

Proposed Syllabus and Scheme of Examination for

B.Sc. Computer Application with Mathematics

(Major)

Under the

Choice Based Credit System

University of Kalyani

December 2017

Computer Application (Major) with Mathematics

Category	No. of Courses	Credit of each course	Total Credit in this Category
Core	12	6	72
Discipline Specific Elective(DSC)	6	6	36
Ability Enhancement Courses(EVS/English)	2	4	08
Skill Enhancement Courses(SEC)	4	3	12
		Total	128

Semester I

Course Code	Name of the Course	Credit
CSM101	Differential Calculus	6
CSM102	Object Oriented Programming in C++	4
CSM103	Computer Fundamentals(C3A)	6
AECC104	Communicative English	4
CSML101	Object Oriented Programming Lab	2
	Total	22

Semester II

Course Code	Name of the Course	Credit
CSM201	Differential Equation	6
CSM202	Data Structure & File Processing	4
CSM203	DBMS(C3B)	4
AECC204	Environmental Studies	4
CSML201	Data Structure Lab	2
CSML202	DBMS Lab	2
	Total	22

Semester III

Course Code	Name of the Course	Credit
CSM301	Real Analysis	6
CSM302	Numerical Computing	4
CSM303	OS and Computer Network	6
SEC304	Logic & Set Theory/Analytical Computing/Number Theory(1L+2P)	3
CSML301	Numerical Computing Lab	2
	Total	21

Semester IV

Course Code	Name of the Course	Credit
CSM401	Algebra	6
CSM402	Design & Analysis of Algorithm	4
CSM403	Multimedia Systems & Applications(C3D)	6
SEC404	Vector Calculus/Transportation & Game Theory/ Probability & Statistics(1L+2P)	3
CSML401	Design & Analysis of Algorithm Lab	2
	Total	21

Semester V

Course Code	Name of the Course	Credit
SEC501	Computer Graphics/Ecommerce/Combinatics (1L+2P)	3
DSE502	Matrices/Integral Calculus/Linear Algebra(DSE1A))	6
DSE503	OS/Data Mining/Cryptography(DSE2A)	6
DSE504	Industrial Training(DSE3A)	6
	Total	21

Semester VI

Course Code	Name of the Course	Credit
SEC601	Modeling & Simulation/Graph Theory/Boolean Algebra(1L+2P)	3
DSE602	Differential Equation/Complex Analysis/Linear Programming(DSE1B)	6
DSE603	Information Security/Data Science/Computer Networks(DSE2B)	6
DSE604	Project(DSE3B)	6
	Total	21

Total Credit: 22+22+21+21+21+21=128

Differential Calculus:

Limit and Continuity (ϵ and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(1+x)$, $(1+x)^m$, Maxima and Minima, Indeterminate forms.

Books Recommended

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

Object Oriented Programming in C++:

Programming Concepts: Algorithm and its characteristics, pseudo code / flow chart, program, identifiers, variables, constants, primitive data types, expressions, structured data types, arrays, compilers and interpreters.

Statements: Assignment statement, if then else statements, switch statement, looping statements while, do while, for, break, continue, input/output statements, functions/procedures.

Object

Oriented Concepts: Abstraction, encapsulation, objects, classes, methods, constructors, inheritance, polymorphism, static and dynamic binding, overloading. Program Development:

Object oriented analysis, design, unit testing & debugging, system testing & integration, maintenance.

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input using the extraction operator \gg and cin , output using the insertion operator \ll and cout , preprocessor directives, increment ($++$) and decrement operations ($--$), creating a C++ program, input/output, relational operators, logical operators and logical expressions, if and if ... else statement, switch and break statements.

“for”, “while” and “do – while” loops, break and continue statement, nested control statement, value returning functions, void functions, value versus reference parameters, local and global variables, static and automatic variables, enumeration type, one dimensional array, two dimensional array, character array, pointer data and pointer variables.

Books Recommended

1. Richard Johnson, *An Introduction to Object-Oriented Application Development*, Thomson Learning, 2006
2. B. Stroustrup, *The C++ Programming Language*, Addison Wesley, 2004.

Computer Fundamentals(C3A):

Introduction: Introduction to computer system, uses, types.

Data Representation: Number systems and character representation, binary arithmetic

Human Computer Interface: Types of software, Operating system as user interface, utility programs

Devices: Input and output devices (with connections and practical demo), keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, plotter

Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks

Computer Organisation and Architecture: C.P.U., registers, system bus, main memory unit, cache memory, Inside a computer, SMPS, Motherboard, Ports and Interfaces, expansion cards, ribbon cables, memory chips, processors.

Overview of Emerging Technologies: Bluetooth, cloud computing, big data, data mining, mobile computing and embedded systems.

Use of Computers in Education and Research: Data analysis, Heterogeneous storage, e-Library, Google Scholar, Domain specific packages such as SPSS, Mathematica etc.

