

## Model Course Structure for Bachelor of Science (Computer Science) Programme as Per NEP 2020

Semester	Major Subject (Core Subject) (6 Credits)	Additional/ Interdisciplinary subject/ Multidisciplinary (4 Credits)	Skill Course/ Vocational Course (2 Credits)	Vocational Course/ Field Visit/ Entrepreneurship skills (4 Credits)	Languages-I (2 Credits)	Extracurricular Courses/Compulso ry course (2 Credits)	Extracurricular Courses/CC (2 Credits)	Total Credits
I	<b>SOS/CSE/C101</b> OOPs using C ++ (4) + C++ Programming Lab (2)	Internet Technologies (3) + HTML Lab (1)	Fundamental of Information Technology-I (2)	Not Applicable	Not Applicable	Not Applicable	Understanding and connecting with Environment (2)	20
II	<b>SOS/CSE/C201</b> Data Structures (4) + Data Structures Lab (2)	E-Commerce (3) + Case Studies (1)	Fundamental of Information Technology-II (2)	Not Applicable	Not Applicable	Not Applicable	Life Skills and personality development (2)	20
<b>Exit option with Certificate (40 Credits)</b>								
III	<b>SOS/CSE/C301</b> Database Management Systems (4) + DBMS Lab (2)	Introduction to Cyber Security (3) + Case Studies (1)	Data Communication and Devices (2)	Not Applicable	Not Applicable	Not Applicable	Indian Knowledge System-I (2)	20
IV	<b>SOS/CSE/C401</b> Design and Analysis of Algorithms (4) + ADA Lab (2)	Cyber Security Tools, Techniques and Countermeasures (4)	Computer Networks and Security (2)	Not Applicable	Not Applicable	Not Applicable	Indian Knowledge System-II (2)	20
<b>Exit option with Diploma in a Particular Discipline (80 Credits)</b>								
V	<b>SOS/CSE/C501</b> Operating System (4) + OS Lab (2)	Not Applicable	Not Applicable	Vocational course-I/ Field Visit/ Entrepreneurship/Aca demic-Industry interface Course (4)	Indian, Modern, Regional Language-I (2)	Culture, traditions and Moral Values (2)		20
VI	<b>SOS/CSE/DSE6</b> (Elective)	Not Applicable	Not Applicable	Vocational course-II/ Field Visit/ Entrepreneurship/Aca demic-Industry interface Course (4)	Indian, Modern, Regional Language-II (2)	Communication Skill Course (Based on Developing soft skills) (2)		20
<b>Exit with Bachelor of Degree in a Particular Discipline (120 Credits)</b>								

**\*Compulsory Community connect Course**

Student will have to qualify a Compulsory Community Connect/Social Service Program/ **Minimum 16 hours of service within any semester (I to IV)**. This courses will be based on community connect, Swachh Bharat Mission, NSS etc. It will be based on number of hours devoted under this course. Concerned department will verify the fulfillment of minimum hours towards CCS.

### **Discipline Specific Elective Papers**

1. JAVA Programming
2. Computer Graphics and Visualization
3. Software Engineering
4. Programming Using C# & .NET
5. Introduction to Python Programming

### **Vocational Courses-I**

1. Python Programming
2. Data Analysis and Visualization
3. Digital Image Processing

### **Vocational Courses-II**

1. Blockchain and its applications
2. Cloud Computing
3. Introduction to Data Science

# B.Sc. Computer Science 1<sup>st</sup> Year Syllabus

**SEMESTER: I**

**Core Course**

## Course Objective

This course is designed to develop structured as well as object-oriented programming skills using C++ programming language. The course provides a complete understanding of the object-oriented programming features, namely Encapsulation, Abstraction, Inheritance and Polymorphism along with an in-depth knowledge of C++ Constructs

<b>Course Code:</b> SOS/CSE/C101	<b>Course Title:</b> OOPs using C++
<b>Course Outcomes (COs):</b> After learning the course, the students should be able to:	
<ul style="list-style-type: none"><li>• Describe the important concepts of object-oriented programming like object and class, Encapsulation, inheritance and polymorphism.</li><li>• Write the skeleton of C++ program.</li><li>• Write the simple C++ programs using the variables, operators, control structures, functions and I/O objects cin and cout.</li><li>• Write the simple object-oriented programs in C++ using objects and classes.</li><li>• Use features of C++ like type conversion, inheritance, polymorphism, I/O streams and files to develop programs for real life problems.</li><li>• Develop the applications using object-oriented programming with C++.</li></ul>	

## Course Content

<b>Unit-1: Basic of C++</b>
Introduction OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures.
<b>Unit-2: C++ Functions</b>
Simple functions, Call and Return by reference, Inline functions, Macro Vs. Inline functions, Overloading of functions, default arguments, friend functions, virtual functions.
<b>Unit-3: Object and Classes</b>
Basics of object and class in C++, Private and public members, static data and function members, constructors and their types, destructors, operator overloading, type conversion.
<b>Unit-4: Inheritance and Polymorphism</b>
Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding, virtual base class, Pointers in C++, Pointers and Objects, this pointer, virtual and pure virtual functions, Implementing polymorphism.
<b>Unit-5: I/O, Templates and Exceptions</b>
Concept of streams, cin and cout objects, C++ stream classes, Unformatted and formatted I/O, template, function templates and class templates, Introduction to exception, try-catch- throw, multiple catch, Overview and use of Standard Template Library

## Recommended Books

Sr.	Title	Author	Publication
1.	Let us C	Y. Kanitker	TMH
2.	The Complete Reference C++	E. Balaguruswamy	TMH
3.	C++: How to Program	Deitel and Deitel	PHI
4.	Object Oriented Programming with ANSI and Turbo C++	Ashok Kamthane	Pearson



## OOPs using C++ Lab

### List of Practical's:

1. Write a program for multiplication of two matrices using OOP.
2. Write a program to perform addition of two complex numbers using constructor overloading. Here the first constructor which takes no argument is used to create objects which are not initialized, second which takes one argument is used to initialize real and image parts to equal values and third which takes two Argument is used to initialize real and image to two different values.
3. Write a program to find the greater of two given numbers in two different classes using friend function.
4. Implement a class string containing the following functions:
  - a. Overload + operator to carry out the concatenation of strings.
  - b. Overload = operator to carry out string copy.
  - c. Overload <= operator to carry out the comparison of strings.
  - d. Function to display the length of a string.
  - e. Function to lower () to convert upper case letters to lower case.
  - f. Function to upper () to convert lower case letters to upper case.
5. Write a program to demonstrate the use of special functions, constructor and destructor in the class template. The program is used to find the bigger of two entered numbers.
6. Write a program to perform the deletion of white spaces such as horizontal tab, vertical tab, space, line feed, new line and carriage return from a text file and store the contents of the file without whitespaces on another file.
7. Write a program to read the class object of student info such as name, age, sex, height and weight from the keyboard and to store them on a specified file using read() and write() functions. Again, the same file is opened for reading and displaying the contents of the file on the screen.
8. Create a base class basic info with data members name, roll no, sex and two member functions getdata and display. Derive a class physical fit from basic info which has data members height and weight and member functions getdata and display. Display all the information using object of derived class.
9. Design three classes STUDENT, EXAM and RESULT. The STUDENT class has data members such as rollno, name. Create a class EXAM by inheriting the STUDENT class. The EXAM class adds data members representing the marks scored in six subjects. Derive the RESULT from the EXAM class and has its own data members such as total marks. Write a program to model this relationship.
10. Write a function power to raise a number  $m$  to power  $n$ . The function takes a double value for  $m$  and int value for Use default value for  $n$  to make the function to calculate squares when this argument is omitted.
11. Create a class TIME with members hours, minutes, seconds. Take input, add two-time objects passing objects to function and display result.
12. Create a class Student which has data members as name, branch, roll no, age, sex, marks in five subjects. Display the name of the student and his percentage that has more than 70%. Use array of objects.



**SEMESTER: I****Additional/ Interdisciplinary/ Multidisciplinary Course****Course Objective**

The objective of this course is to introduce students with the concept of world wide web and Internet. The course emphasis on the common protocol, basic HTML programming, IoT fundamentals and services used for the functionality of Internet technologies.

<b>Course Code:</b> SOS/CSE/AIMC101	<b>Course Title:</b> Internet Technologies
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Understand the basic working of Internet</li> <li>• Differentiate between different functionality of HTML tags</li> <li>• Describe the important features of IoT and Internet Protocols</li> <li>• Understand the basics of PHP language.</li> </ul>	

**Course Content**

<b>Unit-1 The Internet</b>
Classification of Networks, Networking Models, what is Packet Switching, Accessing the Internet, Internet Protocols, Internet Protocol (IP), Transmission Control Protocol (TCP), Internet Address, Structure of Internet Servers Address, Address Space, how does the Internet work, Intranet & Extranet, Internet Infrastructure,
<b>Unit-2 Introduction to HTML</b>
What is HTML, Basic Tags of HTML, HTML Tag, TITLE Tag, BODY Tag, Formatting of Text, Headers, Formatting Tags, PRE-Tag, FONT Tag, Special Characters, Working with Images, META Tag.
<b>Unit-3 Protocols and Services on Internet</b>
Domain Name System, SMTP and Electronic Mail, Http and World Wide Web, Usenet and Newgroups, FTP, Telnet, Internet Tools, Search Engines
<b>Unit-4 IoT</b>
Understanding IoT fundamentals, IOT Architecture and protocols, Various Platforms for IoT, Real time Examples of IoT
<b>Unit-5 PHP</b>
Fundamentals of PHP Development, Various Data Types, Advanced PHP Functions, Classes, Objects, Advanced OOPS in PHP

**Recommended Books**

Sr.	Title	Author	Publication
1.	Learning PHP, MySQL, JavaScript, CSS & HTML5	Robert Nixon	O'Reilly
2.	Introduction to IoT	Sudip Micra	Cambridge University Press
3.	Introduction to Computer Science	ITL	Pearson



**Course Objective**

This course is designed to develop basic knowledge of computer system along with its history and architecture. The course provides a complete understanding of computer memory, Operating system and its types.

<b>Course Code:</b> SOS/CSE/SEC101	<b>Course Title:</b> Fundament of Information Technology-I
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Understand the basic working of Computer system</li> <li>• Differentiate between different type of Operating system</li> <li>• Describe the important features of Internet</li> <li>• Distinguish between different service of WWW.</li> </ul>	

**Course Content**

<b>Unit-1: Knowing Computer</b>
Basic Applications of Computer, Components of Computer System, Central Processing Unit, Keyboard, mouse and VDU, Input devices, Output devices
<b>Unit-2: Memory Organization</b>
Computer Memory and its Types, Concept of Hardware and Software: Application software, Systems software
<b>Unit-3: Basics of Operating System</b>
Types of operating system (LINUX, WINDOWS, ANDROID), The User Interface: Task Bar, Icons, Menu, running applications, Creating and renaming of files and directories
<b>Unit-4: Internet</b>
Internet: Concept of Internet, Basics of Internet Architecture, Applications of Internet, History of Internet, Communication on Internet, Intranet vs Extranet
<b>Unit-5: WWW AND Web Browser</b>
World Wide Web (WWW), Web Browsing Software's, Popular Web Browsing Software's, Search Engines, Popular Search Engines / Search for content, Accessing Web Browser, Using Favorites Folder, Understanding URL, Surfing the web, Using e-governance website

**Recommended Books**

Sr.	Title	Author	Publication
1.	Computing Fundamentals: Introduction to Computers	Faithe Wempen	Sybex
2.	Computer Fundamentals	PK Sinha	BPB
3.	Introduction to Computers	Peter Norton	McGraw Hill Education



**Course Objective**

The objective of this course is to: develop a foundation of set theory concepts and notation. This course provides a variety of various mathematical structures by focusing on mathematical objects, operations, and resulting properties.

