours)

Introduction Basics of Client Server applications, Example of day time client server, concurrent servers, protocols, sockets, port numbers.

Unit 2 (17 hours)

Connection-oriented Socket Applications: Elementary TCP sockets – Socket, connect, bind, listen, accept, fork and exec function, close function, Socket Address Structures, Byte Ordering and Manipulation Functions, TCP Client and Server for Echo, Signal Handling in case of crashing and rebooting of server, Shutdown process function. Socket Options: Getsockopt and stockpot functions, Socket states, Generic socket option.

Unit 3 (15 hours)

Connectionless Socket Applications: TCP-oriented basic concurrent client server applications, UDP oriented Echo client and server application, Handling of errors like lost datagram, Lack of flow control with UDP, determining outgoing interface with UDP.

Unit 4 (7 hours)

Elementary name and Address conversions: Domain Name System, socket functions like gethostbyname, gethostbyname2, gethostbyaddr function, uname function, gethostname function, getservbyname and getservbyport functions.

Essential/recommended readings

1. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, *Unix Network Programming*, The sockets Networking API, Vol. 1, 3rd Edition, PHI.
2. B. A. Forouzan: *Data Communications and Networking*, THM Publishing Company Ltd
3. R. Stevens, *Unix Network Programming*, PHI 2nd Edition

Suggested Practical List : (30 Hours)

Practical exercises such as

1. Implement TCP Echo client and TCP Echo server (Iterative).
2. Implement TCP Echo client and TCP Echo server (Concurrent).
3. Implement TCP daytime client and TCP daytime server (Iterative).
4. Implement TCP daytime client and TCP daytime server (concurrent).
5. Implement UDP Echo Client and UDP Echo Server.
6. Implement UDP daytime Client and UDP daytime server.
7. Implement TCP client and server (concurrent) where client gets input from the user and sends it to server. Server displays it on the screen. Server then gets another input from the user and sends it to client. Client displays it on the screen. The process continues till server or client sends "bye" to the other party.
8. Implement TCP client and server (concurrent) where client requests server to transfer a file. Assume file is smaller than 1K size. If the file is present on the server, it is sent to the client otherwise an error message is sent to client. Client copies the file on the hard disk and disconnects.
9. Implement UDP client and UDP server where server displays the IP address and port number of the client sending the datagram. Client sends a datagram (size 64 bytes) three times to the same server. Server sends the message back to client. Client reports the time elapsed in sending and receiving of the message. Use connected UDP sockets.
10. Write a program to
    a) display name of the host
    b) all IP addresses of the host.
    c) Check whether FTP and HTTP services are running on the system.
    d) Display the name of the service running on port number specified by user.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

(For all the Generic Elective courses offered by your department, please put it in the format provided below)

GENERIC ELECTIVES (GE-5a): Operating Systems

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GE-5a Operating Systems	4	3	0	1	Pass in Class XII	Knowledge of Programming in C/C++/Java/Python at class XII level or above

Learning Objectives

The course introduces Operating System and its importance in computer systems. The focus is to explain the common services provided by an operating system like process management, memory (primary, secondary & virtual) management, I/O management, file management. The course talks about the various functional components of the operating and their design.

Learning outcomes

On successful completion of the course, students will be able to gain knowledge of different concepts of the operating System and its components. They would learn about shell scripts and would be able to use the system in an efficient manner.

SYLLABUS OF GE-5a

Unit 1 (5 hours)

Introduction: Operating Systems (OS) definition and its purpose, Multiprogrammed and Time-Sharing Systems, OS Structure, OS Operations: Dual and Multi-mode, OS as resource manager.

Unit 2 (6 hours)

Operating System Structures: OS Services, System Calls: Process Control, File Management, Device Management, and Information Maintenance, Inter-process Communication, and Protection, System programs, OS structure- Simple, Layered, Microkernel, and Modular.

Unit 3 (10 hours)

Process Management: Process Concept, States. Process Control Block, Context Switch, Process scheduling, Schedulers, Overview of threads and Scheduling Algorithms: First Come First Served, Shortest-Job-First, Priority & Round-Robin.