Reference Books:

1. A. Goel, *Computer Fundamentals*, Pearson Education, 2010.
2. P. Aksoy, L. DeNardis, *Introduction to Information Technology*, Cengage Learning, 2006
3. P. K.Sinha, P. Sinha, *Fundamentals of Computers*, BPB Publishers, 2007

Communicative English:

Introduction: Theory of Communication, Types and modes of Communication

Language of Communication:

- Verbal and Non-verbal
(Spoken and Written)
- Personal, Social and Business
- Barriers and Strategies
- Intra Personal, Inter Personal and Group Communication

Speaking Skills:

- Monologue
- Dialogue

- Group Discussion
- Effective Communication/ Mis- Communication
- Interview
- Public Speech

Reading and Understanding

- Close Reading
- Comprehension
- Summary Paraphrasing
- Analysis and Interpretation
- Translation(from Indian language to English and vice-versa)

Literary/Knowledge Texts

Writing Skills

- Documenting
- Report Writing
- Making notes
- Letter Writing

The Communicative Language Course in English is a **three-tiered** structure, addressing different levels of language learning acquired in school. The three streams **A, B** and **C** are offered to students who have studied English up to class XII, class X and class VIII **respectively**.

Following is a list of **Recommended Readings** to engage with various genres as part of the process of enhancing Listening, Reading, Writing and Speaking skills.

1. *Language through Literature* (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brat iBiswas
2. *Fluency in English Part II* Oxford University Press, 2006
3. *Business English*, Pearson, 2008

Object Oriented Programming Lab:

1. WAP to print the sum and product of digits of an integer.
2. WAP to reverse a number.
3. WAP to compute the sum of the first n terms of the following series
 $S = 1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \dots$
4. WAP to compute the sum of the first n terms of the following series
 $S = 1 - 2 + 3 - 4 + 5 - \dots$
5. Write a function that checks whether a given string is Palindrome or not. Use this function to find whether the string entered by user is Palindrome or not.
6. Write a function to find whether a given no. is prime or not. Use the same to generate the prime numbers less than 100.
7. WAP to compute the factors of a given number.
8. Write a macro that swaps two numbers. WAP to use it.

9. WAP to print a triangle of stars as follows (take number of lines from user):

```
*  
***  
*****  
*****  
*****
```

10. WAP to perform following actions on an array entered by the user:

- i) Print the even-valued elements
- ii) Print the odd-valued elements
- iii) Calculate and print the sum and average of the elements of array
- iv) Print the maximum and minimum element of array
- v) Remove the duplicates from the array
- vi) Print the array in reverse order

The program should present a menu to the user and ask for one of the options. The menu should also include options to re-enter array and to quit the program.

11. WAP that prints a table indicating the number of occurrences of each alphabet in the text entered as command line arguments.

12. Write a program that swaps two numbers using pointers.

13. Write a program in which a function is passed address of two variables and then alter its contents.

14. Write a program which takes the radius of a circle as input from the user, passes it to another function that computes the area and the circumference of the circle and displays the value of area and circumference from the main() function.

15. Write a program to find sum of n elements entered by the user. To write this program, allocate memory dynamically using malloc() / calloc() functions or new operator.

16. Write a menu driven program to perform following operations on strings:

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- a) Show address of each character in string
- b) Concatenate two strings without using strcat function.
- c) Concatenate two strings using strcat function.
- d) Compare two strings
- e) Calculate length of the string (use pointers)
- f) Convert all lowercase characters to uppercase
- g) Convert all uppercase characters to lowercase
- h) Calculate number of vowels
- i) Reverse the string

17. Given two ordered arrays of integers, write a program to merge the two-arrays to get an ordered array.

18. WAP to display Fibonacci series (i)using recursion, (ii) using iteration

19. WAP to calculate Factorial of a number (i)using recursion, (ii) using iteration

20. WAP to calculate GCD of two numbers (i) with recursion (ii) without recursion.
21. Create Matrix class using templates. Write a menu-driven program to perform following Matrix operations (2-D array implementation):
 a) Sum b) Difference c) Product d) Transpose
22. Create the Person class. Create some objects of this class (by taking information from the user). Inherit the class Person to create two classes Teacher and Student class. Maintain the respective information in the classes and create, display and delete objects of these two classes (Use Runtime Polymorphism).
23. Create a class Triangle. Include overloaded functions for calculating area. Overload assignment operator and equality operator.
24. Create a class Box containing length, breath and height. Include following methods in it:
 a) Calculate surface Area
 b) Calculate Volume
 c) Increment, Overload ++ operator (both prefix & postfix)
 d) Decrement, Overload -- operator (both prefix & postfix)
 e) Overload operator == (to check equality of two boxes), as a friend function
 f) Overload Assignment operator
 g) Check if it is a Cube or cuboid
- Write a program which takes input from the user for length, breath and height to test the above class.
25. Create a structure Student containing fields for Roll No., Name, Class, Year and Total Marks. Create 10 students and store them in a file.
26. Write a program to retrieve the student information from file created in previous question and print it in following format:
 Roll No. Name Marks
27. Copy the contents of one text file to another file, after removing all whitespaces.
28. Write a function that reverses the elements of an array in place. The function must accept only one pointer value and return void.
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29. Write a program that will read 10 integers from user and store them in an array. Implement array using pointers. The program will print the array elements in ascending and descending order.

SEMESTER II

Differential Equation:

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

Data Structure & File Processing:

Basic Data Structures: Abstract data structures- stacks, queues, linked lists and binary trees. Sets: Dictionary implementation, use of priority queues, hashing, binary trees, balanced trees, sets with merge-find operations.

Searching: Internal and external searching, use of hashing and balancing techniques.