<b>Course Code:</b> SOS/CSE/SEC102	<b>Course Title:</b> Discrete Mathematics-I
<b>Course Outcomes (COs):</b>	
On successful completion of the course, students will be able to:	
<ul style="list-style-type: none"> <li>• Relate mathematical concepts and terminology to examples in the domain of Computer Science</li> <li>• Model real world problems using various mathematical constructs</li> </ul>	

**Course Content**

<b>Unit-1 Sets</b>
Sets: Set Operations, Computer Representation of Sets, Countable and Uncountable Sets, Principle of Inclusion and Exclusion, Multisets
<b>Unit-2 Functions</b>
Functions: One-to-one and Onto Functions, Inverse Functions and Compositions of Functions, Graphs of Functions; Sequences and Summations: Sequences, Special Integer Sequences, Summations
<b>Unit-3 Relations</b>
Relations: Properties of Binary Relations, Equivalence relations and Partitions, Partial Ordering Relation
<b>Unit-4 Logic</b>
Propositional Logic, Propositional Equivalences, Use of first-order logic to express natural language predicates, Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategies, Mathematical Induction

**Recommended Books**

Sr.	Title	Author	Publication
1.	Schaum's Outline of Discrete Mathematics	Seymour Lipschutz	McGraw Hill Education
2.	Introductory discrete mathematics	V. Balakrishnan	Dover
3.	Discrete Mathematics and Its Applications	Kenneth H. Rosen	McGrwa Hill Education



**Course Objective**

The purpose of the course is to provide students with solid grounding in business uses of information technology in a rapidly changing environment, and to provide discussion of critical issues surrounding the use of IT in organizations

<b>Course Code:</b> SOS/CSE/SEC103	<b>Course Title:</b> Information System for Business-I
<b>Course Outcomes (COs):</b>	
On completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Remember the role of Information System in an organization.</li> <li>• Understand terminologies related to Information System.</li> <li>• Analyze the development process of an Information System.</li> <li>• Understand ethics and responsibilities of a person and organization in a Digital Age.</li> </ul>	

**Course Content**

<b>Unit-1 Introduction</b>
What is an Information System, Components of Information System, Role of Information System, System hardware, Moore's Law, Role of Software in an organization, Types of Software
<b>Unit-2 Database</b>
Data and Databases, Types of Databases, Big Data, Data Warehouse
<b>Unit-3 Tools of Information System</b>
Networking and Communication, Organizational Networking, Information System Security Triad, Tools of Information Security, Personnel Information Security
<b>Unit-4 DSS</b>
Why IT matters, Collaborative Systems, Decision Support Systems

**Recommended Books**

Sr.	Title	Author	Publication
1.	Information Systems for Business and Beyond	David T. Bourgeois	Saylor Academy
2.	Business Information Systems	Paul Bocji	Pearson
3.	Principle of Information System	Ralph Stair	Cengage Learning





**Course Objective**

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.

<b>Course Code: SOS/CSE/C201</b>	<b>Course Title: Data Structures</b>
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Differentiate primitive and non-primitive data structures</li> <li>• Design and apply appropriate data structures for solving computing problems</li> <li>• Apply sorting and searching algorithms to the small and large data sets</li> </ul>	

**Course Content**

<b>Unit-1 Introduction to Data Structure</b>
Data Management concepts, Data types: primitive and non-primitive, Performance Analysis and Measurement, Types of Data Structures: Linear & Non-Linear Data Structures.
<b>Unit-2 Linear Data Structure</b>
Array: Representation of arrays, Applications of arrays, sparse matrix and its representation. Stack: Definitions & Concepts, Operations on Stacks, Applications of Stacks, Polish Expression, Reverse Polish Expression and Their Compilation, Recursion, Tower of Hanoi Queue: Representation of Queue, Operations on Queue, Circular Queue, Priority Queue, Array representation of Priority Queue, Double Ended Queue, Applications of Queue, Linked List: Singly Linked List, Doubly Linked list, Circular linked list, linked implementation of Stack, Linked implementation of Queue, Applications of linked list
<b>Unit-3 Nonlinear Data Structure</b>
Tree: Definitions and Concepts, Representation of binary tree, Binary tree traversal (Inorder, postorder, preorder), Binary search trees, Conversion of General Trees to Binary Trees, Applications of Trees, AVL trees, 2-3 trees, Height Balanced, Weight Balance. Graph: Matrix Representation of Graphs, Elementary Graph operations, (Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree)
<b>Unit-4 Hashing and File Structures</b>
Hashing: The symbol table, Hashing Functions, Collision Resolution Techniques. File Structure: Concepts of fields, records and files, Sequential, Indexed and Relative/Random File Organization
<b>Unit-5 Sorting &amp; Searching</b>
Sorting: Bubble Sort, Selection Sort, Quick Sort, Merge Sort, Searching: Linear Search and Binary Search

**Recommended Books:**

Sr.	Title	Author	Publication
1.	Data structures using C	Tanenbaum	Pearson
2.	Introduction to Data structures	Kamathane	Pearson
3.	Data structures with C	Seymour Lipschutz	McGraw Hill Education



## **Data Structures Lab**

### **List of Practical's:**

1. Implement a program for stack that performs following operations using array.  
(a) PUSH (b) POP (c) PEEP (d) CHANGE (e) DISPLAY
2. Implement a program to convert infix notation to postfix notation using stack.
3. Write a program to implement QUEUE using arrays that performs following operations  
(a) INSERT (b) DELETE (c) DISPLAY
4. Write a program to implement Queue using arrays that performs following operations.  
(a) INSERT (b) DELETE (c) DISPLAY
5. Write a menu driven program to implement following operations on the singly linked list.
  - a. Insert a node at the front of the linked list.
  - b. Insert a node at the end of the linked list.
  - c. Insert a node such that linked list is in ascending order.
  - d. Delete a first node of the linked list.
  - e. Delete a node before specified position.
  - f. Delete a node after specified position.
6. Write a program to implement stack using linked list.
7. Write a program to implement queue using linked list.
8. Write a program which create binary search tree.
9. Implement recursive and non-recursive tree traversing methods inorder, preorder and postorder traversal.
10. Write a program to implement Queue Sort
11. Write a program to implement Merge Sort
12. Write a program to implement Bubble Sort
13. Write a program to implement Linear Search
14. Write a program to implement Binary Search



**Course Objective**

E-Commerce Technologies, is designed for Undergraduate students to present a managerial perspective of the broad study on the introduction of e-commerce and the underlying used technologies involved in the sharing of business information, maintaining business relationships and transactions by means of telecommunications networks.

<b>Course Code:</b> SOS/CSE/AIMC201	<b>Course Title:</b> E-commerce
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Learn the E-Commerce Platform and its concepts</li> <li>• Understand the Technology, infrastructure and Business in E-Commerce</li> <li>• Understand the Security and Challenges in E-Commerce</li> </ul>	

**Course Content**

<b>Unit-1 Introduction to E-Commerce</b>
Introduction: History of E-Commerce, E-Commerce Vs Traditional Commerce, E-Commerce Terminologies and Fundamentals, E-Commerce Framework, Elements of E-Commerce Application, Benefits and Limitation of E-Commerce, m-commerce
<b>Unit-2 Types of E-Commerce or Business Models of E-Commerce</b>
Introduction; Basic understanding of E-Commerce Business: Models of E-Commerce Business: Business to Business (B2B): Business to Consumer (B2C): Consumer to Business (C2B): Consumer to Consumer (C2C): Business to Government (B2G); Government to Business (G2B): Business Applications of E-Commerce
<b>Unit-3 Internet and Commerce</b>
E-Commerce and the Internet: Benefits of E-Commerce using Internet; Issues to Internet based E-Commerce; IT Infrastructure: Internet, Intranet, Extranet; Introduction to Broadband Technology, Introduction to TCP/IP Protocol Suit: World Wide Web(www): E-mail: Communication Channels: Network Security and Firewalls;
<b>Unit-4 Electronic Payment System</b>
Introduction; Emergence of Electronic Payment System: Meaning of Electronic Payment System; Characteristics of E-payment System, Advantages of E-payment System: Electronic Payment Mechanism/Process: Payment Gateways: Electronic Payment Methods: Types of Payment Methods for E-Commerce: Electronic payment issues; Security Properties of Electronic Payments: Electronic Payment and Website: Tools for Promoting Websites
<b>Unit-5 Electronic Data Interchange</b>
Basic Concepts, Type of Data to be interchanged, EDI Vs. E-mail, EDI Benefits, How EDI works, EDI Application in various field, Security and Privacy issues of EDI, EDI for E-Commerce

**Recommended Books:**

Sr.	Title	Author	Publication
1.	E-Commerce: Fundamentals and Applications	Henry Chan	Wiley
2.	E-Commerce	C. Kenneth	Pearson
3.	E-COMMERCE: An Indian Perspective	S. Joseph	PHI



**Course Objective**

The objective of this course is to introduce student with the concept of information technology. The course includes creating spreadsheets, understanding word processing as well as making small presentations.

<b>Course Code:</b> SOS/CSE/SEC201	<b>Course Title:</b> Fundamental of Information Technology-II
<b>Course Outcomes (COs):</b>	
<ul style="list-style-type: none"> <li>• On successful completion of this course, a student will be able to:</li> <li>• create and refine documents using text formatting, tables and graphics.</li> <li>• use mail merge.</li> <li>• create macros and templates in documents.</li> <li>• protect documents.</li> <li>• create presentations containing transitions and animations. learn advanced presentation features like custom slide show, call outs and action buttons.</li> <li>• use referencing and functions for data handling</li> </ul>	

**Course Content**

<b>Unit-1 Introduction to Excel</b>
Formatting excels work book, Perform Calculations with Functions, Sort and Filter Data with Excel, Create Effective Charts to Present Data Visually, Analyze Data Using PivotTables and Pivot Charts
<b>Unit-2: Understanding Word Processing</b>
Creating, opening and saving a document, text formatting, header and footer, creating and editing of tables, importing graphics, insert picture, using word processor's drawing features
<b>Unit-3 Making Small Presentations</b>
Creating presentations, using blank presentation option, using design template option, adding slides, deleting a slide, importing images from the outside world, deleting a slide, numbering a slide, saving presentation transition and animations, adding notes to slides, customize slideshow
<b>Unit-4 Advanced Features</b>
Creating macros, watermarks, templates, reviewing documents, comparing and combining documents, protection of documents-using passwords. Mail merge concept
<b>Unit-5 Data Handling using spreadsheets</b>
Relative, absolute and mixed referencing, mathematical and statistical functions, nested functions

**Recommended Books:**

Sr.	Title	Author	Publication
1.	Computer Basics with Office Automation	Archana Kumar	Wiley
2.	Office 2019 For Dummies	Wallace Wang	Wiley
3.	PowerPoint for Beginners	M L Humphrey	M.L. Humphrey



**Course Objective**

The objective of this course is to: develop a foundation of set theory concepts and notation. This course provides a variety of various mathematical structures by focusing on mathematical objects, operations, and resulting properties.

<b>Course Code:</b> SOS/CSE/SEC202	<b>Course Title:</b> Discrete Mathematics-II
<b>Course Outcomes (COs):</b>	
On successful completion of the course, students will be able to:	
<ul style="list-style-type: none"> <li>• Use different proofing techniques; construct simple mathematical proofs using logical arguments.</li> <li>• Formulate mathematical claims and construct counterexamples.</li> <li>• Describe the concept of graph and tree.</li> </ul>	

**Course Content**

<b>Unit-1 Recurrence</b>
Recurrence Relations, Generating Functions, Linear Recurrence Relations with Constant Coefficients and their solution.
<b>Unit-2 Combinatorics/Counting</b>
The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations.
<b>Unit-3 Graphs</b>
Graphs: Basic Terminology, Multigraphs and Weighted Graphs, Paths and Circuits, Eulerian Paths and Circuits, Hamiltonian paths and Circuits, Shortest Paths, Spanning Trees, Graph Isomorphism, Planar Graphs;
<b>Unit-4 Trees</b>
Trees, Rooted Trees, Path Lengths in Rooted Trees.