Unit 4 (10 hours)

Memory Management: Physical and Logical address space, Swapping Contiguous memory allocation strategies - fixed and variable partitions, Segmentation, Paging, virtual memory: Demand Paging.

Unit 5 (8 hours)

File and Input / Output Device Management: File Concepts, File Attributes, File Access Methods, Directory Structure: Single-Level, Two-Level, Tree-Structured, and Acyclic-Graph Directories, Magnetic Disks, Solid-State Disks, Magnetic Tapes.

Unit 6 (6 hours)

Shell Scripting: Shell variables, parameter passing conditional statements, iterative statements, writing and executing shell scripts, utility programs (cut, paste, grep, echo, pipe, filter etc.)

Essential/recommended readings

1. Galvin, S. P. B., Gagne, G., *Operating System Concepts*, 9th edition, John Wiley Publications, 2016.
2. G. Nutt, Operating Systems, Pearson, 2009

Additional References

1. Dhamdhere, D. M., *Operating Systems: A Concept-based Approach,* 2nd edition, Tata McGraw-Hill Education, 2017.
2. Kernighan, B. W., Pike, R., *The Unix Programming Environment*, Englewood Cliffs, NJ: Prentice-Hall, 1984.
3. Stallings, W., *Operating Systems: Internals and Design Principles*, 9th edition, Pearson Education, 2018.
4. Tanenbaum, A. S., *Modern Operating Systems.* 3rd edition. Pearson Education, 2007.

Suggested Practical List : (30 Hours)

Practical exercises such as

1. Usage of following commands: ls, pwd, cat, who, rm, mkdir, rmdir,cd.

2. Usage of following commands: cal, cat(append), cat(concatenate), mv, cp, man, date.
3. Usage of following commands: chmod, grep, bc.
4. Write a shell script to display date in the mm/dd/yy format.
5. Write a shell script to display the multiplication table any number.
6. Write a shell script to find the factorial of a given number.
7. Program to show the pyramid of special character "*".
8. Write a shell script to find the sum of digits of a given number.
9. Write a shell script to perform the tasks of basic calculator.
10. Write a shell script to find the power of a given number.
11. Write a shell script to check whether the number is Armstrong or not.
12. Write a shell script to find the GCD (greatest common divisor) of two numbers.
13. Write a shell script to check if the number entered at the command line is prime or not.
14. Write a shell script to display on the screen sorted output of "who" command along with the total number of users.
15. Write a shell script to accept a login name. If not a valid login name display message – "Entered login name is invalid".
16. Write a shell script to compare two files and if found equal asks the user to delete the duplicate file.
17. Write a shell script to merge the contents of three files, sort the contents and then display them page by page.
18. Write a shell script to check whether the file have all the permissions or not.
19. Write a shell script to modify "cal" command to display calendars of the specified months.
20. Write a shell script to modify "cal" command to display calendars of the specified range of months.

GENERIC ELECTIVES (GE-5b): Advanced Web Programming

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GE5b: Advanced Web Programming	4	3	0	1	Pass in Class XII	Knowledge of HTML, CSS

Learning Objectives

The course aims to familiarize the students with the concepts and techniques of server side web programming. This will enable the students to create dynamically generated web pages using HTML, PHP, MySql and JQuery.

Learning outcomes

On completion of this course, the student will be able to:

- develop interactive and dynamic websites.
- write programs to communicate with the server using GET and POST methods
- learn to connect and manipulate databases using MySql
- validate server-side/backend data

SYLLABUS OF GE-5b

Unit 1 (7 hours)

Introduction to PHP: Basic syntax, defining variables and constants, data types including arrays, operators and expressions, decision making statements, constructs for iterations.

Unit 2 (5 hours)

String Handling: Creating a string and accessing its content, searching and replacing content of a string, and other built-in functions.

Unit 3 (12 hours)

Handling HTML Form with PHP: Creating a form, submitting data to the server at the backend using GET and POST methods, GET vs POST methods, PHP global functions.

Unit 4 (15 hours)

Database: Connectivity with MySQL: Connectivity with database, database creation, creating tables, create, retrieve, update, and delete (CRUD) operations

Unit 5 (6 hours)

jQuery and JSON: Introduction to jQuery syntax (selectors, events, AJAX, JSON).

