MIT 1.1 Advance Computer Mathematics

Course Objectives:

The course is a blend of continuous and discrete mathematics. It is the controlled manipulation of mathematical formulas, using a collection of techniques for solving problems. The topics treated in the course include sums, recurrences, elementary number theory, binomial coefficients, generating functions, discrete probability and asymptotic methods. The emphasis is on manipulative techniques rather than on existence theorems or combinatorial reasoning.

Instructional Objectives:

At the end of the course, the students will be able to evaluate sums, solve complex recurrence relations, and discover subtle patterns in data. They will be fluent in algebraic techniques and hence obtain exact results than to settle for approximate answers that are valid only in a limiting sense.

Module I

Recurrent Problems: The Tower of Hanoi, Lines in the Plane, The Josephus Problem
Sum: Notations, Sums and Recurrences, Manipulation of Sums, Multiple Sums, General Methods, Finite and Infinite Calculus, Infinite Sums.
Integer Functions: Floors and Ceilings, Floor/Ceiling Applications, Floor/Ceiling Recurrences, 'mod'-The Binary Operation, Floor/Ceiling Sums,

Module II

Number Theory: Divisibility, Primes, Prime Examples, Factorial Factors, Relative Primality, 'mod'-The Congruence Relation, Independent Residues, Additional Applications, Phi and Mu.
Binomial Coefficients: Basic Identities, Basic Practice, Tricks of the Trade, Generating Functions, Hypergeometric Functions, Hypergeometric Transformations, Partial Hypergeometric Sums, Mechanical Summation.

Module III

Special Numbers: Stirling Numbers, Eulerian Numbers, Harmonic Numbers, Harmonic Summation, Bernoulli Numbers, Fibonacci Numbers, Continuants.
Generating Functions: Domino Theory and Change, Basic Maneuvers, Solving Recurrences, Special Generating Functions, Convolutions, Exponential Generating Functions, Dirichlet Generating Functions.

Module IV

Discrete Probability: Definitions, Mean Variance, Probability Generating Functions, Flipping Coins, Hashing.

Asymptotics: A Hierarchy, O Notation, O Manipulation, Two Aymptotic Tricks, Euler's Summation Formula, Final Summation.

Text Book:

Concrete Mathematics – A Foundation for Computer Science by Ronald L. Graham, Donald E. Knuth & Oren Patashnik, 2nd edition, ISBN: 978-81-317-0841-5

MIT 1.2 DATA NETWORKS

Course Objectives:

This course is designed to help students develop a deeper understanding of data networks and evolving integrated networks, and to explore today's various analysis and design tools. It begins with an overview of the principles behind data networks, and then develops an understanding of the modeling issues and mathematical analysis needed to compare the effectiveness of different networks.

Instructional Objectives:

Upon successfully completing the course, the student will be able to:

- Understand a data network system and its components.
- Understand the concepts and techniques used to model and implement communications between processes residing on different host computers and have the ability to analyze and design complete data network systems meeting specific networking requirements.

Module I

INTRODUCTION AND LAYERED NETWORK ARCHITECTURE: Historical Overview , Messages and Switching, Layering - The Physical Layer, The Data Link Control Layer, The Network Layer, The Transport Layer, The Session Layer, The Presentation Layer, The Application Layer, A Simple Distributed Algorithm Problem.

POINT-TO-POINT PROTOCOLS AND LINKS: Introduction, The Physical Layer - Channels and Modems , Error Detection, ARQ - Retransmission Strategies- Stop-and-Wait ARQ, Go Back n ARQ, Selective Repeat ARQ, ARPANET ARQ, Framing, Standard DLCs, Initialization and Disconnect for ARQ Protocols, Point-to-Point Protocols at the Network Layer

Module II

POINT-TO-POINT PROTOCOLS AND LINKS: The Transport Layer, Broadband ISDN and the Asynchronous Transfer Mode

DELAY MODELS IN DATA NETWORKS: Introduction, Queueing Models: Little's Theorem, The M / M /1 Queueing System, The M / M / m, M / M / ∞ / M / M / m/m, and Other Markov Systems, The M/G/l System

Module III

ROUTING IN DATA NETWORKS: Introduction - Main Issues in Routing, Wide-Area Network Routing: An Overview, 3 Interconnected Network Routing - An Overview, Network Algorithms and Shortest Path Routing- Undirected Graphs, Minimum Weight Spanning Trees, Shortest Path Algorithms, Distributed Asynchronous Bellman-Ford Algorithm, Stability of Adaptive Shortest Path Routing, Broadcasting Routing Information - Coping with Link Failures, Flooding - The ARPANET Algorithm, Flooding without Periodic Updates, Broadcast without Sequence Numbers