**Recommended Books:**

Sr.	Title	Author	Publication
1.	Schaum's Outline of Discrete Mathematics	Seymour Lipschutz	McGraw Hill Education
2.	Introductory discrete mathematics	V. Balakrishnan	Dover
3.	Discrete Mathematics and Its Applications	Kenneth H. Rosen	McGrwa Hill Education

**Course Objective**

The purpose of the course is to provide students with solid grounding in business uses of information technology in a rapidly changing environment, and to provide discussion of critical issues surrounding the use of IT in organizations

<b>Course Code:</b> SOS/CSE/SEC203	<b>Course Title:</b> Information System for Business-II
<b>Course Outcomes (COs):</b>	
On successful completion of the course, students will be able to:	
<ul style="list-style-type: none"> <li>• Remember the role of Information System in an organization.</li> <li>• Understand terminologies related to Information System.</li> <li>• Analyze the development process of an Information System.</li> <li>• Understand ethics and responsibilities of a person and organization in a Digital Age.</li> </ul>	

**Course Content**

<b>Unit-1 Business Process</b>
Business process, role of Information System in Business process, ERP Systems, People in Information System, emerging roles
<b>Unit-2 SDLC</b>
Information System Development, System Development Lifecycle, Types of Programming Languages
<b>Unit-3 Globalization</b>
What is Globalization, Impact of Internet on Globalization, what is digital divide, Steps to alleviate Digital Divide
<b>Unit-4 Ethics in Information System</b>
Ethics in Information System, Intellectual Property and Copyright, Patent, Responsibilities of individual, organization and government in Information Age, Future Trends in Information System.

**Recommended Books:**

Sr.	Title	Author	Publication
1.	Information Systems for Business and Beyond	David T. Bourgeois	Saylor Academy
2.	Business Information Systems	Paul Bocji	Pearson
3.	Principle of Information System	Ralph Stair	Cengage Learning



## B.Sc. Computer Science 2<sup>nd</sup> Year Syllabus

**SEMESTER: III**

**Core Course**

### Course 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

<b>Course Code:</b> SOS/CSE/C301	<b>Course Title:</b> Database Management Systems
<b>Course Outcomes (COs):</b>	
<ul style="list-style-type: none"><li>• On successful completion of this course, a student will be able to:</li><li>• Understand the importance of a database system and its difference from the traditional file system processing.</li><li>• Create conceptual data models using entity relationship diagrams for modeling real-life situations and map it to corresponding relational database schema.</li><li>• Construct relational database and formulate queries for data retrieval and data update using SQL.</li><li>• Normalize a database up to 3NF to make it free from update anomalies.</li></ul>	

### Course Content

<b>Unit-1 Introduction to Database</b>
Introduction to database and DBMS, architecture of DBMS, data independence, components of database systems, difference between traditional file system and database management system
<b>Unit-2 E-R Model</b>
Entity types, types of attributes and key, relationships types, constraints on relationship, modeling ER diagram, Database design using ER diagrams
<b>Unit-3 Relational Data Model</b>
Relational model concepts, relation characteristics, relational integrity constraints, types of keys, update anomalies
<b>Unit-4 Normalization</b>
Functional dependencies, Use of normalization, First, Second and Third normal forms, BCNF
<b>Unit-5 SQL</b>
Overview of SQL query language, Data definition and manipulation languages, set operations. DDL: to construct the database and alter its contents, DML: Querying in SQL to retrieve data from the database, use of join and simple aggregate functions

### Text Books:

Sr.	Title	Author	Publication
1.	Database System Concepts	S. Abraham	McGraw Hill Education
2.	Introduction to Database Management Systems	Atul Kahate	Pearson
3.	Learning SQL	Alan Beaulieu	O'Reilly



## DBMS LAB

### List of Practical's

Suggestive list of database schemes and corresponding queries:

1. Create a database having the following three tables to store the details of students of the Computer Department in a college.

**Student (Rollno, Name, DOB, Address, Phoneno)**

**Paper Details (Paper\_code, Paper\_Name)**

**Academic details (Rollno, Paper\_code, Attendance, Marks)**

- i. Identify primary and foreign keys. Create the tables with keys and insert at least 5 records in each table.
- ii. Design a query that will return the records (from the second table) along with the name of the student from the first table, related to students who have attendance more than 75 and marks more than 60 in paper P2.
- iii. List all students who live in "Delhi" and have marks greater than 60 in paper with code P1.
- iv. Find the total attendance and total marks obtained by each student.
- v. List the names of the students who have got the highest marks in paper P2.
- vi. Find the average marks obtained by each student
- vii. Update the name of the paper with Paper code P1 from "Introduction to Computers" to "Computer Science Fundamentals".
- viii. List the names of the students who have got the lowest marks in paper "Computer Science Fundamentals".
- ix. List the names of all the students whose name ends with 'sh'.
- x. List the total number of students who have secured above 90 in paper P4.
- xi. Add another column 'Email' in the Student table.
- xii. Update the phone number of the student with Roll number 34 to '9888812345'.

2. Create the following tables with primary key and foreign keys, enter at least 5 records in each table and answer the queries given below.

**Suppliers (SNo, Sname, Status, SCity)**

**Parts (PNo, Pname, Colour, Weight, City)**

**Project (JNo, Jname, Jcity)**

**Shipment (Sno, Pno, Jno, Quantity)**

- i. Get supplier numbers for suppliers in Guwahati with status greater than 20.
- ii. Get supplier details for suppliers who supply part P2. Display the supplier list in increasing order of supplier numbers.
- iii. Get suppliers names for suppliers who do not supply part P2.
- iv. For each shipment get full shipment details, including total shipment weights computed  $\text{Weight} \times \text{Quantity}$  of corresponding parts.
- v. Get all the shipments where the quantity is in the range 300 to 750 inclusive.
- vi. Get part nos. for parts that either weigh more than 1Kg or are supplied by suppliers S2 or both.
- vii. Get the names of cities that store more than two red parts.
- viii. Update the city of S1 supplier to "Delhi".
- ix. Get part numbers for parts supplied by a supplier in Allahabad to a project in Chennai.
- x. Find the names of all parts whose color starts with the letter b.
- xi. Change the datatype of the weight attribute in the Parts table from int to float.
- xii. Find the number of parts of each color.

3. E-R diagrams

4. SQL Queries





**Course Objectives**

This course is geared towards generating and enhancing awareness about cyber security challenges and the concepts of cyber security and cyber ethics among the students to help them become responsible cyber citizens and participate safely and securely in the rapidly evolving information-age society.

<b>Course Code:</b> SOS/CSE/AIMC301	<b>Course Title:</b> Introduction to Cyber Security
<b>Course Outcomes (COs):</b>	
After successful completion of course the student will be able to:	
<ul style="list-style-type: none"> <li>• Remember the broad set of technical, social &amp; political aspects of Cyber Security.</li> <li>• Understand the importance of ethical hacking, its tool and ethical hacking process.</li> <li>• Analyze security principles to system design.</li> <li>• Understand the methods for authentication, access control, intrusion detection and prevention in Cyber Security.</li> </ul>	

**Course Content**

<b>Unit-1 Introduction to Cyber Security</b>
Importance and challenges in Cyber Security, Cyberspace, and Cyber threats, Cyber warfare, CIA Triad, Cyber Terrorism, Cyber Security of Critical Infrastructure
<b>Unit-2 Hackers and Cyber Crimes</b>
Types of Hackers - Hackers and Crackers, Cyber-Attacks and Vulnerabilities, Malware threats, Sniffing, Gaining Access - Escalating Privileges, Executing Applications, Hiding Files, Covering Tracks. Worms, Trojans, Viruses, Backdoors
<b>Unit-3 Ethical Hacking</b>
Ethical Hacking Concepts and Scopes, Threats and Attack Vectors, Information Assurance, Threat Modeling, Enterprise Information Security Architecture, Vulnerability Assessment and Penetration Testing
<b>Unit-4 Social Engineering</b>
Types of Social Engineering - Insider Attack - Preventing Insider Threats - Social engineering Targets and Defence Strategies
<b>Unit-5 IT Security Act &amp; Cyber Security Initiatives in India</b>
IT Act, Hackers-Attacker-Countermeasures, Web Application Security, Counter Cyber Security Initiatives in India, Cyber Security Incident Handling, Cyber Security Assurance

**Text Books:**

Sr.	Title	Author	Publication
1.	Cyber Security and Cyber Laws	Nilakshi Jain	Wiley
2.	Cyber Security	Nina Godbole	Wiley
3.	Beginners Guide to Ethical Hacking and Cyber Security	Abhinav Ojha	Notion Press



**Course objective**

The objectives of this course are to: understand the concepts behind computer networks and data communication. Learn the use of different layers in standard reference models used for communication. Learn the main features of protocols used at various layers. Understand the utility of different networking devices.

<b>Course Code:</b> SOS/CSE/SEC301	<b>Course Title:</b> Data Communication and Networking-I
<b>Course Outcomes (COs):</b>	
On successful completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Describe the hardware and software components used in a network.</li> <li>• Compare OSI and TCP/IP reference models at various layers.</li> <li>• Describe, analyze and compare different data link,</li> </ul>	

**Course Content**

<b>Unit-1 Introduction</b>
Components of data communication, Types of Computer Network, Internet, Intranet, Network Topologies, Layered Architecture Approach, OSI Reference Model, TCP/IP Reference Model.
<b>Unit-2 Physical Layer</b>
Analog Signal, Digital signal, digital modulation techniques (ASK, PSK, QAM), encoding techniques, the maximum data rate of a channel
<b>Unit-3 Transmission Media</b>
Transmission media (guided transmission media, wireless transmission, satellite communication), multiplexing (frequency division multiplexing, time-division multiplexing, wavelength division multiplexing)
<b>Unit-4 Data Link Layer</b>
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.

**Text Books:**

Sr.	Title	Author	Publication
1.	Data Communications and Networking	A. Forouzan	McGraw Hill Education
2.	Computer Networking	Kurose	Pearson
3.	Computer Networks	Andrew S. Tanenbaum	Pearson

**Course objective**

The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems on the computer.