Essential/recommended readings

1. Nixon, R. Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5, O'Reilly, 2018.
2. Holzner S. PHP: The Complete Reference, McGraw Hill, 2017
3. Murach J, Murach's PHP and MySQL, 2nd edition, Mike Murach & Associates, 2014.
4. Duckett, J. JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.

Additional References

1. https://www.w3schools.com/php/default.asp

2. https://www.tutorialspoint.com/php/index.htm

Suggested Practical List : (30 Hours)

Practical exercises such as

1. Write a PHP script to reverse the digits of a number.
2. Create a web page containing two text boxes and a button named "Evaluate". When the user enters numbers in the text boxes and clicks on the "Evaluate" button, a function should evaluate the sum of the numbers and display the result.
3. Write a PHP script to perform following string operations using in-built functions and built an interactive web page having buttons for each of the following operation:
   a. Find the length of a string
   b. Find a substring from a string
   c. Replace text within a string
   d. Remove whitespace and other predefined characters from both sides of a string.
   e. Check if a value is a string
   f. Convert the first character of each word in a string into uppercase.
4. Design a Login form and validate that form using PHP code. Display error message box when data is not valid otherwise redirect to the next page and display "Welcome username!".
5. Design a student registration form, using appropriate input fields consisting of following:
   a. First Name
   b. Last Name
   c. Gender
   d. Roll Number
   e. Phone Number
   f. Course

Submit and retrieve the form data using $_POST, $_GET variable.

6. Write PHP Code to make connection to MySql database, create database and tables and perform insertion, deletion, and retrieval of the data (Using SQL operations like .JOIN, ORDER BY, GROUP BY) Display the messages such as "The record is added in the database!" when data is inserted into the database, "A record is deleted from the database" when data is deleted from the database. Use appropriate button names such as Add Data, Delete Data, and Display Data.

jQuery and JSON

1. Change text color and contents using button click events using jQuery
2. Select elements using ID, class, elements name, attribute name
3. Run code on click events in jQuery

4. Handle HTML form, store the data in JSON object, pass them to another page and display it there using jQuery/Javascript

<div style="border: 2px solid; background: #8cc63f; height: 80px;"></div>

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GE5c: Java Based Web App Development	4	3	0	1	Pass in Class XII	DSC 04 Object Oriented Programming with C++/ GE 1a Programming using C++ / GE1b Programming with Python/ DSC 01 Programming using Python/ GE 3b: Java Programming / A programming course at class XII level

Learning Objectives

The course aims to familiarize the students with the concepts and techniques of web app development based on Java. The students will learn about database connectivity, use of HTTP protocol, client side programming, and use of servlets and JSP for server side programming.

Learning outcomes

On successful completion of this course, students will be able to:

- develop an understand of client-server architecture, HTTP protocol, and web application components.
- connect an application to database and perform basic database operations.
- create servlets and JSP for web applications
- deploy web applications

SYLLABUS OF GE-5c

Unit 1 (8 hours)

Review of Programming Language: Programming Constructs, Data types, Operators, Concepts of Class, Interface, Inheritance, Exception Handling, Util package, Multithreading, event handling.

Unit 2 (10 hours)

Java Database Connections: Database connectivity, Connection, statement, result set object, Metadata, Connection pooling, CRUD operations, Prepared and callable statements

Unit 3 (15 hours)

Introduction to servlets: Concepts of Streams, events and listener, recap of HTML, CSS, XML, Servlet package and interface, life cycle of servlet, deployment descriptor, Filters, HHTP and Generic servlet, request dispatcher, Request Response classes, Dynamic page designing using servlet.

Unit 4 (12 hours)

Introduction to JSP: JSP Life cycle, tags in JSP, custom tags, Expression Language, Introduction to Struts Framework, Implicit objects, database access using JSP

Essential/recommended readings

1. Herbert Schildt, *Java : The Complete Reference*, 12th edition, McGraw-Hill Education, 2021.
2. Hans Bergsten, *Java Server Pages*, 3rd edition, O'Reilly, 2003.
3. Jim Keogh, *The Complete Reference J2EE*, 1st edition, McGraw-Hill Education, 2017.