Memory Management: Garbage collection algorithms for equal sized blocks, storage allocation for objects with mixed size, buddy systems.

Physical Devices: Characteristics of storage devices such as disks and tapes, I/O buffering. Basic File System Operations: Create, open, close, extend, delete, read-block, write-block, protection mechanisms.

File Organizations: Sequential, indexed sequential, direct, inverted, multi-list, directory systems, Indexing using B-tree, B+ tree and their variants, hashing – hash function, collision handling methods, extendible hashing.

Books Recommended

1. M.T. Goodrich, R. Tamassia and D. Mount, *Data Structures and Algorithms in C++*, John Wiley and Sons, Inc., 2004.
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, *Introduction to Algorithms*, 2nd Ed., Prentice-Hall of India, 2006.
3. Robert L. Kruse and A.J. Ryba, *Data Structures and Program Design in C++*, Prentice Hall, Inc., NJ, 1998.
4. B. Stroustrup, *The C++ Programming Language*, Addison Wesley, 2004
5. D.E. Knuth, *Fundamental Algorithms* (Vol. I), Addison Wesley, 1997

DBMS(C3B):

Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools

E-R Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams

Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF

Structured Query Language: SQL queries, create a database table, create relationships between database tables, modify and manage tables, queries, forms, reports, modify, filter and view data.

Reference Books :

1. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008
2. R. Elmasri, S. Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition, 2007
3. MySQL : Reference Manual

Environmental Studies:

Concept of Environment: Definition and concept of environment; Types and components of environment (Lithosphere, Atmosphere, Hydrosphere, Biosphere); Scope and multidisciplinary nature of the subject; Man-environment relationships; Public awareness – Earth Summits, recent Conventions on climate change

Concepts of Ecology: Subdivisions of ecology; Ecological classification (hydrophytes, xerophytes, halophytes, *etc.*) and their morphological, physiological and biochemical adaptation; Ecological factors -climatic, edaphic, physiographic and biotic; Limiting factor and Shelford's Law, Liebig law; Concept of Biological clock, circadian rhythm

Concepts of Ecosystem and Biomes: Structural and functional aspects of major ecosystems (with special reference to freshwater, mangrove and desert); Trophic levels, Ecological pyramids, food chain and food webs; Energy flow in ecosystem - Energy flow models
Biomes: Concept, types and characteristics of biome types

Renewable and non-renewable resources : Forest, Water, Minerals, Food, energy

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem. Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem :-

- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: Introduction – Definition : genetic, species and ecosystem diversity.

Environmental Pollution: Cause, effects and control measures of :-

- a. Air pollution
- b. Water pollution
- c. Soil pollution
- d. Marine pollution
- e. Noise pollution
- f. Thermal pollution
- g. Nuclear hazards

Data Structure Lab:

1. Write a program to search an element from a list. Give user the option to perform Linear or Binary search. Use Template functions.
2. WAP using templates to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort.
3. Implement Linked List using templates. Include functions for insertion, deletion and search of a number, reverse the list and concatenate two linked lists (include a function and also overload operator +).
4. Implement Doubly Linked List using templates. Include functions for insertion, deletion and search of a number, reverse the list.
5. Implement Circular Linked List using templates. Include functions for insertion, deletion and search of a number, reverse the list.
6. Perform Stack operations using Linked List implementation.
7. Perform Stack operations using Array implementation. Use Templates.
8. Perform Queues operations using Circular Array implementation. Use Templates.
9. Create and perform different operations on Double-ended Queues using Linked List implementation.
10. WAP to scan a polynomial using linked list and add two polynomial.
11. WAP to calculate factorial and to compute the factors of a given no. (i)using recursion, (ii) using iteration
12. (ii) WAP to display fibonacci series (i)using recursion, (ii) using iteration
13. WAP to calculate GCD of 2 number (i) with recursion (ii) without recursion
14. WAP to create a Binary Search Tree and include following operations in tree:
 - (a) Insertion (Recursive and Iterative Implementation)
 - (b) Deletion by copying
 - (c) Deletion by Merging
 - (d) Search a no. in BST
 - (e) Display its preorder, postorder and inorder traversals Recursively
 - (f) Display its preorder, postorder and inorder traversals Iteratively
 - (g) Display its level-by-level traversals

- (h) Count the non-leaf nodes and leaf nodes
- (i) Display height of tree
- (j) Create a mirror image of tree
- (k) Check whether two BSTs are equal or not
- 15. WAP to convert the Sparse Matrix into non-zero form and vice-versa.
- 16. WAP to reverse the order of the elements in the stack using additional stack.
- 17. WAP to reverse the order of the elements in the stack using additional Queue.
- 18. WAP to implement Diagonal Matrix using one-dimensional array.
- 19. WAP to implement Lower Triangular Matrix using one-dimensional array.
- 20. WAP to implement Upper Triangular Matrix using one-dimensional array.
- 21. WAP to implement Symmetric Matrix using one-dimensional array.
- 22. WAP to create a Threaded Binary Tree as per inorder traversal, and implement operations like finding the successor / predecessor of an element, insert an element, inorder traversal.
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- 23. WAP to implement various operations on AVL Tree.

DBMS Lab:

Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College.