<b>Course Code:</b> SOS/CSE/SEC302	<b>Course Title:</b> Numerical Computing-I
<b>Course Outcomes (COs):</b>	
Upon completion of the course students shall be able to:	
<ul style="list-style-type: none"> <li>• Recognize the error in the number generated by the solution.</li> <li>• Compute solution of algebraic and transcendental equation by numerical methods like Bisection method and Newton Raphson method.</li> <li>• Apply method of interpolation and extrapolation for prediction. Recognize elements and variable in statistics and summarize qualitative and quantitative data</li> </ul>	

**Course Content**

<b>Unit-1 Introduction</b>
Numbers and their accuracy, Computer Arithmetic, Mathematical preliminaries, Errors and their Computation, General error formula, Error in a series approximation.
<b>Unit-2 Solution of Algebraic and Transcendental Equation</b>
Bisection Method, Iteration method, Method of false position, Newton-Raphson method, Methods of finding complex roots, Muller's method, Rate of convergence of Iterative methods.
<b>Unit-3 Interpolation</b>
Differences, Difference tables Polynomial Interpolation: Newton's forward and backward formula Central Difference Formulae: Gauss forward and backward formula, Stirling's, Bessel's, Everett's formula.
<b>Unit-4 Interpolation with Unequal Intervals</b>
Lagrange's Interpolation, Newton Divided difference formula, Hermite's Interpolation,

**Recommended Books**

Sr.	Title	Author	Publication
1.	Computer-Based Numerical & Statistical Techniques	M. Goyal	Infinity Science Press LLC
2.	Numerical Methods	M.K. Jain	New Age
3.	Introductory Methods of Numerical Analysis	S.S. Sastry	PHI Learning



**Course Objective**

This course introduces the students to the fundamental concepts of digital computer organization, design and architecture. It aims to develop a basic understanding of the building blocks of the computer system and highlights how these blocks are organized together to architect a digital computer system

<b>Course Code:</b> SOS/CSE/SEC303	<b>Course Title:</b> Computer System Architecture-I
<b>Course Outcomes (COs):</b>	
Upon completion of the course students shall be able to:	
<ul style="list-style-type: none"> <li>• Differentiate between logic gate and compute truth tables</li> <li>• Analyze circuits and flip-flops</li> <li>• Design basic combinatorial circuit and manage its components</li> <li>• Understand various data representation methods.</li> </ul>	

**Course Content**

<b>Unit-1 Digital Logic Circuits</b>
Logic Gates, Truth Tables, Boolean Algebra, Digital Circuits, Combinational Circuits
<b>Unit-2 Sequential Circuits</b>
Circuit Simplification using Karnaugh Map, Don't Care Conditions, Flip-Flops, Characteristic Tables, Excitation Table
<b>Unit-3 Digital Components</b>
Designing of combinational circuits- Half Adder, Full Adder, Decoders, Encoders, Multiplexers, Registers and Memory (RAM, ROM and their types), Arithmetic Microoperations, Binary Adder
<b>Unit-4 Data Representation and Basic Computer Arithmetic</b>
Number System, $r$ and $(r-1)$ 's Complements, data representation and arithmetic operations.

**Recommended Books**

Sr.	Title	Author	Publication
1.	Digital Design	Morris Mano	Pearson Education
2.	Computer System Architecture	Morris Mano	Pearson Education
3.	Computer Organization and Architecture	W. Stallings	Prentice Hall of India



**Course objective**

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.

<b>Course Code:</b> SOS/CSE/C401	<b>Course Title:</b> Design and Analysis of Algorithms
<b>Course Outcomes (COs):</b>	
On successful completion of this course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Compute and compare the asymptotic time complexity of algorithms.</li> <li>• Use appropriate algorithm design technique(s) for solving a given problem.</li> <li>• Appreciate the difference between tractable and intractable problems.</li> </ul>	

**Course Content**

<b>Unit-1 Introduction to Algorithm + Sorting</b>
Asymptotic analysis: Big-O, Big-Theta, Insertion Sort, Selection Sort, Bubble Sort, Heapsort, Linear Time Sorting, Selection Problem, Analysis of time complexity of all algorithms
<b>Unit-2 Graphs</b>
Representation of graphs, Traversal of graphs (BFS and DFS), Directed graphs, Directed Acyclic Graphs and Topological Ordering
<b>Unit-3 Divide and Conquer</b>
Introduction to divide and conquer technique, Merge Sort, Quick Sort with analysis of time complexity. Maximum Sub-array problem, Strassen's algorithm for matrix multiplication.
<b>Unit-4 Greedy Algorithms</b>
Introduction to the Greedy algorithm design approach, application to minimum spanning trees, fractional knapsack problem, shortest path problem with analysis of time complexity.
<b>Unit-5 Dynamic Programming &amp; Intractability</b>
Introduction to the Dynamic Programming approach, application to weighted interval scheduling, integer knapsack problem with analysis of time complexity, Introduction to NP, NP-hard and NP-complete classes.

**Text Books:**

Sr.	Title	Author	Publication
1.	Introduction to Algorithms	Cormen	MIT Press
2.	Introduction to the Design and Analysis of Algorithms	Levitin	Addison Wesley
3.	Design and Analysis of Algorithms	Sandeep Sen	Cambridge University Press



## Design and Analysis of Algorithms LAB

### List of Practical's

1. Write a program to sort the elements of an array using Insertion Sort (The program should report the number of comparisons).
2. Write a program to sort the elements of an array using Merge Sort (The program should report the number of comparisons).
3. Write a program to sort the elements of an array using Heap Sort (The program should report the number of comparisons).
4. Write a program to multiply two matrices using the Strassen's algorithm for matrix multiplication.
5. Write a program to sort the elements of an array using Radix Sort.
6. Write a program to sort the elements of an array using Bucket Sort.
7. Display the data stored in a given graph using the Breadth-First Search algorithm.
8. Display the data stored in a given graph using the Depth-First Search algorithm.
9. Write a program to determine a minimum spanning tree of a graph using the Prim's algorithm.
10. 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.
11. Write a program to solve the weighted interval scheduling problem.
12. Write a program to solve the 0-1 knapsack



**Course objective**

The course focuses on covering all cyber security landscapes theoretically and practically. This course provides a range of career opportunities in Cyber Security Sectors as Network/Application Security Analyst, Cyber Security Analyst, Security Automation, Cyber Security Practitioner, Cyber Defense Analyst, Penetration Tester, Information Security Engineer in leading IT Industries and to act as Cyber Security Experts in in Governmental Organizations. Cyber Security, Tools, Techniques and Counter Measures course teaches learners to protect the confidentiality, availability and integrity of information and information systems.

<b>Course Code:</b> SOS/CSE/AIMC401	<b>Course Title:</b> Cyber Security Tools, Techniques and Countermeasures
<b>Course Outcomes (COs):</b>	
On successful completion of this course, the student will be able to:	
<ul style="list-style-type: none"> <li>• compare the various encryption techniques.</li> <li>• identify the Intrusion and execute prevention methods.</li> <li>• describe various tools related to cyber security.</li> </ul>	

**Course Content**

<b>Unit-1 Cryptography</b>
Cryptography in Practice, Historical Perspectives - Algorithms - Hashing Functions - Symmetric Encryption, Asymmetric Encryption, Quantum Cryptography, Cryptography Algorithm Uses.
<b>Unit-2 Intrusion Detection Systems</b>
History of Intrusion Detection Systems, IDS Overview, Network-Based IDSs, Host-Based IDSs, Intrusion Prevention Systems, Honeypots and Honeynets - Tools.
<b>Unit-3 Online Banking, Credit Card and UPI Security</b>
Online Banking Security, Mobile Banking Security, Security of Debit and Credit Card, UPI Security.
<b>Unit-4 Information Destroying and Recovery Tools</b>
Recovering from Information Loss, Destroying Sensitive Information

**Text Books:**

Sr.	Title	Author	Publication
1.	Cyber Security and Cyber Laws	Nilakshi Jain	Wiley
2.	Cyber Security	Nina Godbole	Wiley
3.	Beginners Guide to Ethical Hacking and Cyber Security	Abhinav Ojha	Notion Press



**Course objective**

The objectives of this course are to: understand the concepts behind computer networks and data communication. Learn the use of different layers in standard reference models used for communication. Learn the main features of protocols used at various layers. Understand the utility of different networking devices.

<b>Course Code:</b> SOS/CSE/SEC401	<b>Course Title:</b> Data Communication and Networking-II
<b>Course Outcomes (COs):</b>	
On successful completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• describe, analyze and compare different data link, network, transport and application layer protocols.</li> <li>• design/implement transport and network layer protocols in a simulated networking environment.</li> <li>• describe application layer protocols.</li> </ul>	

**Course Content**

<b>Unit-1 Networking Devices</b>
NIC, Hub Switch Router Bridge Gateway Modem Repeater Access Point
<b>Unit-2 Network Layer</b>
Networks and Internetworks, virtual circuits and datagrams, addressing, subnetting, Routing algorithm (Distance vector and Dijkstra routing), Network Layer protocol- (ARP, IPV4, ICMP, IPV6).
<b>Unit-3 Transport Layer</b>
Process to process Delivery- (client-server paradigm, connectionless versus connection-oriented service, reliable versus unreliable); User Datagram Protocols, TCP/IP protocol, Flow Control
<b>Unit-4 Application Layer</b>
FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), Telnet (Remote login protocol), WWW (World Wide Web), HTTP (HyperText Transfer Protocol)

**Text Books:**

Sr.	Title	Author	Publication
1.	Data Communications and Networking	A. Forouzan	McGraw Hill Education
2.	Computer Networking	Kurose	Pearson
3.	Computer Networks	Andrew S. Tanenbaum	Pearson





**Course objective**

The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems on the computer.

<b>Course Code:</b> SOS/CSE/SEC402	<b>Course Title:</b> Numerical Computing-II
<b>Course Outcomes (COs):</b>	
Upon completion of the course students shall be able to:	
<ul style="list-style-type: none"> <li>• Use various methods for numerical integration and differentiation summarize qualitative and quantitative data.</li> <li>• Calculate solution of differential equations.</li> <li>• Outline properties of curve fitting and compute coefficient of regression.</li> </ul>	

**Course Content**

<b>Unit-1 Numerical Integration and Differentiation</b>
Introduction, Numerical differentiation, Numerical Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Boole's rule, Weddle's rule
<b>Unit-2 Solution of differential Equations</b>
Picard's Method, Euler's Method, Taylor's Method, Runge-Kutta Methods, Predictor Corrector Methods, Automatic Error Monitoring and Stability of solution.
<b>Unit-3 Linear System of Algebraic Equations</b>
Gauss Elimination method, Gauss Jordan method, LU decomposition method, Gauss-Jacobi method, Gauss-Seidel Method
<b>Unit-4 Curve fitting</b>
B-spline and Approximation, Fitting linear and non-linear curves, weighted least square approximation, method of least square for continuous functions, Regression Analysis: Linear and Non-Linear

**Recommended Books**

Sr.	Title	Author	Publication
1.	Computer-Based Numerical & Statistical Techniques	M. Goyal	Infinity Science Press LLC
2.	Numerical Methods	M.K. Jain	New Age
3.	Introductory Methods of Numerical Analysis	S.S. Sastry	PHI Learning



**Course Objective**

This course introduces the students to the fundamental concepts of digital computer organization, design and architecture. It aims to develop a basic understanding of the building blocks of the computer system and highlights how these blocks are organized together to architect a digital computer system

<b>Course Code:</b> SOS/CSE/SEC403	<b>Course Title:</b> Computer System Architecture-II
<b>Course Outcomes (COs):</b>	
Upon completion of the course students shall be able to:	
<ul style="list-style-type: none"> <li>• Outline the basic organization of computer Bus.</li> <li>• Differentiate between different types of memory available in computer system &amp; their functions.</li> <li>• Explain the process of the Direct Memory Access.</li> </ul>	

**Course Content**

<b>Unit-1 Basic Computer Organization and Design</b>
Bus organization, Micro programmed vs Hardwired Control, Instruction Codes, Instruction Format, Instruction Cycle, Instruction pipelining, Memory Reference, Register Reference and Input Output Instructions, Program Interrupt and Interrupt Cycle.
<b>Unit-2 Processors</b>
General register organization, Stack Organization, Addressing Modes, Overview of Reduced Instruction Set Computer (RISC), Complex Instruction Set Computer (CISC), Multicore processor and Graphics Processing Unit (GPU)
<b>Unit-3 Memory and Input-Output Organization</b>
Memory hierarchy (main, cache and auxiliary memory), Input-Output Interface.
<b>Unit-4 Modes of Transfer</b>
Programmed I/O, Interrupt initiated I/O, Direct memory access.