Suggested Practical List : (30 Hours)

Practical exercises such as

1. Setting up the development environment: Install Java Development Kit (JDK), Eclipse IDE, and Apache Tomcat web server. Create a new web project in Eclipse.
2. Writing and deploying a "Hello World" servlet: Create a simple servlet that prints "Hello World" on the web page. Deploy the servlet on Tomcat and test it in a web browser.
3. Handling HTTP requests and responses: Write a servlet that reads input from HTTP requests and sends output as HTTP responses.
4. Creating a JSP page: Create a JSP page that displays dynamic.
5. Write a servlet that handles form submissions and saves the data to a database using JDBC.
6. Write a servlet that implements user authentication and authorization using a database.
7. Creating a web application using MVC architecture: Create a web application using Model-View-Controller (MVC) architecture. Use servlets as controllers, JSP pages as views.
8. Deploying a web application to a server: Configure and deploy a web application to a server using Apache Tomcat Manager or other deployment tools.

DISCIPLINE SPECIFIC CORE COURSE (DSC-5): Database Management Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSC 5: Database Management Systems	4	3	0	1	Pass in Class XII	NIL

Learning Objectives

The course introduces the students to the fundamentals of database management system and its applications. Emphasis is given on the popular relational database system. Students will learn about the importance of database structure and its designing using Entity Relationship diagram and formal approach using normalization. Basic concepts of file indexing and transaction processing will be taught. The course would give students hands-on practice of structured query language to create, manipulate and implement a relational database.

Learning outcomes

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

● Use relational database management software to create and manipulate the database.
● Create conceptual data models using entity relationship diagrams for modeling real-life situations and map it to corresponding relational database schema.
● Use the concept of functional dependencies to remove redundancy and update anomalies.
● Apply normalization theory to get a normalized database scheme to get anomalies free database.
● Write queries in relational algebra.
● Implement relational databases and formulate queries for data retrieval and data update problems using SQL.
● Learn the importance of index structures and concurrent execution of transactions in database systems.

Unit 1 (5 hours)

Introduction to Database: Database, characteristics of database approach, data models, database management system, three-schema architecture, components of DBMS, data independence, and file system approach vs database system approach.

Unit 2 (6 hours)

Entity Relationship Modeling: Conceptual data modeling - motivation, entities, entity types, attributes, relationships, relationship types, constraints on relationship, Entity Relationship diagram as conceptual data model.

Unit 3 (6 hours)

Relational Data Model: Data anomalies, Relational Data Model - Characteristics of a relation, schema-instance distinction, types of keys, relational integrity constraints. Relational algebra operators like selection, projection, cartesian product, join and write queries using them.

Unit 4 (8 hours)

Structured Query Language (SQL): DDL to create database and tables, table constraints, DML, Querying in SQL to retrieve data from the database, aggregation functions group by and having clauses, generate and query views.

Unit 5 (10 hours)

Database Design: Mapping an Entity Relationship diagram to corresponding relational database scheme, functional dependencies and Normal forms, 1NF, 2NF, and 3NF decompositions and desirable properties of them.

Unit 6 (10 hours)

File indexing and Transaction Processing: Need of file indexes, types of indexes, file organizations, single- and multi-level indexing, concurrent execution of transactions, ACID properties, need of data recovery.

Essential/recommended readings

1. Elmasri, R., Navathe, B. S., *Fundamentals of Database Systems*, 7th edition, Pearson Education, 2016.
2. Murach, J., *Murach's MySQL,* 3th edition, Pearson, 2019.

Additional References

1. Connolly, T. M., Begg, C. E., *Database Systems: A Practical Approach to Design, Implementation, and Management*, 6th edition, Pearson, 2019.
2. Ramakrishnan, R., Gehrke, J., *Database Management Systems*, 3rd edition, McGraw-Hill, 2014.
3. Silberschatz, A., Korth, H.F., Sudarshan S., *Database System Concepts*, 7th edition, McGraw Hill, 2019.

Suggested Practical List : (30 Hours)

Practical exercises such as

Create and use the following student-course database schema for a college to answer the given queries using the standalone SQL editor.