LibraryBooks (Accession number, Title, Author, Department, PurchaseDate, Price)

IssuedBooks (Accession number, Borrower)

- a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.
- b) Delete the record of book titled "Database System Concepts".
- c) Change the Department of the book titled "Discrete Maths" to "CS".
- d) List all books that belong to "CS" department.
- e) List all books that belong to "CS" department and are written by author "Navathe".
- f) List all computer (Department="CS") that have been issued.
- g) List all books which have a price less than 500 or purchased between "01/01/1999" and "01/01/2004".
- 2) Create a database having three tables to store the details of students of Computer Department in your college.
 - Personal information about Student (College roll number, Name of student, Date of birth, Address, Marks(rounded off to whole number) in percentage at 10 + 2, Phone number)
 - Paper Details (Paper code, Name of the Paper)
 - Student's Academic and Attendance details (College roll number, Paper code, Attendance, **15Marks in home examination**).
- a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each

table.

b) Design a query that will return the records (from the second table) along with the name of student from the first table, related to students who have more than 75% attendance and more than 60% marks in paper 2.

c) List all students who live in “Delhi” and have marks greater than 60 in paper 1.

d) Find the total attendance and total marks obtained by each student.

e) List the name of student who has got the highest marks in paper 2.

3) Create the following tables and answer the queries given below:

Customer (CustID, email, Name, Phone, ReferrerID)

Bicycle (BicycleID, DatePurchased, Color, CustID, ModelNo)

BicycleModel (ModelNo, Manufacturer, Style)

Service (StartDate, BicycleID, EndDate)

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) List all the customers who have the bicycles manufactured by manufacturer “Honda”.

c) List the bicycles purchased by the customers who have been referred by customer “C1”.

d) List the manufacturer of red colored bicycles.

e) List the models of the bicycles given for service.

4) Create the following tables, enter at least 5 records in each table and answer the queries given below.

EMPLOYEE (Person_Name, Street, City)

WORKS (Person_Name, Company_Name, Salary)

COMPANY (Company_Name, City)

MANAGES (Person_Name, Manager_Name)

a) Identify primary and foreign keys.

b) Alter table employee, add a column “email” of type varchar(20).

c) Find the name of all managers who work for both Samba Bank and NCB Bank.

d) Find the names, street address and cities of residence and salary of all employees who work

for “Samba Bank” and earn more than \$10,000.

e) Find the names of all employees who live in the same city as the company for which they work.

f) Find the highest salary, lowest salary and average salary paid by each company.

g) Find the sum of salary and number of employees in each company.

h) Find the name of the company that pays highest salary.

5) Create the following tables, 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, Qunatity)

- a) Identify primary and foreign keys.
- b) Get supplier numbers for suppliers in Paris with status>20.
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- c) Get suppliers details for suppliers who supply part P2. Display the supplier list in increasing order of supplier numbers.
- d) Get suppliers names for suppliers who do not supply part P2.
- e) For each shipment get full shipment details, including total shipment weights.
- f) Get all the shipments where the quantity is in the range 300 to 750 inclusive.
- g) Get part nos. for parts that either weigh more than 16 pounds or are supplied by suppliers S2, or both.
- h) Get the names of cities that store more than five red parts.
- i) Get full details of parts supplied by a supplier in Delhi.
- j) Get part numbers for part supplied by a supplier in Allahabad to a project in Chennai.
- k) Get the total number of project supplied by a supplier (say, S1).
- l) Get the total quantity of a part (say, P1) supplied by a supplier (say, S1).

Semester III

Real Analysis:

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of \mathbb{R} , Archimedean property of \mathbb{R} , intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Sequences and series of functions, Pointwise and uniform convergence. M_n -test, M -test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Books Recommended

1. T.M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

Numerical Computing:

Solution to Transcendental and Polynomial Equations: Iterative methods, bisection method, secant method, Newton-Raphson method, fixed point iteration, methods for finding complex roots. Matrices and Linear System of Equations: LU decomposition method for solving systems of equations, Symmetric positive definite matrices and least square approximation, iterative algorithms for linear equations.

Interpolation: Polynomial interpolation, Newton-Gregory, Stirling's, Bessel's and Lagrange's interpolation formula, Newton's divided differences interpolation formulae. Curve fitting:

Bspline and Approximation: Fitting linear and non-linear curves, weighted least square approximation, method of least square for continuous functions.

Numerical Differentiation and Integration: Numerical differentiation and errors in numerical differentiation, Newton-Cotes formulae, trapezoidal rule, Simpson's rule, Gaussian integration.

Numerical Solutions of Ordinary Differential Equations: Picard's and Taylor's series, Euler's and Runge-Kutta (RK) methods. Finite Element Method: Boundary value problems, Rayleigh and Galerkin methods of approximation, applications.

Books Recommended

1. K.E. Atkinson, W. Han, *Elementary Numerical Analysis*, 3rd Ed., Wiley, 2003.
2. C. Xavier, S.S. Iyengar, *Introduction to Parallel Algorithms*, Wiley-Interscience, 1998.
3. A. Kharab, R.B. Guenther, *An Introduction to Numerical Methods: A MATLAB Approach*, 1st Ed., Chapman and Hall/CRC, 2001.
4. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, 2007.
5. S.R. Otto and J.P. Denier, *An Introduction to Programming and Numerical Methods in MATLAB*, Springer, 2005.
6. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 7th Ed., New Age International Publishers, 2007

OS and Computer Network:

OS:

Introduction: Operating System as a resource manager, operating system classification, system calls, traps, architectures for operating systems. Device Management: Goals of I/O software,

Design of device drivers. Processor Management: Process overview, process states and state transition, multiprogramming, multi-tasking, levels of schedulers and scheduling algorithms. Process Synchronization - Critical section and mutual exclusion problem, classical synchronization problems, deadlock prevention. Multithreading Memory Management: Classical memory management techniques, paging, segmentation, virtual memory. File Management: Overview of file management system, disk space management, directory structures. Protection domains, access control lists, protection models.