**Recommended Books**

Sr.	Title	Author	Publication
1.	Digital Design	Morris Mano	Pearson Education
2.	Computer System Architecture	Morris Mano	Pearson Education
3.	Computer Organization and Architecture	W. Stallings	Prentice Hall of India



## B.Sc. Computer Science 3<sup>rd</sup> Year Syllabus

SEMESTER: V

Core Course

### Course Objective

The course is designed to explain the need and structure of an operating system using its common services such as process management (creation, termination etc.), CPU Scheduling, Process Synchronization, Handling Deadlocks, main memory management, virtual memory,

<b>Course Code:</b> SOS/CSE/C501	<b>Course Title:</b> Operating System
<b>Course Outcomes (COs):</b> On successful completion of the course, students will be able to:	
<ul style="list-style-type: none"><li>• Understand the need of an Operating System &amp; Define Multiprogramming and Multithreading concepts.</li><li>• Implement Process Synchronization service (Critical Section, Semaphores), CPU scheduling service with various algorithms.</li><li>• Learn Main memory Management (Paging, Segmentation) algorithms, Handling of Deadlocks.</li></ul>	

### Course Content

<b>Unit-1 Introduction</b>
Operating Systems (OS) definition and its purpose, Multiprogramming and Time-Sharing Systems, OS Structure, OS Operations: Dual and Multi-mode, OS as resource manager.
<b>Unit-2 Operating System Structures</b>
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
<b>Unit-3 Process Management</b>
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, Process Synchronization: The critical-section problem and Peterson's Solution, Deadlock characterization, Deadlock handling
<b>Unit-4 Memory Management</b>
Physical and Logical address space, Swapping, Contiguous memory allocation strategies - fixed and variable partitions, Segmentation, Paging, virtual memory: Demand Paging, Page Replacement algorithms: FIFO Page Replacement, Optimal Page replacement, LRU page replacement
<b>Unit-5 File System and Disk Scheduling</b>
File Concepts, File Attributes, File Access Methods, Directory Structure: Single-Level, Two-Level, Tree-Structured, and Acyclic-Graph Directories. Mass Storage Structure: Magnetic Disks, Solid-State Disks, Magnetic Tapes, Disk Scheduling algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, and C-LOOK Scheduling

### Text Books:

Sr.	Title	Author	Publication
1.	Operating System Concepts	Galvin	Wiley
2.	Operating Systems: A Concept-based Approach	Dhamdhare	McGraw Hill Education
3.	Operating Systems: Internals and Design Principles	W. Stallings	Pearson Education
4.	Modern Operating Systems	Andrew S. Tanenbaum	Pearson Education



## Operating System LAB

### List of Practical's

1. Study and explain the types of operating systems (their types with structure, functionality, dependencies, application software with their differences).
2. Installation of any one of the operating system.
3. Implement any file allocation technique (Linked, Indexed or Contiguous).
4. Present the output of following CPU Scheduling algorithm:
  - i. FCFS
  - ii. SJF
  - iii. Priority
  - iv. Round Robin
5. Present the output of following Page Replacement Algorithm:
  - i. FIFO
  - ii. LRU
  - iii. OPTIMAL
6. To implement first fit, best fit and worst fit algorithm for memory management.
7. Present the output for Producer – Consumer problem concept.
8. Simulate Bankers algorithm.
9. Implementation of Disk Scheduling Algorithms



**Course Objective**

The objectives of this course are to: Understand the foundations, basic concepts and techniques of Artificial Intelligence (AI). Apply informed search techniques for different applications. Impart knowledge about the use of core AI techniques having applicability to a wide range of real-world problems. Learn about various knowledge representation techniques and writing Prolog programs. Learn about the latest techniques for developing AI system

<b>Course Code:</b> SOS/CSE/VO501	<b>Course Title:</b> Artificial Intelligence
<b>Course Outcomes (COs):</b>	
On completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Understand the basics of Artificial Intelligence and gain knowledge of the learning process and its models.</li> <li>• Understand different types of search techniques.</li> <li>• Understand different knowledge representation schemes.</li> <li>• Understand the AI applications in the design of expert systems.</li> <li>• Understand basic concepts of machine learning, ANN, SVM and fuzzy logic</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction: Introduction to Artificial Intelligence, Background and Applications, AI techniques, Tic Tac-Toe problem, Problem Characteristics.
<b>Unit-2</b>
Problem Solving and Searching Techniques: Problem Characteristics, Production Systems, Water Jug Problem, Control Strategies, Breadth First Search, Depth First Search, Hill climbing and its Variations, Heuristics Search Techniques: Best First Search. 8-Puzzle Problem.
<b>Unit-3</b>
Knowledge Representation: Definition of Knowledge, Knowledge Based Systems, Representation of Knowledge. Introduction to First Order Predicate Logic, Conversion to clausal form, Unification, Resolution Principle
<b>Unit-4</b>
Expert Systems: Introduction to Expert Systems, Characteristic Features of Expert Systems, Applications of Expert Systems, Components and Working of Expert Systems
<b>Unit-5s</b>
Introduction to Machine Learning Techniques: Fuzzy Logic, Fuzzy Set, Membership Function, Union, intersection and complement of a fuzzy set, Introduction to Artificial Neural Network, Introduction to Support Vector Machine.

**Text Books:**

Sr.	Title	Author	Publication
1.	Introduction to A.I and Expert Systems	DAN.W. Patterson	PHI
2.	Artificial Intelligence-A Modern Approach	Russell & Norvig	Pearson
3.	Artificial Intelligence	Rich & Knight	McGraw Hill Education



**Course Objective**

This course will provide fundamental approaches and techniques used to develop good quality software. This includes learning of various software development process frameworks, requirement analysis, design modeling, qualitative and quantitative software metrics, risk management, and testing techniques.

<b>Course Code:</b> SOS/CSE/VO502	<b>Course Title:</b> Software Engineering
<b>Course Outcomes (COs):</b>	
After successful completion of course the students will be able to:	
<ul style="list-style-type: none"> <li>• Familiarize Software and Software Engineering.</li> <li>• Evaluate the Software Requirement Analysis.</li> <li>• Design about the Structured Analysis.</li> <li>• Identify the Software Design.</li> <li>• Appropriate about the Software Testing methods</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction: The Evolving Role of Software, Software characteristics, Software Engineering as a Layered Technology, Software Process Framework and Umbrella Activities, Process Models.
<b>Unit-2</b>
Requirement Analysis: Software Requirement Analysis, Initiating Requirement Engineering Process, Requirement Analysis and Modelling Techniques, Flow Oriented Modelling, Need for SRS, Characteristics and Components of SRS
<b>Unit-3</b>
Software Project Management: Estimation in Project Planning Process, Project Scheduling. Risk Management: Software Risks, Risk Identification, Risk Projection and Risk Refinement
<b>Unit-4</b>
Software Engineering Principles & Tools: Tools of Design (Data Flow Diagrams, Data Dictionary, Decision Tree, Decision Tables), Modularization (Coupling).
<b>Unit-5</b>
Testing Strategies & Tactics: Software Testing Fundamentals, Test Strategies for Conventional Software, Validation Testing, System testing, Black-Box Testing, White-Box Testing and their type, Basis Path Testing

**Text Books:**

Sr.	Title	Author	Publication
1.	Software Engineering Concepts	R.F.Fairley	McGraw Hill Education
2.	Software Engineering: A Practitioners Approach	R.S.Press Man	McGraw Hill Education
3.	Fundamentals of Software Engineering	Rajib Mall	PHI



**Course Objective**

This course is designed to introduce the students to real-world data analysis problems, use of statistics to get a deterministic view of data and interpret results in the field of exploratory data science using Python.

<b>Course Code:</b> SOS/CSE/VO503	<b>Course Title:</b> Data Analysis and Visualization
<b>Course Outcomes (COs):</b>	
On successful completion of the course, students will be able to:	
<ul style="list-style-type: none"> <li>• Apply descriptive statistics to obtain a deterministic view of data</li> <li>• Perform data handling using Numpy arrays</li> <li>• Load, clean, transform, merge and reshape data using Pandas</li> <li>• Visualize data using Pandas and matplotlib libraries</li> <li>• Solve real world data analysis problems</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction to basic statistics and analysis: Fundamentals of Data Analysis, Statistical foundations for Data Analysis, Types of data, Descriptive Statistics, Correlation and covariance, Linear Regression, Statistical Hypothesis Generation and Testing, Python Libraries: NumPy, Pandas, Matplotlib
<b>Unit-2</b>
Array manipulation using NumPy: NumPy array: Creating NumPy arrays; various data types of NumPy arrays, indexing and slicing, swapping axes, transposing arrays, data processing using NumPy arrays.
<b>Unit-3</b>
Data Manipulation using Pandas: Data Structures in Pandas: Series, DataFrame, Index objects, loading data into Panda's data frame, Working with DataFrames: Arithmetic's, Statistics, Binning, Indexing, Reindexing, Filtering, handling missing data, Hierarchical indexing, Data wrangling: Data cleaning, transforming, merging and reshaping
<b>Unit-4</b>
Plotting and Visualization: Using Matplotlib to plot data: figures, subplots, markings, color and line styles, labels and legends, plotting functions in Pandas: Line, bar, Scatter plots, histograms, stacked bars, Heatmap
<b>Unit-5</b>
Data Aggregation and Group operations: Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation

**Text Books:**

Sr.	Title	Author	Publication
1.	Data Analysis: Data Wrangling with Pandas, NumPy and IPython	W. McKinney	O'Reilly
2.	Hands-On Data Analysis with Pandas	Molin S	Packt
3.	Fundamentals of Mathematical Statistics	Gupta S.C	S. Chand



**Course Objective**

This course is designed to develop understanding of object-oriented programming concepts like Classes, Objects, Inheritance and Polymorphism using Java. The course provides understanding of multithreading and exception handling in Java. It also introduces how to create Java applications with graphical user interface (GUI).

<b>Course Code:</b> SOS/CSE/DSEC601	<b>Course Title:</b> JAVA Programming
<b>Course Outcomes (COs):</b>	
On completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Use the syntax and semantics of java programming language and basic concepts of OOP.</li> <li>• Develop reusable programs using the concepts of inheritance, polymorphism, interfaces and packages.</li> <li>• Apply the concepts of Multi-threading and Exception handling to develop efficient and error free codes.</li> <li>• Create &amp; Maintain MYSQL Databases using JAVA</li> <li>• Design event driven GUI Applications</li> </ul>	

**Course Content**

<b>Unit-1 Introductory Concepts</b>
Program, identifiers, variables, constants, primitive datatypes, expressions, Naming Conventions, Type casting, operators, control statements, structured data types, arrays, functions.
<b>Unit-2 Object Oriented Concepts</b>
Abstraction, encapsulation, objects, classes, methods, constructors, inheritance, polymorphism, static and dynamic binding, Anonymous block, Static Data members, overloading and overriding, Usage of super and this keyword, Abstract classes, Interfaces and Packages, Access modifiers, object class.
<b>Unit-3 Database Programming</b>
Database Programming, The Design of JDBC. The Structured Query Language, JDBC Installation, Basic JDBC Programming Concepts, Query Execution, Scrollable and Updatable Result Sets, Metadata, Row Sets, Transactions.
<b>Unit-4 AWT</b>
AWT: Components and container used in AWT, Layout managers, Listeners and Adapter classes, Event Delegation model, Swing: Introduction to Swing Component and Container Classes

**Text Books:**

Sr.	Title	Author	Publication
1.	The Complete Reference	Naughton, Schildt	TMH
2.	Programming in JAVA	Balagurusamy E	TMH
3.	Java2 Black book	Steven Holzner	Dreamtech





**Course Objective**

This course introduces fundamental concepts of Computer Graphics with focus on modeling, rendering and interaction aspects of computer graphics. The course emphasizes the basic principles needed to design, use and understand computer graphics system

<b>Course Code:</b> SOS/CSE/DSEC602	<b>Course Title:</b> Computer Graphics
<b>Course Outcomes (COs):</b>	
On successful completion of the course, students will be able to:	
<ul style="list-style-type: none"> <li>• Describe Standard raster and vector scan devices as well as Graphical Input and output devices</li> <li>• Implement algorithms for drawing basic primitives such as line, circle and ellipse.</li> <li>• Implement algorithms for line clipping, polygon clipping and polygon filling.</li> <li>• Implement a 3D object representation scheme, carryout 2D and 3D transformation, 3D projections</li> <li>• Implement visible surface determination algorithms, Illumination models and surface rendering methods</li> </ul>	

**Course Content**

<b>Unit-1 Introduction</b>
Introduction to Graphics systems, Basic elements of Computer graphics, Applications of computer graphics. Architecture of Raster and Random scan display devices, input/output devices
<b>Unit-2 Drawing and clipping primitives</b>
Raster scan line, circle and ellipse drawing algorithms, Polygon filling, line clipping and polygon clipping algorithms
<b>Unit-3 Transformation and Viewing</b>
2D and 3D Geometric Transformations, 2D and 3D Viewing transformations (Projections- Parallel and Perspective), Vanishing points
<b>Unit-4 Visible Surface determination and Surface Rendering</b>
Z-buffer algorithm, List-priority algorithm and area subdivision algorithm for visible surface determination. Illumination and shading models, RGB Color model and Basics of Computer Animation

**Text Books:**

Sr.	Title	Author	Publication
1.	Computer Graphics	Hearn, D & Baker,	Prentice Hall of India
2.	Computer Graphics: Principles and Practice in C	Foley	Pearson Education
3.	Mathematical Elements for Computer Graphics,	D.F. Rogers	McGraw Hill Education



**Course Objective**

This course is designed to provide the knowledge of Dot Net Frameworks along with C#. The course emphasis on basic concepts of C# and general introduction of C# Libraries.