STUDENT	Roll No	StudentName	CourseID	DOB
	Char(6)	Varchar(20)	Varchar(10)	Date

COURSE	CID	CourseName	Course Type	Teacher-in-charge	TotalSeats	Duration
	Char(6)	Varchar (20)	Char (8)	Varchar (15)	Unsigned int	Unsigned int

ADMISSION	Roll No	CID	DateOfAdmission
	Char(6)	Char(6)	Date

Here Rollno (ADMISSION) and SID (ADMISSION) are foreign keys. Note that course type may have two values viz. Fulltime and Parttime and a student may enroll in any number of courses

1. Retrieve names of students enrolled in any course.

3. Retrieve students' names starting with letter 'A'.
4. Retrieve students' details studying in courses 'computer science' or 'chemistry'.
5. Retrieve students' names whose roll no either starts with 'X' or 'Z' and ends with '9'
6. Find course details with more than N students enrolled where N is to be input by the user
7. Update student table for modifying a student name.
8. Find course names in which more than five students have enrolled
9. Find the name of youngest student enrolled in course 'BSc(P)CS'
10. Find the name of most popular society (on the basis of enrolled students)
11. Find the name of two popular part time courses (on the basis of enrolled students)
12. Find the student names who are admitted to full time courses only.
13. Find course names in which more than 30 students took admission

14. Find names of all students who took admission to any course and course names in which at least one student has enrolled
15. Find course names such that its teacher-in-charge has a name with 'Gupta' in it and the course is full time.
16. Find the course names in which the number of enrolled students is only 10% of its total seats.
17. Display the vacant seats for each course
18. Increment Total Seats of each course by 10%
19. Add enrollment fees paid ('yes'/'No') field in the enrollment table.
20. Update date of admission of all the courses by 1 year.
21. Create a view to keep track of course names with the total number of students enrolled in it.
22. Count the number of courses with more than 5 students enrolled for each type of course.
23. Add column Mobile number in student table with default value '9999999999'
24. Find the total number of students whose age is > 18 years.
25. Find names of students who are born in 2001 and are admitted to at least one part time course.
26. Count all courses having 'science' in the name and starting with the word 'BSc'.

Students are also encouraged to implement the database given in the textbook and do the related queries.

Computer Science Courses for Undergraduate Programme of study with Computer Science discipline as one of the two Core Disciplines
(For e.g. courses for B.A. Programmes with Computer Science as Major discipline)

Computer Science Major

DISCIPLINE SPECIFIC CORE COURSE (DSC-5): Database Management System

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSC05: Database Management System	4	3	0	1		NIL

Learning Objectives

The course will give an overview of categories of data models used by database management systems and writing queries in relational algebra. The importance of file indexing and controlled execution of transactions will be taught. The course would give students hands-on practice   to write complex queries, nested queries using aggregate functions in SQL and to use basic database administration commands.

Learning outcomes

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

- Write queries using relational algebra, a procedural language.
- Use the concept of functional dependencies to remove data anomalies and arrive at normalized database design.
- Understand the data storage system, file organization and need of file indexing.
- Learn the importance of transaction processing and concurrency control.
- Write complex and nested SQL queries, and learn basic database administration commands.
- Acquire information about emerging technologies.

SYLLABUS OF DSC 05

Unit 1 (6 hours)

Data models and Relational Algebra: Categories of data models, types of database users, Relational Algebra Operations from SET Theory, SELECT, PROJECT, JOIN, DIVISION Operations.

Unit 2 (8 hours)

Normalization: Functional dependencies, minimal cover, normalizing database with multiple keys till 3NF, Boyce-Codd Normal Form

Unit 3 (8 hours)

Database Storage and index Structures: Storage of data, file structure, file organization and its types: Sequential, Heap and Indexed, Hash file, need for file Indexing, single- and multi-level indexing.

Unit 4 (8 hours)

Transaction Processing: Concurrent execution of transactions and their handling, ACID properties, need of data recovery and log files.

Unit 5 (8 hours)

Advanced SQL: Nested and complex queries using Inner JOIN, Left JOIN, Right JOIN, Full JOIN, views, Database Administration Commands: COMMIT, ROLLBACK, drop database, control permissions etc.

Unit 6 (7 hours)

Emerging Technology: Distributed Database Concepts, Introduction to emerging technologies like Data Warehousing and OLAP, Data Mining.