Module IV

FLOW CONTROL: Introduction - Means of Flow Control, Main Objectives of Flow Control, Window Flow Control- End-to-End Windows, Node-by-Node Windows for Virtual Circuits, The Isarithmic Method, Window Flow Control at Higher Layers, Window Flow Control at Higher Layers, 5 Dynamic Window Size Adjustment, Rate Control Schemes- Queueing analysis of the leaky bucket scheme

Text Book:

Data Networks - DimitriBertsekas& Robert Gallager Second Edition PHI Pvt. Ltd ISBN-81-203-0780-1

Reference Books:

1) Computer Networks- Andrew Tanenbaum 4th Edition Pearson Education ISBN: 81-7808-785-5
2) Data and Computer Communications – William Stallings 8th Edition, Pearson education, ISBN-978-81-317-1536-9
3) ISDN and Broadband ISDN with Frame Relay and ATM – William Stallings 4th Edition Pearson Education, ISBN-81-7808-422-8
4) Computer Networks and Internet – Douglas Comer 2nd Edition Pearson Education ISBN-81-7808-086-9

MIT 1.3 Advanced Programming using Cpp and Java

Course Objectives:

C++ and Java are languages that are widely used in Software Development. The objective of the course is to enable the student to gain mastery in various advanced C++ and Java topics.

Instructional Objectives:

To know the major mechanisms available in C++ and Java languages to meet demanding Software Engineering problems where efficiency of coding and execution, speed and correctness of implementation are important.

To understand the optimizations and tradeoffs that are encountered with the various mechanisms available in the C++ and Java languages.

Module I

Utilities: Pairs and Tuples, Smart Pointers, Fractional Arithmetic using ratio template class, Clocks and Timers

STL Containers: Arrays, Vectors, Deques, Maps

STL Iterators: Iterator Categories, Iterator Adapters, Writing User Defined Iterators
STL Function Objects and Lambdas : Concept of Function Objects, Predefined Function Objects and Binders, Using Lambdas

Module II

STL Algorithms: Overview, Nonmodifying Algorithms, Modifying Algorithms, Removing Algorithms, Mutating Algorithms, Sorting Algorithms

Strings: String class with examples

Module III

C++ Input /Output Using Stream Classes: Common Background of Input / Output Streams, Fundamental Stream Classes and Objects, Standard Stream Operators, State of Streams, Standard Input / Output functions, Stream Manipulators, Formatting, File Access, Stream Classes for Strings, Input / Output Operators for User Defined Types, Connecting Input and Output Streams

C++ Concurrency: High Level Interface async() and Futures

Module IV

INPUT/OUTPUT and Serialization in Java: How java platform supports I/O, Programing I/O, Byte Oriented Stream Classes, File I/O Basics, Character Streams, The New I/O(NIO) Programing Interface, Object Serialization

Collections Framework: The Utility Package, The collection Framework, Pattern Recognition with Regular Expressions

Using Relational Databases: Best practices for programming for databases, JDBC Drivers for RDBMS Systems, Using the java.sql API, Coding Transactions, Using the javax.sqlapi, Connection pooling,

JAVA and XML: XML structure, Parsing an XML Document with SAX, Parsing an XML Document with DOM and JDOM, Generating an XML Document with DOM, Validating XML documents using DTD and XML Schema, Transforming XML using XPATH, Stylesheet Example

TextBooks:

1) The C++ Standard Library by Nicolai M. Josuttis, Second Edition ISBN:978-0321623218
2) The C++ Programming Language, 4th Edition, BjarneStroustrup, ISBN-13: 978-0321563842
3) Java Programming - Advanced Topics, Mixed media product By Joe Wigglesworth and Paula McMillan, Third Edition, ISBN-13: 978-0619159689

MIT 1.4 Information Storage and Retrieval

Course Objectives:

This course on information storage and retrieval focuses on the theory and concepts of information retrieval system, introduces the basic principles of information storage, processing, and retrieval in terms of the information retrieval system analysis and design. The topics in this course include query structure and its characteristics, the representation of documents and other objects within an information system, internal matching mechanisms, document analysis, user's perspective, retrieval effectiveness measure, alternative retrieval techniques, output presentation, data file structures, visualization for information, the Internet search engine, and discussion of current research trends in the field. The aim of this course is to prepare students as information retrieval system analysts and designers.

Instructional Objectives:

At the end of the course the student will be able to:

- To outline basic terminology and components in information storage and retrieval systems.
- To understand the unique features of Internet-based information retrieval.
- To describe current trends in information retrieval such as information visualization.

Module I

Introduction: Motivation: Information versus Data Retrieval, Information retrieval at the center of the stage; Basic Concepts: The user task, Logical view of the documents; Past, Present and Future: Early developments, Information Retrieval in the library, The web and digital libraries; The Retrieval Process.

Boolean retrieval: An example information retrieval problem; A first take at building an inverted index; Processing Boolean queries; The extended Boolean model versus ranked retrieval.

The term vocabulary and postings lists: Document delineation and character sequence decoding, Determining the vocabulary of terms, Faster postings list intersection via skip pointers, Positional postings and phrase queries.

Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction, Phonetic correction.

Index construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes

Module II

Index compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression

Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, Variant tf-idf functions

Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.

Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance, A broader perspective: System quality and user utility, Results snippets.

Module III

Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

Vector space classification: Document representations and measures of relatedness in vector spaces, Rocchio classification, k nearest neighbor, Linear versus nonlinear classifiers, Classification with more than two classes, The bias-variance tradeoff

Support vector machines and machine learning on documents: Support vector machines: The linearly separable case, Extensions to the SVM model, Issues in the classification of text documents, Machine learning methods in ad hoc information retrieval

Module IV

Matrix decompositions and latent semantic indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing

Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.

Web crawling and indexes: Overview, Crawling, Distributing indexes, Connectivity servers, Link analysis, The Web as a graph, PageRank, Hubs and Authorities.

Text Books:

1. Introduction to Information Retrieval by Manning, C.D., Raghavan, P. and Schütze, H., 2008, Cambridge University Press, ISBN-13: 978-1-107-66639-9.
2. Information Storage and Retrieval by R. R. Korfhage, published by John Wiley & Sons in 1997. ISBN 0-471-14338-3.

Reference Books:

1. Modern Information Retrieval,R. Baeza-Yates, B. Ribeiro-Neto. Addison-Wesley, 1999, Pearson Publishers, ISBN 978-81-317-0977-1.

MIT1.5 Advanced Database Management Systems

Course Objective:

This course deals with the transition from homogenous database systems to distributed database systems based on advanced concepts of Fragmentation and Allocation. The course also deals with the latest advancements in the computer networking infrastructure that supports these systems.

Instructional Objective:

At the end of the course the student will be able to:

- Understand the key concepts and terminology of DDBMS
- Comprehend Fragmentation and Allocation in Distributed Database Design.
- Know the strategies and methods for Query Processing, Optimization, and Distributed Database

Transaction Processing.

- Learn the basics of Parallel Database Systems.

Module I

Relational Data Model Concepts: Relational Model Concepts, Relational Constraints and relational Database Schemas, Update Operations and dealing with Constraint Violations, Basic Relational Algebra Operations, Additional Relational Operations

SQL- The Relational Database Standard: Data Definition, Constraints, and Schema Changes in SQL 2, Basic Queries in SQL, More complex SQL Queries, Insert, Delete and Update Statements in SQL, Views in SQL

Functional Dependencies and Normalization for Relational Databases: Informal Design guidelines for relation Schemas, Functional Dependencies, Normal Forms based on Primary keys, General Definitions of second and Third Normal Forms

Further Dependencies in Relational Database Design: Multivalued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form

ModuleII

Introduction to Distributed Databases: Distributed data processing,What is a distributed database system? Data Delivery Alternatives, Promises of DDBSs, Complications introduced by distribution, Design Issues, Distributed DBMS Architecture,

Distributed Database Design: Top Down Design Process, Distribution Design issues , Fragmentation, Allocation, Data Directory

Database Integration: Bottom Up Design methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning

Module III

Data and Access Control: View Management, Data Security, Semantic Integrity control

Query Decomposition and Data Localization: Query Decomposition, Localization of Distributed Data

Optimization of Distributed Queries: Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization

Module IV

Introduction to Transaction Management: Definition of a Transaction, Properties of Transactions, Types of Transactions, Architecture Revisited

Distributed Concurrency Control: Serializability Theory, Taxonomy of Concurrency Control Mechanisms, Locking-based Concurrency , Control Algorithms, Timestamp-

based Concurrency Control Algorithms, Optimistic Concurrency Control Algorithms, Deadlock Management, "Relaxed" Concurrency Control

Parallel Database Systems: Parallel Database System Architectures, Parallel Data Placement, Parallel Query Processing, Load Balancing, Database Clusters

Text Books:

1. Fundamentals of Database Systems – By Elmasri&Navathe, Third Edition, Addison WesleyISBN-10: 0805317554 • ISBN-13: 9780805317558
2. Distributed Database Systems- M. Tamer Ozsu, Patrick Valduriez, Third Edition, Pearson EducationISBN 978-1-4419-8833-1

Reference Books:

1. Distributed Databases Principles and Systems Stefano Ceri, Giuseppe Pelagatti, McGraw Hill ISBN: 9780070265110
2. Database System Concepts, Abraham Silberschatz, Henry F. Korth, Fourth Edition, McGraw Hill, ISBN: 0071122680, 9780071122689