Books Recommended

1. A.S. Tanenbaum, *Modern Operating Systems*, 3rd Ed., Prentice-Hall of India, 2008.
2. William Stallings, *Operating Systems: Internals and Design Principles*, 5th Ed., Prentice-Hall of India, 2006.
3. Gary Nutt, *Operating Systems: A Modern Approach*, 3rd Ed., Addison Wesley, 2004.
4. D.M. Dhamdhere, *Operating Systems: A Concept Based Approach*, 2nd Ed., Tata McGrawHill, 2007.

Computer Network:

Basic Concepts: Components of data communication, distributed processing, Line configuration, topology, transmission mode, and categories of networks. OSI and TCP/IP Models: Layers and their functions, comparison of models. Digital Transmission: Interfaces and Modems: DTE-DCE Interface, modems, cable modems. Transmission Media: Guided and unguided, Attenuation, distortion, noise, throughput, propagation speed and time, wavelength, Shannon Capacity. Telephony: Multiplexing, error detection and correction, Many to one, one to many, WDM, TDM, FDM, circuit switching, packet switching and message switching. Data Link control protocols: Line discipline, flow control, error control, synchronous and asynchronous protocols overview. ISDN: Services, historical outline, subscriber's access, ISDN, Layers, and broadband ISDN.

Devices: Repeaters, bridges, gateways, routers, The Network Layer, Design Issues, Network Layer Addressing and Routing concepts (Forwarding Function, Filtering Function); Routing Methods (Static and dynamic routing, Distributed routing, Hierarchical Routing); Distance Vector Protocol, Link State protocol.

Transport and upper layers in OSI Model: Transport layer functions, connection management, Functions of session layers, Presentation layer, and Application layer.

Books Recommended

1. A.S. Tanenbaum, *Computer Networks*, 4th Ed., Pearson Education Asia, 2003.
2. Behrouz A. Forouzan, *Data Communication and Networking*, 2nd Ed., Tata McGraw Hill.
3. D. E. Comer, *Internetworking with TCP/IP*, Pearson Education Asia, 2001.
4. William Stallings, *Data and Computer Communications*, 7th Ed., Pearson education Asia, 2002.

Logic & Set Theory/Analytical Computing/Number :

Logic and Sets

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Book Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

Analytical Computing:

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd. 2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994

Analytic Number:

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius inversion formula, the greatest integer function, Euler's phi-function.

Books Recommended:

1. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
3. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007

Numerical Computing Lab:

Find the roots of the equation by bisection method.

2. Find the roots of the equation by secant/Regula-Falsi method.
3. Find the roots of the equation by Newton's method.
4. Find the solution of a system of nonlinear equation using Newton's method.
5. Find the solution of tridiagonal system using Gauss Thomas method.
6. Find the solution of system of equations using Jacobi/Gauss-Seidel method.
7. Find the cubic spline interpolating function.
8. Evaluate the approximate value of finite integrals using Gaussian/Romberg integration.
9. Solve the boundary value problem using finite difference method.

Note: Programming is to be done in any one of Computer Algebra Systems:
MATLAB / MATHEMATICA / MAPLE.

Semester IV

Algebra:

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n . Cyclic groups from number systems, complex roots of unity, circle group, the general linear group $GL_n(n, R)$, groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group $Sym(n)$, Group of quaternions. Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n , ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p , Q , R , and C . Field of rational functions.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publication, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984

Design & Analysis of Algorithm:

Introduction: RAM model, $O(\log n)$ bit model. Review of data structures: Balanced trees, Mergeable sets. Algorithm Design Techniques: Iterative techniques, Divide and conquer, dynamic programming, greedy algorithms.

Searching and Sorting Techniques: Review of elementary sorting techniques-selection sort, bubble sort, insertion sort, more sorting techniques-quick sort, heap sort, merge sort, shell sort, external sorting.

Lower bounding techniques: Decision Trees, Adversaries. **String Processing:** KMP, BoyreMoore, Robin Karp algorithms.

Introduction to randomized algorithms: Random numbers, randomized Qsort, randomly Built BST **Number Theoretic Algorithms:** GCD, Addition and Multiplication of two large numbers, polynomial arithmetic, Fast-Fourier Transforms.

Graphs: Analysis of Graph algorithms Depth-First Search and its applications, minimum Spanning Trees and Shortest Paths. **Introduction to Complexity Theory:** Class P, NP, NP-Hard, NP Completeness. **Introduction to Approximation Algorithms**

Books Recommended

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, *Introduction to Algorithms*, PrenticeHall of India, 2006.
2. J. Kleinberg and E. Tardos, *Algorithms Design*, Pearson Education, 2006.
3. S. Baase, *Computer Algorithms: Introduction to Design and Analysis*, Addison Wesley, 1999.
4. A.V. Levitin, *Introduction to the Design and Analysis of Algorithms*, Pearson Education, 2006

Multimedia Systems & Applications(C3D):

Multimedia: Introduction to multimedia, components, uses of multimedia, multimedia applications, virtual reality.