Essential/recommended readings

1. Elmasri R. and Navathe B. S. *Fundamentals of Database Systems*, 7th Edition, Pearson Education, 2016.
2. Murach J. *Murach's MySQL,* 3th Edition, Pearson, 2019.

Additional References

1. Silberschatz, A., Korth, H.F., & Sudarshan, S. Database System Concepts, 8th Edition, McGraw Hill, 2019.

2. Ramakrishnan, R. & Gehrke, J. Database Management Systems, 3rd Edition, Tata McGraw Hill Education, 2014.

Suggested Practical List : (30 Hours)

MySQL might be used for practical purposes.

The following concepts must be introduced to the students:

1. Multiple table queries (join on different and same tables)
2. Nested select statements
3. Set manipulation using (any, in, contains, all, not in, not contains, exists, not exists union, intersect, minus, etc.)
4. Categorization using group by... having
5. Arranging using order by

List of sample queries to be done using the above schema.

Create tables with relevant column and integrity constraints and populate the tables with data.

Perform the following queries on the database:

1. Display all the details of all employees working in the company.
2. Display ssn, lname, fname, address of employees who work in department no 7.
3. Retrieve the birthdate and address of the employee whose name is 'Franklin T. Wong' and who is a manager
4. Retrieve the name and salary of every employee working in department 'Production'
5. Display maximum and minimum salaries of each department
6. Retrieve all employee names whose address is in 'Bellaire' and working on at least one project
7. Modify the datatype of hours column to float in works_on table.
8. Retrieve all employees who age is more than 35 years
9. Retrieve all employees in department 5 whose salary is between 50,000 and 60,000(inclusive)
10. Add another column named "Join_Date" in the employee table and "Address" in the department table
11. Retrieve the names of all employees who do not have supervisors
12. Retrieve SSN and department name for all employees
13. Retrieve the name and address of all employees who work for the 'Research' department
14. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birthdate

15. For each employee, retrieve the employee's name, and the name of his or her immediate supervisor
16. Retrieve all combinations of Employee Name and Department Name
17. Make a list of all project numbers for projects that involve an employee whose last name is 'Narayan' either as a worker or as a manager of the department that controls the project
18. Increase the salary of all employees working on the 'ProductX' project by 15%. Retrieve employee name and increased salary of these employees
19. Retrieve a list of employees and the project name each works in, ordered by the employee's department, and within each department ordered alphabetically by employee first name
20. Select the names of employees whose salary does not match with salary of any employee in department 10
21. Drop the column "Join_Date" from the employee table
22. Retrieve the name of each employee who has a dependent with the same first name and same sex as the employee
23. Retrieve the employee numbers of all employees who work on project located in Bellaire, Houston, or Stafford.
24. Change the name of existing table DEPT_LOCATIONS to DLOCATIONS
25. Find the sum of the salaries of all employees, the maximum salary, the minimum salary and the average salary for each department. Display with proper headings
26. Find the sum of the salaries and number of employees of the 'Marketing' department, as well as the maximum salary, the minimum salary, and the average salary in this department
27. Select the names of employees whose salary is greater than the average salary of all employees in department 10
28. For each department, retrieve the department number, the number of employees in the department and their average salary
29. For each project, retrieve the project number, the project name, and the number of employees who work on that project for more than 10 hours
30. Change the location and controlling department number for all projects having more than 5 employees to 'Bellaire' and 6 respectively
31. For each department having more than 10 employees, retrieve the department name, number of employees drawing more than 40,000 as salary
32. Display employee names having no dependent in descending order along with their age
33. For each department, find the number of female and number of male employees along with name of manager of that department
34. Find the name and age of youngest employee in each department
35. Change the name of MINIT attribute of an employee table to MNAME using alter command
36. Create a view to keep names of employees and their department names if they are not working on any project
37. Create a view to keep track of all employee names who are working on same projects as that of employee 'Franklin T. Wong'
38. Execute system administrative commands like commit, rollback, granting control permissions, etc.