<b>Course Code:</b> SOS/CSE/DSEC603	<b>Course Title:</b> Programming using C# & .NET
<b>Course Outcomes (COs):</b>	
On completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Acquire the knowledge of the structure and model of the programming language C #</li> <li>• Understand the use of programming language C # for various programming technologies</li> <li>• Evaluate user requirements for software functionality required to decide whether the programming language C # can meet user requirements</li> </ul>	

**Course Content**

<b>Unit-1 The .NET Framework</b>
Introduction, Common Language Runtime, Common Type System, Common Language specification, The Base Class Library, The .Net class library Intermediate language, Just-in time Compilation, Garbage Collection, Application Installation and Assemblies, Web services, Unified classes
<b>Unit-2 C# Basics</b>
Introduction, Data Types, Identifiers, Variables and constants, C# statements, Object Oriented Concept, Object and Classes, Arrays and Strings, System collections, Delegates and Events, Indexes, Attributes, versioning
<b>Unit-3 C# Using Libraries</b>
Namespace- System, Input Output, Multi-Threading, Networking and Sockets, Data Handling, Windows Forms, C# in web application, Error Handling
<b>Unit-4 Advanced Features Using C#</b>
Web services, Windows services, messaging, Reflection, COM, Localization.

**Text Books:**

Sr.	Title	Author	Publication
1.	Programming with C#	E. Balagurusamy	TMH
2.	Beginning Visual C#	Wiley	Wrox
3.	Applied Microsoft .NET Framework Programming	Jeffrey Richter	Microsoft

**Note:**

1. Vocational Courses for V and VI Semester are in preparation
2. Elective Papers (Fourth Year – with Research) for VII and VIII semesters are in preparation
3. Major Elective Papers (Fourth Year - Honours) for VII and VIII semesters are in preparation.



**Course Objective**

This course covers the basic concepts behind blockchain and presents Bitcoin and other cryptocurrencies as the motivation for blockchain technologies. It provides a substantive discussion about different technologies behind blockchain and cryptocurrencies

<b>Course Code:</b> SOS/CSE/VO601	<b>Course Title:</b> Blockchain and its Applications
<b>Course Outcomes (COs):</b> On successful completion of the course, students will be able to: <ul style="list-style-type: none"> <li>• understand the applications of blockchain in different domains</li> <li>• learn the practical applications of cryptocurrency such as Bitcoin and Ethereum</li> <li>• understand basic technologies like cryptographic hash functions, blocks, Merkel trees, elliptic curve cryptography and digital signatures.</li> <li>• to have knowledge of decentralized consensus algorithms like proof of work, proof of stack, proof of capacity etc.</li> <li>• to learn how to record transactions in blockchain, computing bitcoin address etc.</li> <li>• to learn about smart contracts and their applications</li> <li>• to learn about permissioned and permission less blockchain and Hyperledger's.</li> <li>• to gain knowledge of real-world aspects of Bitcoin, such as wallets and mining techniques</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction: History of money, Digital Currencies, Ledgers, Cryptography, Centralized and Decentralized systems, peer to peer systems, the purpose of Blockchain, types of blockchain (public, private and semi-private blockchain), application of blockchain (in government, healthcare, real estate, voting, insurance, non-fungible tokens, metaverse, Web 3.0).
<b>Unit-2</b>
Cryptocurrency and Design: Concept of cryptocurrency, History of Bitcoin, concept of mining, challenges of blockchain/bitcoin design (performance, scalability, efficiency, security, governance, public policy and legal framework).
<b>Unit-3</b>
Blockchain Technology: Properties of hash functions, Cryptographic hash functions, hashes (as names, references and commitments), Blocks, Block Headers, Merkel Trees, chain forks, Asymmetric Cryptography, Digital signatures
<b>Unit-4</b>
Blockchain and Money Transactions: Satoshi and Bitcoin, Recording of transactions in blockchain, transaction inputs, outputs and format, Bitcoin address. Smart contracts (Ethereum and other currencies): Overview of smart contracts, tokens and Ethereum as a platform for smart contracts, blockchain technology as regulatory authority

**Text Books:**

Sr.	Title	Author	Publication
1.	Mastering blockchain Distributed ledger technology, decentralization, and smart contracts explained	Imran Bashir	Packt
2.	Mastering Blockchain	Lorne Lantz	
3.	Introducing Ethereum and Solidity Foundations of Cryptocurrency and Blockchain Programming for beginners	Chris Dannen	Apress

**Course Objective**

The objective of this course is to provide graduate students with the comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture and applications by introducing and researching state-of-the-art in Cloud Computing fundamental issues, technologies, applications and implementations.

<b>Course Code:</b> SOS/CSE/VO602	<b>Course Title:</b> Cloud Computing
<b>Course Outcomes (COs):</b>	
After successful completion of course the student will be able to:	
<ul style="list-style-type: none"> <li>• Understand the key dimensions of the challenges and benefits of Cloud Computing.</li> <li>• Describe the principles of Parallel and Distributed Computing and evolution of cloud computing from existing technologies</li> <li>• Implement different types of Virtualization technologies and Service Oriented Architecture systems.</li> <li>• Choose among various cloud technologies for implementing applications.</li> <li>• Install and use current cloud technologies.</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction: Cloud-definition, benefits, usage scenarios, History of Cloud Computing, Cloud Architecture, Types of Clouds, Players in Cloud Computing, issues in Clouds
<b>Unit-2</b>
Types of Cloud services, Software as a Service, Platform as a Service, Infrastructure as a Service, Database as a Service, Monitoring as a Service, Communication as services. Service Providers- Google, Amazon, Microsoft Azure, IBM, Sales force.
<b>Unit-3</b>
Collaborating Using Cloud Services Email Communication over the Cloud, CRM Management, Project Management, Event Management, Task Management, Calendar, Schedules, Word Processing, Presentation, Spreadsheet, Databases, Desktop, Social Networks and Groupware
<b>Unit-4</b>
Virtualization for Cloud Need for Virtualization, Pros and cons of Virtualization, Types of Virtualizations, System VM, Process VM, Virtual Machine monitor, Virtual machine properties, HLL VM, Hypervisors, Xen, KVM, VMWare, Virtual Box, Hyper-V
<b>Unit-5</b>
Cloud Security: Infrastructure Security- Network level security, Host level security, Application-level security, Data security, Authentication in cloud computing, Cloud security challenges.

**Text Books:**

Sr.	Title	Author	Publication
1.	Cloud Computing Bible	Barrie Sosinsky	Wiley
2.	Cloud Computing: Concepts, Technology & Architecture	Thomas Erl	Prentice Hall
3.	Virtual Machines	James E Smith	Morgan Kaufmann

**Course Objective**

The course covers the basic concepts and techniques of Machine Learning from both theoretical and practical perspective. The material includes classical ML approaches as Version Spaces and Decision Trees, new approaches as Inductive Logic Programming and Minimum Description Length Principle (MLD) as well as "hot" topics as SVM and Clustering.

<b>Course Code:</b> SOS/CSE/VO603	<b>Course Title:</b> Machine Learning
<b>Course Outcomes (COs):</b>	
On successful completion of this course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Differentiate between supervised and unsupervised learning tasks.</li> <li>• Appreciate the need of preprocessing, feature scaling and feature selection.</li> <li>• Understand the fundamentals of classification, regression and clustering</li> <li>• Implement various machine learning algorithms learnt in the course.</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction: Basic definitions and concepts, key elements, supervised and unsupervised learning, introduction to reinforcement learning, applications of ML
<b>Unit-2</b>
Preprocessing: Feature scaling, feature selection methods. dimensionality reduction (Principal Component Analysis).
<b>Unit-3</b>
Regression: Linear regression with one variable, linear regression with multiple variables, gradient descent, over-fitting, regularization. Regression evaluation metrics.
<b>Unit-4</b>
Classification: Decision trees, Naive Bayes classifier, logistic regression, k-nearest neighbor classifier, perceptron, multilayer perceptron, neural networks, back-propagation algorithm, Support Vector Machine (SVM). Classification Evaluation metrics
<b>Unit-5</b>
Clustering: Approaches for clustering, distance metrics, K-means clustering, hierarchical clustering

**Text Books:**

Sr.	Title	Author	Publication
1.	Machine Learning	Mitchell, T.M	McGraw Hill Education
2.	An Introduction to Statistical Learning with Applications in R	James, G	Springer
3.	Introduction to Machine Learning	Alpaydin, E.	MIT



# B.Sc. Computer Science 4<sup>th</sup> Year Syllabus

SEMESTER: VII

Core Course

## Course Objective

This course is designed as the first course that introduces programming concepts using Python to Computer Science students. The course focuses on the development of Python programming to solve problems of different domains. It also introduces the concept of object-oriented programming

<b>Course Code:</b> SOS/CSE/CR701 or CH701	<b>Course Title:</b> Introduction to Python Programming
<b>Course Outcomes (COs):</b> On successful completion of the course, students will be able to: <ul style="list-style-type: none"><li>• Understand the basics of programming language</li><li>• Develop, document, and debug modular Python programs.</li><li>• Apply suitable programming constructs and built-in data structures to solve a problem.</li><li>• Use and apply various data objects in Python.</li><li>• Use classes and objects in application programs and handle files.</li></ul>	

## Course Content

<b>Unit-1 Introduction to Programming</b>
Problem solving strategies; Structure of a Python program; Syntax and semantics; Executing simple programs in Python.
<b>Unit-2 Creating Python Programs</b>
Identifiers and keywords; Literals, numbers, and strings; Operators; Expressions; Input/output statements; Defining functions; Control structures (conditional statements, loop control statements, break, continue and pass, exit function), default arguments.
<b>Unit-3 Built-in data structures</b>
Mutable and immutable objects; Strings, built-in functions for string, string traversal, string operators and operations; Lists creation, traversal, slicing and splitting operations, passing list to a function; Tuples, sets, dictionaries and their operations.
<b>Unit-4 Object Oriented Programming</b>
Introduction to classes, objects and methods; Standard libraries
<b>Unit 5 File and exception handling</b>
File handling through libraries; Errors and exception handling.