Text: Fonts & Faces, Using Text in Multimedia, Font Editing & Design Tools, Hypermedia & Hypertext.

Images: Still Images – bitmaps, vector drawing, 3D drawing & rendering, natural light & colors, computerized colors, color palettes, image file formats.

Sound: Digital Audio, MIDI Audio, MIDI vs Digital Audio, Audio File Formats.

Video: How video works, analog video, digital video, video file formats, video shooting and editing.

Animation: Principle of animations, animation techniques, animation file formats.

Internet and Multimedia: www and HTML, multimedia on the web – web servers,

web browsers, web page makers and site builders.

Making Multimedia: Stages of a multimedia project, Requirements to make good multimedia, Multimedia Hardware - Macintosh and Windows production Platforms, Hardware peripherals - Connections, Memory and storage devices, Multimedia software and Authoring tools.

References:

1. Tay Vaughan, "Multimedia: Making it work", TMH, Eighth edition.
2. Ralf Steinmetz and Klara Naharstedt, "Multimedia: Computing, Communications Applications", Pearson.
3. Keyes, "Multimedia Handbook", TMH.
4. K. Andleigh and K. Thakkar, "Multimedia System Design", PHI.

Vector Calculus/Transportation & Game Theory/ Probability & Statistics:

Vector Calculus

Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence and curl.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

Transportation and Game Theory

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.

Probability and Statistics

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller and John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007

Design & Analysis of Algorithm Lab:

1. i. Implement Insertion Sort (The program should report the number of comparisons)
ii. Implement Merge Sort(The program should report the number of comparisons)
2. Implement Heap Sort(The program should report the number of comparisons)
3. Implement Randomized Quick sort (The program should report the number of comparisons)
4. Implement Radix Sort
5. Create a Red-Black Tree and perform following operations on it:
 - i. Insert a node
 - ii. Delete a node
 - iii. Search for a number & also report the color of the node containing this number.
6. Write a program to determine the LCS of two given sequences
7. Implement Breadth-First Search in a graph
8. Implement Depth-First Search in a graph
9. Write a program to determine the minimum spanning tree of a graph

For the algorithms at S.No 1 to 3 test run the algorithm on 100 different inputs of sizes varying from 30 to 1000. Count the number of comparisons and draw the graph. Compare it with a graph of $n \log n$

Semester V

Computer Graphics/Ecommerce/Combinatics:

Computer Graphics

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices. Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing.

Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn and M.P. Baker, *Computer Graphics*, 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, *Computer Graphics: Principals and Practices*, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, *Procedural Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 2001.
4. D.F. Rogers and A.J. Admas, *Mathematical Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 1990

Electronic Commerce

Building Blocks of Electronic Commerce: Introduction, internet and networking technologies, Internet and network protocols, web server scalability, software technologies for building Ecommerce applications, distributed objects, object request brokers, component technology, web services, web application architectures.

Design of auction, optimization algorithms, for market places, multi-agent systems.

Global E-commerce and Law: Cyber law in India. Comparative evaluation of Cyber laws of certain countries.

Books Recommended

1. E.M. Awad, *Electronic Commerce from Vision to Fulfillment*, 3rd Ed., Prentice-Hall of India, 2006
2. P.T. Joseph, *E-Commerce: An Indian Perspective*, Prentice-Hall of India, 2007.
3. Scott Bonneau, Tammy Kohl, Jeni Tennison, Jon Duckett and Kevin Williams, *XML Design Handbook*, Wrox Press Ltd., 2003.
4. Michael Cheshar, Ricky Kaura, and Peter Linton, *Electronic Business and Commerce*, Springer, 2003.
5. W.J. Pardi, *XML in Action: Learn to Quickly Create Dynamic, Data-driven Sites with the Web's Hottest New Technology*, Prentice Hall of India, 1999.
6. P. Weill and M.R. Vitale, *Place to Space: Migrating to eBusiness Models*, Harvard Business School Press, 2001.
7. D. Whiteley, *E-commerce: Strategy, Technologies and Applications*, Tata McGraw-Hill Edition, 2001.
8. M. Fitzgerald, *Building B2B Applications with XML: A Resource Guide*, John Wiley and Sons, Inc., 2001

Combinatorial Optimization

Introduction: Optimization problems, neighbourhoods, local and global optima, convex sets and functions, simplex method, degeneracy; duality and dual simplex algorithm, computational considerations for the simplex and dual simplex algorithms-Dantzig-Wolfe algorithms.

Integer Linear Programming: Cutting plane algorithms, branch and bound technique and approximation algorithms for travelling salesman problem.

Books Recommended

1. C.H. Papadimitriou and K. Steiglitz, *Combinatorial Optimization: Algorithms and Complexity*, Prentice-Hall of India, 2006
2. K. Lange, *Optimization*, Springer, 2004.
3. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, John Wiley and Sons, 2004.
4. H.A. Taha, *Operations Research: An Introduction*, 8th Ed., Prentice Hall, 2006

Matrices/Integral Calculus/Linear Algebra:

Matrices

R , R_2 , R_3 as vector spaces over R . Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R_2 , R_3 . Translation, Dilation, Rotation, Reflection in a point, line and plane.