DISCIPLINE SPECIFIC CORE COURSE (A5): Machine Learning

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
A5: Machine Learning	4	3	0	1	Pass in Class XII	A1 Programming Fundamentals using Python, A2 Data Visualization using Python

Learning Objectives

The course aims at introducing the basic concepts and techniques of machine learning so that a student can apply machine learning techniques to a problem at hand.

Learning outcomes

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

- Differentiate between supervised and unsupervised learning tasks.
- Appreciate the need of preprocessing, feature scaling and feature selection.
- Understand the fundamentals of classification, regression and clustering
- Implement various machine learning algorithms learnt in the course.

SYLLABUS OF A5

Unit 1 (8 hours)

Introduction: Basic definitions and concepts, key elements, supervised and unsupervised learning, introduction to reinforcement learning, applications of ML.

Unit 2 (10 hours)

Preprocessing: Feature scaling, feature selection methods. dimensionality reduction (Principal Component Analysis).

Unit 3 (12 hours)

Regression: Linear regression with one variable, linear regression with multiple variables, gradient descent, over-fitting, regularization. Regression evaluation metrics.

Unit 4 (15 hours)

Classification: Decision trees, Naive Bayes classifier, logistic regression, k-nearest neighbor classifier, perceptron, multilayer perceptron, neural networks, Support Vector Machine (SVM). Classification evaluation metrics.

Essential/recommended readings

1. Mitchell, T.M. *Machine Learning*, McGraw Hill Education, 2017.
2. James, G., Witten. D., Hastie. T., Tibshirani., R. *An Introduction to Statistical Learning with Applications in R*, Springer, 2014.
3. Alpaydin, E. *Introduction to Machine Learning*, MIT press, 2009.

Additional References

1. Flach, P., *Machine Learning: The Art and Science of Algorithms that Make Sense of Data*, Cambridge University Press, 2015.
2. Christopher & Bishop, M., *Pattern Recognition and Machine Learning*, New York: Springer-Verlag, 2016.
3. Sebastian Raschka, *Python Machine Learning,* Packt Publishing Ltd, 2019.

Suggested Practicals List : (30 Hours)

Practical exercise such as

Use Python for practical labs for Machine Learning. Utilize publically available datasets from online repositories like https://data.gov.in/ and https://archive.ics.uci.edu/ml/datasets.php

For evaluation of the regression/classification models, perform experiments as follows:

i. Scale/Normalize the data
ii. Reduce dimension of the data with different feature selection techniques

iv. Perform k-cross-validation on datasets for evaluation

Report the efficacy of the machine learning models as follows:

i. MSE and R^2 score for regression models
ii. Accuracy, TP, TN, FP, TN, error, Recall, Specificity, F1-score, AUC for classification models

For relevant datasets make prediction models for the following

1. Naïve Bayes Classifier
2. Simple Linear Regression multiple linear regression
3. Polynomial Regression
4. Lasso and Ridge Regression
5. Logistic regression
6. Artificial Neural Network
7. *k*-NN classifier
8. Decision tree classification
9. SVM classification
10. K-Means Clustering
11. Hierarchical Clustering

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 (For e.g. courses for B.A. Programmes with Computer Science as Non-major discipline)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSC05: Database Management System	4	3	0	1	Pass in Class XII	

Learning Objectives

The course will give an overview of categories of data models used by database management systems and writing queries in relational algebra. The importance of file indexing and controlled execution of transactions will be taught. The course would give students hands-on practice   to write complex queries, nested queries using aggregate functions in SQL and to use basic database administration commands.

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- Acquire information about emerging technologies.

Unit 1 (6 hours)

Data models and Relational Algebra: Categories of data models, types of database users, Relational Algebra Operations from SET Theory, SELECT, PROJECT, JOIN, DIVISION Operations.

Unit 2 (8 hours)

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Database Storage and index Structures: Storage of data, file structure, file organization and its types: Sequential, Heap and Indexed, Hash file, need for file Indexing, single- and multi-level indexing.

Unit 4 (8 hours)

Transaction Processing: Concurrent execution of transactions and their handling, ACID properties, need of data recovery and log files.

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Advanced SQL: Nested and complex queries using Inner JOIN, Left JOIN, Right JOIN, Full JOIN, views, Database Administration Commands: COMMIT, ROLLBACK, drop database, control permissions etc.

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