## Text Books:

Sr.	Title	Author	Publication
1.	Python Programming	Taneja, S	Pearson Education
2.	Introduction to Computing and Problem-Solving using Python	Balaguruswamy E.	McGraw Hill Education



## PYTHON PROGRAMMING LAB

### List of Practical's

1. Write a program to demonstrate different number datatypes in python.
2. Write a program to perform different arithmetic operations on numbers in python.
3. Write a program to create, concatenate and print a string and accessing sub-string from a given string.
4. Write a python script to print the current date in following format "Sun May 29 02:26:23 IST 2017".
5. Write a python program to create, append and remove lists in python.
6. Write a program to demonstrate working with tuples in python.
7. Write a program to demonstrate working with dictionaries in python.
8. Write a python program to find largest of three numbers.
9. Write a python program to convert temperature to and from Celsius to Fahrenheit.
10. Write a python program to construct the following pattern using nested for loop.
11. Write a python program to print prim numbers less than 20.
12. Write a python program to define a module and import a specific function in that module to another program.
13. Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first the second file.
14. Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order.
15. Write a Python class to convert an integer to a roman numeral.



**Course Objective**

This course is intended to provide an introduction into the field of Data Science. Students will develop skills in appropriate technology and basic statistical methods by completing hands-on projects focused on real-world data and addresses the social consequences of data analysis and application

<b>Course Code:</b> SOS/CSE/CR801 or CH801	<b>Course Title:</b> Introduction to Data Science
<b>Course Outcomes (COs):</b>	
Upon course completion, a student will be able to:	
<ul style="list-style-type: none"> <li>• Identify and describe the methods and techniques commonly used in data science.</li> <li>• Demonstrate proficiency with the methods and techniques for obtaining, organizing, exploring, and analyzing data.</li> <li>• Recognize how data analysis, inferential statistics, modeling, machine learning, and statistical computing can be utilized in an integrated capacity.</li> <li>• Create and modify customizable tools for data analysis and visualization per the evaluation of characteristics of the data and the nature of the analysis.</li> <li>• Demonstrate the ability to clean and prepare data for analysis and assemble data from a variety of sources.</li> </ul>	

**Course Content**

<b>Unit-1</b>
Introduction to Data Science – Evolution of Data Science – Data Science Roles – Stages in a Data Science Project – Applications of Data Science in various fields – Data Security Issue
<b>Unit-2</b>
Data Collection and Data Pre-Processing Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization.
<b>Unit-3</b>
Exploratory Data Analytics Descriptive Statistics – Mean, Standard Deviation, Skewness and Kurtosis – Box Plots – Pivot Table – Heat Map – Correlation Statistics – ANOVA.
<b>Unit-4</b>
Model Development Simple and Multiple Regression – Model Evaluation using Visualization – Residual Plot – Distribution Plot – Polynomial Regression and Pipelines – Measures for In-sample Evaluation – Prediction and Decision Making.
<b>Unit-5</b>
Model Evaluation Generalization Error – Out-of-Sample Evaluation Metrics – Cross Validation – Overfitting – Under Fitting and Model Selection – Prediction by using Ridge Regression – Testing Multiple Parameters by using Grid Search

**Text Books:**

Sr.	Title	Author	Publication
1.	Doing Data Science	Cathy O'Neil	O'Reilly
2.	Data Science and Big data Analytics	David Dietrich	EMC
3.	The Intersection of IoT and Data Science	Jojo Moolayil	PACKT





## DATA SCIENCE LAB

### List of Practical's

1. R As Calculator Application
2. Descriptive Statistics In R
3. Reading And Writing Different Types of Datasets
4. Visualizations
5. Correlation And Covariance
6. Regression Model
7. Multiple Regression Model
8. Regression Model for Prediction
9. Classification Model
10. Clustering Model



**Discipline Specific Elective Papers – VII Semester (B.Sc. with Research) \*\*\*\***  
**&**  
**Discipline Major Elective Papers – VII Semester (B.Sc. Honours) \*\*\*\***

**SEMESTER: VII**

**DSE/DME (Elective)**

**Course Objective**

The course introduces the students to the basic concept in the field of satellite communication. This will enable the students to know how to place a satellite in an orbit and about the earth & space segment. The satellite services like broadcasting are also studied thoroughly.

<b>Course Code:</b> SOS/CSE/CE701	<b>Course Title:</b> Satellite Communications
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• To prepare the student to excel in basic knowledge of satellite communication principles.</li> <li>• To provide students with solid foundation in orbital mechanics and launches for the satellite communication</li> <li>• To train the students with the basic knowledge of link design of satellite with a design examples.</li> <li>• To provide the better understanding of multiple access systems and earth station technology.</li> <li>• To prepare the students with knowledge in satellite navigation and GPS and satellite packet communication</li> </ul>	

**Course Content**

<b>Unit-1:</b> Communication Satellite: Orbit and Description: A Brief history of satellite Communication, satellite Frequency Bands, Satellite Systems, Applications, Orbital Period and Velocity, effects of orbital Inclination, Azimuth and Elevation, Coverage angle and slant Range, Eclipse, Orbital Perturbations, Placement of a Satellite in a Geo-Stationary orbit
<b>Unit-2:</b> Satellite Sub-Systems: Attitude and Orbit Control system, TT&C subsystem, Attitude Control subsystem, Power systems, Communication subsystems, Satellite Antenna Equipment. Satellite Link: Basic Transmission Theory, System Noise Temperature and G/T ratio, Basic Link Analysis, Interference Analysis, Design of satellite Links for a specified C/N, (With and without frequency Re-use), Link Budget.
<b>Unit-3:</b> Propagation Effects: Introduction, Atmospheric Absorption, Cloud Attenuation, Tropospheric and Ionospheric Scintillation and Low angle fading, Rain induced attenuation, rain induced cross polarization interference. Multiple Access: Frequency Division Multiple Access (FDMA) - Intermodulation, Calculation of C/N, Time Division Multiple Access (TDMA) -Frame Structure, Burst Structure, Satellite switched TDMA
<b>Unit-4:</b> Earth Station Technology: Transmitters, Receivers, Antennas, Tracking Systems, Terrestrial Interface, Power Test Methods, Lower Orbit Considerations. Satellite Navigation and Global Positioning Systems: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers, GPS C/A Code Accuracy
<b>Unit-5:</b> Satellite Packet Communications: Message Transmission by FDMA: M/G/1 Queue, Message Transmission by TDMA, PURE ALOHA-Satellite Packet Switching, Slotted Aloha, Packet Reservation, Tree Algorithm.

**Recommended Books**

Sr.	Title	Author	Publication
1.	Satellite Communications	Timothy Pratt	Wiley
2.	Satellite Communications Engineering	L. Pritchard	Pearson
3.	3Digital Satellite Communications	T. Ha	McGraw

**Course Objective**

This course introduces students to the fundamentals of information retrieval extending into image retrieval. It lays the theoretical foundation of various essential concepts related to image searches, together with examples of natural and texture image types. It will provide an insight to content-based image retrieval, understanding of the technologies, and solutions of content-based image retrieval.

<b>Course Code:</b> SOS/CSE/CE702	<b>Course Title:</b> Information and Image Retrieval
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• On the successful completion of the course, the student would be able to:</li> <li>• Understand the concept of information retrieval and the information retrieval models.</li> <li>• Understand the working of Text based and content-based image retrieval systems.</li> <li>• Identify and evaluate the use of content-based features in indexing and retrieval of various types of media content</li> <li>• Extract different visual features from images</li> <li>• Understand indexing and the semantics of visual data</li> <li>• Understand query specification and evaluate the retrieval</li> </ul>	

**Course Content**

<b>Unit-1:</b> An example information retrieval problem, the extended Boolean model versus ranked retrieval, the term vocabulary and postings lists: Tokenization, stop words, Normalization (equivalence classing of terms), Stemming and lemmatization, term weighting model: Inverse document frequency, Information retrieval system evaluation
<b>Unit-2:</b> CBIR and feature extraction: Image Retrieval: Multimedia Information retrieval, Text Based Image Retrieval (TBIR), Content Based Image Retrieval (CBIR), Hybrid systems. Architecture of a typical CBIR system, Low-level features of an image: Color – color space, color moments, color histogram, color coherence vector (CCV), color correlogram, invariant color features. Texture – Tamura features, coarseness, contrast, SAR Model, Wavelet transform feature. Shape- Moment invariants, turning angles, Fourier descriptors.
<b>Unit-3:</b> Similarity measures and Performance evaluation: Similarity measures used in content-based image retrieval: Minkowski-form distance, Mahalanobis distance, Canberra distance, Earth Mover distance, Quadratic form distance Performance evaluation used in content-based image retrieval: user Comparison, precision and recall, P-R graph, Average Precision, F-measure, Average Normalized Modified Retrieval Rank
<b>Unit-4:</b> CBIR systems: QBIC: Query by Image Content, VIR, VisualSEEK, WebSEEK, NeTRA, MARS: Multimedia Analysis and Retrieval System, SIMPLiCity.

**Recommended Books**

Sr.	Title	Author	Publication
1.	Introduction to Information Retrieval	C. Manning	Cambridge
2.	Content-Based Image Retrieval: Ideas, Influences, and Current Trends	Vipin Tyagi	Springer

**Course Objective**

The objective of this course is to introduce students to deep learning algorithms and their applications in order to solve real problems.

<b>Course Code:</b> SOS/CSE/CE703	<b>Course Title:</b> Deep Learning
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Describe the feed-forward and deep networks.</li> <li>• Design single and multi-layer feed-forward deep networks and tune various hyper-parameters.</li> <li>• Implement deep neural networks to solve a problem</li> <li>• Analyze performance of deep networks.</li> <li>• Use pre-trained models to solve a problem.</li> </ul>	

**Course Content**

<b>Unit-1:</b> Introduction to neural networks: Artificial neurons, perceptron, computational models of neurons, Structure of neural networks, Multilayer feedforward neural networks (MLFFNN), Backpropagation learning, Empirical risk minimization, bias-variance trade-off, Regularization, output units: linear, SoftMax.
<b>Unit-2:</b> Deep neural networks: Difficulty of training DNNs, Greedy layer wise training, Optimization for training DNN's, Newer optimization methods for neural networks (AdaGrad, RMSProp, Adam), Regularization methods (dropout, drop connect, batch normalization).
<b>Unit-3:</b> Convolution neural networks (CNNs): Introduction to CNN - convolution, pooling, Deep CNNs - LeNet, AlexNet. Training CNNs, weights initialization, batch normalization, hyperparameter optimization, Understanding and visualizing CNNs, using a pre trained convnet
<b>Unit-4:</b> Recurrent neural networks (RNNs): Sequence modeling using RNNs, Backpropagation through time, LongShort Term Memory (LSTM), Bidirectional RNN, Bidirectional LSTM

**Recommended Books**

Sr.	Title	Author	Publication
1.	Deep Learning	Yodhua Bengio	MIT
2.	Deep Learning with python	Francois Chollet	Meaning

**Course Objective**

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.

<b>Course Code:</b> SOS/CSE/CE704	<b>Course Title:</b> Data Mining-I
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Pre-process the data for subsequent data mining tasks</li> <li>• Apply a suitable classification algorithm to train the classifier and evaluate its performance.</li> <li>• Apply appropriate clustering algorithm to cluster the data and evaluate clustering quality</li> <li>• Use association rule mining algorithms and generate frequent item-sets and association rules</li> </ul>	

**Course Content**

<b>Unit-1:</b> 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
<b>Unit-2:</b> Data Pre-processing: Data aggregation, sampling, dimensionality reduction, feature subset selection, feature creation, variable transformation.
<b>Unit-3:</b> 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
<b>Unit-4:</b> Association rule mining: Transaction data-set, frequent itemset, support measure, rule generation, confidence of association rule, Apriori algorithm, Apriori principle
<b>Unit-5:</b> Classification: Naive Bayes classifier, Nearest Neighbour classifier, decision tree, overfitting, confusion matrix, evaluation metrics and model evaluation.

**Recommended Books**

Sr.	Title	Author	Publication
1.	Introduction to Data Mining	Tan P.N	Pearson
2.	Data Mining: Concepts and Techniques	Han J	Morgan
3.	Data Mining and Machine Learning: Fundamental Concepts and Algorithms	Zaki M.	Cambridge

**Course Objective**

This course is designed to provide exposure to more sophisticated algorithms for some tractable problems, some advanced topics in algorithms such as NP Completeness and how to handle NP hard problems in practice.

<b>Course Code:</b> SOS/CSE/CE705	<b>Course Title:</b> Advanced Algorithms
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Understand and develop more sophisticated algorithms using some of the known design techniques.</li> <li>• Identify NP hard problems.</li> <li>• Use polynomial time reductions to prove NP hardness of problems.</li> <li>• Design approximation algorithms for NP hard problems and find their approximation ratio.</li> </ul>	

**Course Content**

<b>Unit-1:</b> More applications of Divide and Conquer, Greedy and Dynamic Programming approaches: Counting Inversions, Closest pair of points, Integer Multiplication, Huffman Code, Segmented Least Squares etc.
<b>Unit-2:</b> Network Flows: Ford Fulkerson algorithm for max flow problem.
<b>Unit-3:</b> Backtracking: Constructing All Subsets, Constructing All Permutations, Constructing all paths in a graph
<b>Unit-4:</b> Polynomial time reductions via gadgets: SAT and 3-SAT problems; Reducing 3-SAT to Independent set, Clique and Vertex cover. Proving NP completeness: Circuit satisfiability, 3-SAT, Sequencing Problems, Graph coloring, Subset sum.
<b>Unit-5:</b> Introduction to Approximation Algorithms: Definition, Concept of approximation factor, Bounding the optimal solution, concept of tight example. Combinatorial Approximation Algorithms: Set cover, Minimizing makespan, k-center. LP based Approximation Algorithms: Approximation algorithms for Vertex cover/Set cover via LP rounding

**Recommended Books**

Sr.	Title	Author	Publication
1.	Algorithm Design	T.H Cormen	Prentice Hall of India
2.	The Design of Approximation Algorithms	D.P. Williamson	Cambridge

**Discipline Specific Elective Papers – VIII Semester (B.Sc. with Research) \*\*\*\***  
**&**  
**Discipline Major Elective Papers – VIII Semester (B.Sc. Honours) \*\*\*\***

**SEMESTER: VIII**

**DSE/DME (Elective)**

**Course Objective**

Internet of Things plays an important role in connecting the things i.e., variety of devices through the Internet. The IoT has emerged as a cutting-edge technology with applications in manufacturing, healthcare, Agriculture, transport, mining, smart cities and many more. This course covers the fundamentals of IoT with its architecture, protocols and Applications. It also covers the overview and programming of two widely used IoT platforms Arduino and Raspberry Pi

<b>Course Code:</b> SOS/CSE/CE801	<b>Course Title:</b> IoT and its Application
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Demonstrate the architecture and functioning of IoT systems including the sensors and microcontrollers with their interfacing and software need considering application areas.</li> <li>• Diagnose the various IoT protocols with detailing of their elements and overall functioning within IoT systems for efficient communication</li> <li>• Develop the software components of IoT system using Arduino/Raspberry Pi Programming.</li> <li>• Design an IoT system to take the benefit of the Clouds for computing and storage considering security issues.</li> </ul>	

**Course Content**

<b>Unit-1:</b> Introduction to Internet of Things: Application areas of IoT, Characteristics of IoT, Things in IoT, IoT stack, Enabling technologies, IoT challenges, IoT levels, IoT and cyber physical system, IoT and WSN
<b>Unit-2:</b> Sensors, Microcontrollers, and Their Interfacing: Sensor interfacing, Types of sensors, Controlling sensors, Microcontrollers, ARM
<b>Unit-3:</b> Protocols for IoT: Messaging protocols, Transport protocols, IPv4, IPv6, URI, Cloud for IoT: IoT and cloud, Fog computing, Security in cloud, Case study
<b>Unit-4:</b> Application Building with IoT: Various application of IoT: Food, Healthcare, Lavatory maintenance, Water quality, Warehouse, Retail, Driver Assistance, Collision impact
<b>Unit-5:</b> Arduino and Raspberry Pi: Arduino: Architecture, Programming and Application Raspberry Pi: Architecture, Programming and Application, IoT Security: Various security issues and need, architecture, requirement, challenges and algorithms

**Recommended Books**

Sr.	Title	Author	Publication
1.	Internet of Things	Vasudevans and Sundaram	Wiley
2.	IoT Fundamentals	D. Hence	Cisco Press
3.	Internet of Things with ARDUINO and BOLT	Ashwin Pajankar	BPB

**Course Objective**

The course introduces the students to distributed algorithms in synchronous and asynchronous network models. The course would give the students hands-on practice to write programs for distributed algorithms using Remote Procedure Call (RPC) or Message Passing Interface (MPI)

<b>Course Code:</b> SOS/CSE/CE802	<b>Course Title:</b> Distributed Algorithms
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Describe Network Models for distributed Algorithms</li> <li>• Develop elementary synchronous distributed algorithms</li> <li>• Develop elementary asynchronous distributed algorithms Syllabus</li> </ul>	

**Course Content**

<b>Unit-1:</b> System Model/Network Models: Synchronous Network Model, Asynchronous System Model, Asynchronous Network Model
<b>Unit-2:</b> Synchronous Network Algorithms: Distributed problems in Synchronous Networks such as Leader Election in a Synchronous Ring. Algorithms in General Synchronous Networks (for example Leader Election in a General Network, Breadth-First Search, Maximal Independent Set etc). Problems of reaching consensus in a distributed network namely, distributed consensus with link failures coordinated Attack Problem (Deterministic Version and Randomized Version) and distributed consensus with link failures (Stopping failures, Introduction to Byzantine Failures). More Consensus Problems such as the k-Agreement etc.
<b>Unit-3:</b> Asynchronous Network Algorithms: Basic Asynchronous Network Algorithms such as Leader Election in a Ring, Leader Election in an Arbitrary Network etc. Logical Time Asynchronous Networks, Adding Logical Time to Asynchronous Algorithms, Applications such as Banking System etc. Basics of Network Resource Allocation (mutual Exclusion, resource allocation etc) and Basics of Asynchronous Networks with Process Failures such as k-Agreement etc.

**Recommended Books**

Sr.	Title	Author	Publication
1.	Distributed Algorithms	Lynch, N	Morgan Kaufmann Publishers
2.	Elements of Distributed Computing	Garg, V	Wiley



**Course Objective**

The objective of this course is to learn about creativity and imagination for making them self- motivated artists with strength in creative vision and concept development

<b>Course Code:</b> SOS/CSE/CE803	<b>Course Title:</b> Multimedia and its Applications
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• understand multimedia with the fundamentals of Art and Design</li> <li>• understand Graphic Design for creating effective visual communication and web Design for global communication through a website</li> </ul>	

**Course Content**

<b>Unit-1:</b> Introduction: Definition Multimedia and uses, applications, Hardware and Software requirements, multimedia presentation and authoring tools, LAN and multimedia, multimedia servers and database: vector graphics, 3-D graphics program, animation techniques, shading, anti-aliasing, morphing: video on demand.
<b>Unit-2:</b> Text and Graphics: Uses of text in multimedia, families and faces of fonts, outline fonts, bitmap fonts, international characters sets and hypertext digital font techniques. Graphics- Introduction, types, color and color models, color palettes, vector drawing, 3-D drawing and rendering, making still images, editing and capturing images.
<b>Unit-3:</b> Audio and Video: Digital representation of sound, MIDI audio, MIDI vs. Digital Audio, Audio file formats, adding sound to your multimedia project, Audio software and hardware, Video basic, how video works, broadcast video standard, Analog video, Digital video, shooting and editing video, video compression and file format.
<b>Unit-4:</b> Animation and multimedia authoring: Introduction, principles, types and uses, cell animation, computer animations, morphing, Animation software compression techniques: need and types of compression- lossy and lossless, CODECs, authoring basic, types of authoring tools.
<b>Unit-5:</b> Multimedia on the web: Introduction, Bandwidth, text on the web- Dynamic and embedded font technology, Audio and video on the web, buffering and streaming, webcasting, video conferencing

**Recommended Books**

Sr.	Title	Author	Publication
1.	Multimedia: Making It Work	Tay Vaughan	McGraw Hill
2.	Computer Graphics and Multimedia	A. P. Godse	Technical Publication
3.	Sound and Video	Lozano	PHI

**Course Objective**

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's.

<b>Course Code:</b> SOS/CSE/CE804	<b>Course Title:</b> Data Mining-II
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Differentiate between partition-based, density-based and hierarchical clustering</li> <li>• Build ensemble models to improve predictive performance of the classifier</li> <li>• Identify anomalies and outliers using supervised and unsupervised techniques</li> <li>• Analyze time-series data and extract patterns from the stamped data</li> <li>• Mine textual data and do topic modelling.</li> </ul>	

**Course Content**

<b>Unit-1:</b> Clustering: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Comparison of different methods
<b>Unit-2:</b> Ensemble Methods: Need of ensemble, Random Forests, Bagging and Boosting.
<b>Unit-3:</b> Anomaly Detection: Outliers and Outlier Analysis, Outlier Detection Methods, Statistical Approaches, Proximity-based and density-based outlier detection, Clustering-based approaches
<b>Unit-4:</b> Mining Text Data: Document Preparation and Similarity, Clustering Methods for Text, Topic Modeling
<b>Unit-5:</b> Stream Mining: Time series basics, Date Ranges, Frequencies, and Shifting, Resampling and moving windows functions, Decay function, Clustering stamped data: STREAM and CluStream

**Recommended Books**

Sr.	Title	Author	Publication
1.	Introduction to Data Mining	Tan P.N.	Pearson
2.	Data Mining: The Textbook,	Agarwal C.	Springer
3.	Data Mining: Introductory and Advanced Topics	Dunham M.	Pearson

**Course Objective**

The course introduces basic graph theory and draws distinction between graph as an abstract structure and real-life situation modeled as network. This course aims to expose the students to the strengths and capabilities of network analysis and their applications through the use of open-source software's.

<b>Course Code:</b> SOS/CSE/CE805	<b>Course Title:</b> Social Network Analysis
<b>Course Outcomes (COs):</b>	
After learning the course, the students should be able to:	
<ul style="list-style-type: none"> <li>• Model real life situation as networks</li> <li>• Identify and apply quantitative network measures to characterize social networks at the local and global level</li> <li>• Generate synthetic networks that satisfy properties of real-world networks</li> <li>• Discover, analyze and evaluate the intrinsic community structure of networks</li> <li>• Model an information diffusion process for predictive analysis of networks</li> </ul>	

**Course Content**

<b>Unit-1:</b> Introduction to Social Network Analysis: Graph theory, random walk, degree distribution, mapping of real-world situation into networks and applications of social network analysis, types of networks
<b>Unit-2:</b> Network Measures: Centrality measures, Page Rank, Hubs and Authority, Assortativity, Transitivity and Reciprocity, Similarity and Structural Equivalence
<b>Unit-3:</b> Network Models: Properties of Real-World Networks, Random Network Model, Small World Network Model, Preferential Attachment Model
<b>Unit-4:</b> Community Structure in Networks: Types of Communities, Community Detection algorithms and evaluation of communities obtained
<b>Unit-5:</b> Information Diffusion in social media: Information Cascades, Diffusion of Innovations, Basic Epidemic Models

**Recommended Books**

Sr.	Title	Author	Publication
1.	Social Network Analysis	Chakraborty T	Wiley
2.	Social Media Mining: An Introduction	Zafarani R	Cambridge
3.	Network Science	Barabási A. L.	Cambridge