Matrix form of basic geometric transformations. Interpretation of eigen values and eigenvectors for such transformations and eigen spaces as invariant subspaces. Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3.

Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.

Books Recommended

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, *Theory and Problems of Matrix Operations*, Tata McGraw Hill, 1989.

Integral Calculus

Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Double and Triple integrals.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.

Linear Algebra

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate

matrix.

Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., PrenticeHall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007

OS/Data Mining/Cryptography:

OS:

Introduction: Operating System as a resource manager, operating system classification, system calls, traps, architectures for operating systems. Device Management: Goals of I/O software, Design of device drivers. Processor Management: Process overview, process states and state transition, multiprogramming, multi-tasking, levels of schedulers and scheduling algorithms. Process Synchronization - Critical section and mutual exclusion problem, classical synchronization problems, deadlock prevention. Multithreading Memory Management: Classical memory management techniques, paging, segmentation, virtual memory. File Management: Overview of file management system, disk space management, directory structures. Protection domains, access control lists, protection models.

Books Recommended

1. A.S. Tanenbaum, *Modern Operating Systems*, 3rd Ed., Prentice-Hall of India, 2008.
2. William Stallings, *Operating Systems: Internals and Design Principles*, 5th Ed., Prentice-Hall of India, 2006.
3. Gary Nutt, *Operating Systems: A Modern Approach*, 3rd Ed., Addison Wesley, 2004.
4. D.M. Dhamdhere, *Operating Systems: A Concept Based Approach*, 2nd Ed., Tata McGrawHill, 2007.

Data Mining

Overview: The process of knowledge discovery in databases, predictive and descriptive data mining techniques, supervised and unsupervised learning techniques. Techniques of Data Mining: Link analysis, predictive modeling, database segmentation, score functions for data mining algorithms, Bayesian techniques in data mining. Issues in Data Mining: Scalability and data management issues in data mining algorithms, parallel and distributed data mining, privacy, social, ethical issues in KDD and data mining, pitfalls of KDD and data mining.

Books Recommended

1. Margaret H. Dunham, *Data Mining: Introductory and Advanced Topics*, Pearson, 2002.

2. Jiawei Han and Micheline Kamber, *Data Mining: Concepts and Techniques*, 2nd Ed., Morgan Kaufmann, 2006.
3. Arun Pujari, *Data Mining Techniques*, University Press, 2001.
4. D. Hand, H. Mannila and P. Smyth, *Principles of Data Mining*, Prentice-Hall of India, 2006.
5. G.K. Gupta, *Introduction to Data Mining with Case Studies*, Prentice-Hall of India, 2006

Cryptography

Elementary number theory: Prime numbers, Fermat's and Euler's theorems, Testing for primality, Chinese remainder theorem, discrete logarithms. Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form $GF(p)$, Polynomial Arithmetic, Finite fields of the form $GF(2)$. Data Encryption Techniques: Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems. Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.

Book Recommended

1. W. Stallings, *Cryptography and Network Security Principles and Practices*, 4th Ed., PrenticeHall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing*, 3rd Ed., Prentice-Hall of India, 2007.
3. M.Y. Rhee, *Network Security*, John Wiley and Sons, NY, 2002.

Semester VI

Modeling & Simulation/Graph Theory/Boolean Algebra:

Modeling and Simulation

Systems and environment: Concept of model and model building, model classification and representation, Use of simulation as a tool, steps in simulation study.

Continuous-time and Discrete-time systems: Laplace transform, transfer functions, state space models, order of systems, z-transform, feedback systems, stability, observability, controllability.

Statistical Models in Simulation: Common discrete and continuous distributions, Poisson process, empirical distributions.

Random Numbers: Properties of random numbers, generation of pseudo random numbers, techniques of random number generation, tests for randomness, random variate generation using inverse transformation, direct transformation, convolution method, acceptance-rejection.

Books Recommended

1. Narsingh Deo, *System Simulation with Digital Computer*, Prentice Hall of India, 1999.
2. Averill Law, *Simulation Modeling and Analysis*, 3rd Ed., Tata McGraw-Hill, 2007.
3. G. Gordan, *System Simulation*, 2nd Ed., Pearson Education, 2007.
4. A.F. Seila, V. Ceric and P. Tadikamalla, *Applied Simulation Modeling* (International Student

Edition), Thomson Learning, 2004.

5. Jerry Banks, *Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice*, Wiley Inter Science, 1998.

6. J. Banks, J.S. Carson, B.L. Nelson, *Discrete Event System Simulation*, 4th Ed., Prentice Hall of India, 2004.

7. N.A. Kheir, *Systems Modeling and Computer Simulation*, Marcel Dekker, 1988.

8. B.P. Zeigler, T.G. Kim, and H. Praehofer, *Theory of Modeling and Simulation*, 2nd Ed., Academic Press, 2000

Graph Theory

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.

2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004

Boolean Algebra

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms.

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Books Recommended

1. B A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press,

Cambridge, 1990.

2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Differential Equation/Complex Analysis/Linear Programming:

Difference Equations

Difference Calculus: Introduction, The Difference Operator, Summation, Generating Functions and Approximate Summation.

Linear Difference Equations: First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear

Equations that can Be Linearized, The z-Transform.

Stability Theory: Initial Value Problems for Linear Systems, Stability of Linear Systems, Phase Plane Analysis for Linear Systems, Fundamental Matrices and Floquet Theory, Stability of Nonlinear Systems, Chaotic Behavior.

Asymptotic Methods: Introduction, Asymptotic Analysis of Sums, Linear Equations, Nonlinear Equations.

Books Recommended

1. Walter Kelley and Allan Peterson, *Difference Equations, An Introduction with Applications*, Academic Press, 1991.
2. Calvin Ahlbrant and Allan Peterson, *Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations*, Kluwer, 1996.
3. Saber Elaydi, *An Introduction to Difference Equations*, Springer, 1999.

Complex Analysis

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals.

Cauchy-Goursat theorem, Cauchy integral formula.

Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

Laurent series and its examples, absolute and uniform convergence of power series.

Books Recommended

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, *Complex analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., 1997

Linear Programming

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes.

Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual, sensitivity analysis.

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.

2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research*, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice- Hall India, 2006.

Information Security/Data Science/Computer Networks:

Information Security

Overview of Security: Protection versus security; aspects of security—data integrity, data availability, privacy; security problems, user authentication, Orange Book. Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer overflow; system threats- intruders; communication threats- tapping and piracy. Cryptography: Substitution, transposition ciphers, symmetric-key algorithms—Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions. Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures. Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring;

Books Recommended

1. W. Stallings, *Cryptography and Network Security Principles and Practices*, 4th Ed., PrenticeHall of India, 2006.
2. C. Pfleeger and SL. Pfleeger, *Security in Computing*, 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security*, SpringerVerlag Berlin, 2003.
5. J.M. Kizza, *Computer Network Security*, Springer, 2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices*, Pearson Education, 2006.

Data Science:

Data Scientist’s Tool Box: Turning data into actionable knowledge, introduction to the tools that will be used in building data analysis software: version control, markdown, git, GitHub, R, and RStudio.

R Programming Basics: Overview of R, R data types and objects, reading and writing data, Control structures, functions, scoping rules, dates and times, Loop functions, debugging tools, Simulation, code profiling

Getting and Cleaning Data: Obtaining data from the web, from APIs, from databases and from colleagues in various formats. basics of data cleaning and making data —tidyl.

Exploratory Data Analysis: Essential exploratory techniques for summarizing data, applied before formal modeling commences, eliminating or sharpening potential hypotheses about the world that can be addressed by the data, common multivariate statistical techniques used to

visualize high-dimensional data.

Reproducible Research: Concepts and tools behind reporting modern data analyses in a reproducible manner, To write a document using R markdown, integrate live R code into a literate statistical program, compile R markdown documents using knitr and related tools, and organize a data analysis so that it is reproducible and accessible to others.

Reference Books

1. Rachel Schutt, Cathy O'Neil, "Doing Data Science: Straight Talk from the Frontline" by Schroff/O'Reilly, 2013.
2. Foster Provost, Tom Fawcett, "Data Science for Business" What You Need to Know About Data Mining and Data-Analytic Thinking" by O'Reilly, 2013.
3. John W. Foreman, "Data Smart: Using data Science to Transform Information into Insight" by John Wiley & Sons, 2013.
4. Ian Ayres, "Super Crunchers: Why Thinking-by-Numbers Is the New Way to Be Smart" Ist Edition by Bantam, 2007.
5. Eric Segel, "Predictive Analytics: The Power to Predict who Will Click, Buy, Lie, or Die", 1st Edition, by Wiley, 2013.
6. Matthew A. Russel, "Mining the Social Web: Data mining Facebook, Twitter, LinkedIn, Goole+, GitHub, and More", Second Edition, by O'Reilly Media, 2013

Computer Networks

Basic Concepts: Components of data communication, distributed processing, Line configuration, topology, transmission mode, and categories of networks. OSI and TCP/IP Models: Layers and their functions, comparison of models. Digital Transmission: Interfaces and Modems: DTE-DCE Interface, modems, cable modems. Transmission Media: Guided and unguided, Attenuation, distortion, noise, throughput, propagation speed and time, wavelength, Shannon Capacity. Telephony: Multiplexing, error detection and correction, Many to one, one to many, WDM, TDM, FDM, circuit switching, packet switching and message switching. Data Link control protocols: Line discipline, flow control, error control, synchronous and asynchronous protocols overview. ISDN: Services, historical outline, subscriber's access, ISDN, Layers, and broadband ISDN.

Devices: Repeaters, bridges, gateways, routers, The Network Layer, Design Issues, Network Layer Addressing and Routing concepts (Forwarding Function, Filtering Function); Routing Methods (Static and dynamic routing, Distributed routing, Hierarchical Routing); Distance Vector Protocol, Link State protocol.

Transport and upper layers in OSI Model: Transport layer functions, connection management, Functions of session layers, Presentation layer, and Application layer.

Books Recommended

1. A.S. Tenenbaum, *Computer Networks*, 4th Ed., Pearson Education Asia, 2003.
2. Behrouz A. Forouzan, *Data Communication and Networking*, 2nd Ed., Tata McGraw Hill.

3. D. E. Comer, *Internetworking with TCP/IP*, Pearson Education Asia, 2001.
4. William Stallings, *Data and Computer Communications*, 7th Ed., Pearson education Asia, 2002.

Project: