**Subject Code:** MCIT-109
**Subject Name:** Advanced Algorithms

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 50% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 Hours |
| **Total Marks:** 150 | **Course Type:** Programme Core |

**Course Outcomes:**

**After completing this course students will be able to:**

1. Understand the implementation of symbol table using hashing techniques.
2. Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
3. Develop algorithms for text processing applications
4. Identify suitable data structures and develop algorithms for computational geometry problems.
5. To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.

**Prerequisites:** Data Structures
**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)
**Detailed Contents:**

**Part-A**

**Dictionaries:** Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic, Probing, Double Hashing, Rehashing, Extendible Hashing. [8 hrs]
**Problem Analysis:** Probabilistic Analysis, Amortized Analysis, Competitive Analysis, Hiring problem. [5 hrs]
**Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists. [5 hrs]

**Part-B**

**Trees:** Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees**.** [4 hrs]
**Text Processing:** Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem. [10 hrs]
**Applications:** Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem. [4 hrs]

**Text Books:**

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002

**Reference Books:**

1. Advanced Data Structures: An Introduction to Data Structures and Algorithms, November 2020,Publisher: PageWizard Games, Learning & Entertainment

**Subject Code:** LMCIT-109
**Subject Name:** Advanced Algorithms Laboratory

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Practical | **Credits:** 1 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 100% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 Hours |
| **Total Marks:** 100 | **Course Type:** Programme Core |

**Prerequisite**: Basic understanding of programming concepts & C ++.

**Course Outcomes:**

**After completing this course students will be able to:**

1. Understand the implementation of Binary Search Tree and algorithms for red-black trees, B-trees and Splay Tree.
2. Develop algorithms for text processing applications.
3. Experiment on latest efficient algorithms on trees for solving contemporary problems
4. To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
5. Implement algorithms for Knuth-Morris-Pratt algorithm.

**Detailed Contents**

1. Write a Program for Binary Search Tree to implement following operations:
   a. Insertion
   b. Deletion: Delete node with only child & Delete node with both children
   c. Finding an element
   d. Finding Min element
   e. Finding Max element
   f. Left child of the given node
   g. Right child of the given node
   h. Finding the number of nodes, leaves nodes, full nodes, ancestors, descendants.
2. Write a Program for to red-black trees, B-trees and Splay trees
3. Write a Program to perform string matching using Knuth-Morris-Pratt algorithm.
4. Write a Program to perform for text processing applications
5. Write a Program to implement 2-D range search over computational geometry problem
6. Write a Program on latest efficient algorithms on trees for solving contemporary problems.
7. Write a Program to implement insertion, deletion, display and search operation in m-way B tree

**Mini- Project:** By using various concepts of data structures, students are required to prepare a project by a single student. He has to submit a project report of 8 to 10 pages (approximately) and the will have to demonstrate the project as well as have to give a presentation of the same.
**Note:** It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

**Subject Code:** MCIT-110
**Subject Name:** Object Oriented Analysis and Design using UML

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 Hours |
| **Total Marks:** 150 | **Course Type:** Programme Core |

**Course Outcomes:**
**After studying this course the student will be able to:**

1. Use fundamental design principles, methods, patterns and strategies in the creation of object oriented analysis and design and its supporting documents.
2. Relate the requirements modeling and design techniques to infer the flow and behaviour of the system.
3. Demonstrate design basics like domain models, class diagrams, and interaction (sequence and communication) diagrams.
4. Apply use cases and use case diagrams and other components for the behavioral modeling.
5. Design practical solutions for the real-life case studies using various UML artifacts.
6. Demonstrate models for multithreaded applications.

**Prerequisites: Object Oriented Programming, Soft Computing, Data Mining**

**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)

**Detailed Contents:**

**Part-A**

**Introduction:** Modeling, The Importance of Modeling, Principles of Modeling, Object-Oriented Modeling, An Overview of the UML, A Conceptual Model of the UML, Modeling a System's Architecture, Software Development Life Cycle [6 Hrs]

**Structural Modeling:** Classes, attributes, operations, and responsibilities, Relationships, Modeling the Vocabulary of a System, Modeling the Distribution of Responsibilities in a System, Modeling Nonsoftware Things, Modeling Primitive Types, Dependency, generalization, and association relationships, Modeling single inheritance, Modeling structural relationships. [6 Hrs]

**Diagrams, views, and models:** Structural Diagrams-Class Diagram, Object Diagram, Component Diagram and Deployment Diagram, Modeling different views of a system, Modeling different levels of abstraction, Modeling complex views, Organizing diagrams and other artifacts, Advanced classes, Advanced relationships. [6 hrs]

**Part-B**

**Behavioral Modeling:** Interactions, Use cases and Use case diagrams. Interaction diagrams - Notations, Conditional messaging, Branching, Time constraints, Sequence diagram, Collaboration diagram and Activity diagrams. [6 Hrs]

**Advanced Behavioral Modeling**: Signal events, call events, time events, and change events, Modeling a family of signals, Modeling exceptions, Handling events in active and passive, State Machines, transitions, and activities, Modeling the lifetime of an object, Creating well-structured algorithms, Active objects, processes and threads, Modeling multiple flows of control, Modeling interprocess communication, Building thread-safe abstractions. [7 Hrs]

**Architectural Modeling:** Modeling a Client/Server System, Modeling a Fully Distributed System, Systems, subsystems, models, and views, Modeling the architecture of a system, Modeling systems of systems, Organizing the artifacts of development. [5 Hrs]

**Text Books:**

1. Grady Booch, James Rumbaugh, Ivar Jacobson, "Unified Modeling Language User Guide", 2nd Edition, Addison-Wesley Professional, 2005.
2. Grady Booch, "Object-Oriented Analysis and Design with Applications", Pearson India, 3rd Edition, 2015.
3. James Rumbaugh, "Object-Oriented Modeling and Design with UML", 2nd Edition , Pearson Prentice Hall, 2005.
4. Roger S Pressman, "Software Engineering: A practitioner's approach", 7th Edition, McGraw Hill Education, 2010.
5. Mahesh. P. Matha, "Object Oriented Analysis and Design Using UML", PHI Publication, 2008
6. Ian Sommerville, "Software Engineering", 10th Edition, Pearson India, 2018.
7. Rajesh Gupta, Paul Le Guernic, Sandeep Kumar Shukla, Jean-Pierre Talpin, "Formal Methods and Models for System Design: A System Level Perspective", Springer Science & Business Media, 2004

**Reference Books:**

1. Ali Bahrami, "Object Oriented System Development", McGraw-Hill, 1999.
2. Meilir, Page-Jones, "Fundamentals of Object Oriented Design in UML", Addison Wesley, 2000.
3. Donald W. Boyd, "Systems Analysis and Modeling: A Macro to Micro Approach with Multidisciplinary Applications", Academic Press, 2001
4. Hassan Gomaa, "Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures", Cambridge University Press, 2011.
5. Ned Kock, "Systems Analysis & Design Fundamentals: A Business Process Redesign Approach, SAGE Publications, 2006.
6. Jennifer Preece, Yvonne Rogers and Helen Sharp, "Interaction Design: Beyond Human-Computer Interaction", Third Edition, 2002

**Subject Code:** LMCIT-110
**Subject Name:** Object Oriented Analysis and Design using UML Laboratory

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Practical | **Credits:** 1 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 100% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 Hours |
| **Total Marks:** 100 | **Course Type:** Programme Core |

**Prerequisite**: **Object Oriented Programming, Soft Computing, Data Mining**

**Course Outcomes:**
**After completing this course students will be able to:**

1. Apply object-oriented methods for the design and analysis of real world applications.
2. Create UML diagrams for architectural modelling using UML framework based tool.
3. Stimulate further software design and development in the light of object-orientation by appropriate modeling and documentation of each stage.
4. Devise construction & testing framework and maintenance model diagrams on various case studies
5. Work in teams, based on assigned roles, to design practical solutions for the real-life case studies using UML artifacts
6. Create models for multithreaded applications.

**Detailed Contents**

1. Basic hands-on for modeling UML concepts
2. Implementing System Architecture through development of Analysis Model
3. Development of Class Diagram and Code Generation from Class Diagram
4. Modeling different levels of abstraction
5. Identification of entity and operational classes in Class Relationship Modeling
6. Identification and development of Use Case Diagrams and Use Case Descriptions.
7. Development of Problem Domain Object Model
8. Implementing System Construction through development of Sequence Diagram
9. Development of State Transition Diagram to introduce dynamism in static modeling
10. Modeling interprocess communication

**Subject Code:** MCIT-112
**Subject Name:** Advanced Bioinformatics

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 15% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 Hours |
| **Total Marks:** 150 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying this course the student will be able to:**

1. Analyze various Bioalgorithms and tools like Point Accepted Mutation (PAM), Blocks Substitution Matrix (BLOSUM) etc.
2. Examine and conceptualize the concepts of Alignment and Gene Prediction Methods.
3. Identify and quantify Protein Structure and Modeling
4. Comprehend the usage if Bioinformatics in Computer-aided Drug Design
5. Implementation of various Biomolecular and Simulation packages

**Prerequisites:** Introduction to Bioinformatics
**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)

**Detailed Contents:**

**Part-A**

**Bioalgorithms and Tools:**
Introduction, Concept of Alignment, Sequence Alignment, Scoring Matrices, Point Accepted Mutation (PAM), Blocks Substitution Matrix (BLOSUM), Alignment of Pairs of Sequences, Alignment Algorithms, Heuristic Methods, Multiple Sequence Alignment [5 hrs]

**Gene Prediction Methods**:
Introduction, Biological Overview, Gene Prediction, Computational Methods of Gene Prediction, Methods of Gene Prediction, Combination of Two Methods, Complexities regarding Gene Prediction. [5 hrs]

**Protein Structure and Modeling:**
Protein and Secondary Structure Prediction, Levels of Protein Structure, Conformational Parameters of Secondary Structure of a Protein, Secondary Structure Types, Secondary Structure Prediction, Software's for Secondary Structure Prediction, Limitations of Secondary Structure Prediction.
[8 hrs]

**Part-B**

**Bioinformatics in Computer-aided Drug Design:**
Introduction, The Drug Discovery Process, Structural Bioinformatics in Drug Discovery, Structure-Activity Relationship (SAR) and Quantitative Structure-Activity Relationship (QSAR) Techniques in Drug Design, Graph Theory, Molecular Docking, Briefing on Drug Bank, AutoDock- The Docking Software and Auto Dock Tools (ADT) [8 hrs]

**Modeling of Biomolecular Systems:**
Introduction, Monte Carlo Methods, Molecular Dynamics, Energy Minimization, Leading Molecular Dynamics (MD) Simulation Packages, Markov Chains and Hidden Markov Model (HMM), Application of Viterbi Algorithm, Application of HMMs to specific problems, Advantages of HMM, Genetics Computer Group (GCG) Wisconsin Package [8hrs]

**Text Books:**

1. Rastogi, S.C., Mendiratta, N., Rastogi, P. (2018). Bioinformatics: Methods and Applications - Genomics, Proteomics and Drug Discovery (4th ed.). India: PHI Learning.
2. Antao, T. (2015). Bioinformatics with Python Cookbook (2nd ed.). Birmingham, UK: PACKT Publishing.
3. Ghosh, Z. and Mallick, B. (2013). Bioinformatics: Principles and Applications (4th ed.)UK: Oxford University Press.

**Reference Books:**

1. Bergeron, B. (2017). Bioinformatics Computing (4th ed.). India: Prentice Hall Inc. Ignacimuthu, S. (2013).
2. Basic Bioinformatics (3rd ed.) 2017. India, New Delhi: Narosa Publishing House Pvt. Ltd.

**E-Books and Online Learning Material:**

1. An Introduction to Bioinformatics Algorithms by Neil C. Jones and Pavel A. Pevznerhttp://www.cs.ukzn.ac.za/~hughm/bio/docs/IntroToBioinfAlgorithms.pdf Accessed on Dec. 09, 2019
2. Protein Structure Prediction by Sitao Wu and Yang Zhang https://zhanglab.ccmb.med.umich.edu/papers/2009_8.pdfAccessed on Dec.10, 2019

**Online Courses and Video Lectures:**

1. http://bix.ucsd.edu/bioalgorithms/presentations/Ch08_GraphsDNAseq.pdf Accessed on Dec.10, 2019
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5187414/ Accessed on Dec. 14, 2019

**Subject Code:** LMCIT-112
**Subject Name:** Advanced Bioinformatics Laboratory

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Practical | **Credits: 1** |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 100% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 Hours |
| **Total Marks:** 100 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying this course the student will be able to:**

1. Analysis of protein sequence from protein database
2. Analysis of Primary, Secondary and Tertiary Structure of Protein.
3. Implementation of Pair-wise and Multiple Sequence Alignment by using ClustalW.
4. Phylogenetic analysis by using web tool.
5. Quaternary structural analysis.

**Pre-requisites:** Knowledge of Database Management Systems
**Detailed Contents:**

1. Analysis of protein sequence from protein database.
2. Primary structure analysis of protein.
3. Secondary structure analysis of protein.
4. Tertiary structure analysis of protein.
5. Pair-wise sequence alignment by using ClustalW.
6. Multiple sequence alignment by using ClustalW.
7. Phylogenetic analysis by using web tool.
8. Quaternary structural analysis.

**Subject Code:** MCIT-113
**Subject Name:** Data Analytics

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 40% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 Hours |
| **Total Marks:** 150 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying this course students will be able to:**

1. Demonstrate proficiency with statistical analysis of data.
2. Graphically interpret data.
3. Identify the risks and risk management.
4. Implement large scale analytics projects from various domains.
5. Develop applications based on Agile Framework.

**Prerequisites:** Data Mining, Machine Learning, Programming skills, Soft Computing
**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)

**Detailed Contents:**

**Part-A**

**Data Analytics and Project Management:**
Key role of data analytics in the process of driving change in project management, Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning and R-Programming. [9 hrs]

**Categories of Analytics and Risk Management:**
Descriptive Analytics, Predictive Analytics, Perspective Analytics, Measures of central tendency, Measures of location of dispersions, Practice and analysis with R, Risk Management Process, Establishing Tolerance, Data Collection risk and risk collection, Exploratory risks in data analytics, Confirmatory Analytics risks, predictive risks in data analytics, risks in communicating results, resolving data analytics risks. [9 hrs]

**Part-B**

**Basic analysis techniques:**
Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Regression analysis, Practice and analysis with R. [9 hrs]

**Agile Project Management and Data Analytics:**
Introduction, The Changing Data Landscape, Volume, Variety , Velocity and Veracity, CRISP-DM and Agile Methodology, Agile Principles and Cross-industry standard process for data mining (CRISP-DM) Alignment, Challenges of Agile Software Development Applied to Data Analytics, Future Trends in Agile and Data Analytics, Data Analytics and Scrum, Agile, SCRUM and Data Analytics in Online Transactional Processing (OLTP) and Online Analytical Processing (OLAP). [9 hrs]

**Text Books:**

1. Seweryn Spalek, "Data Analytics in Project Management", 6th Edition, CRC Press – Taylor and Francis Group, 2019.
2. G. James, D. Witten, T Hastie, and R. Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer, 2013.

3. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", Prentice Hall Inc.", 9th Edition.2010

**Reference Books:**

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", (9th Edition.), Prentice Hall Inc.2010
2. Trevor Hastie Robert Tibshirani Jerome Friedman, "The Elements of Statistical Learning, Data Mining, Inference, and Prediction" (2nd Edition.), Springer, 2014.
3. Anna Maria Paganoni and Piercesare Secchi, "Advances in Complex Data Modeling and Computational Methods in Statistics", Springer, 2013.
4. Mark Gardener, "Beginning R: The Statistical Programming Language", Wiley, 2013.

**Subject Code:** LMCIT-113
**Subject Name:** Data Analytics Laboratory

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Practical | **Credits: 1** |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 100% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 Hours |
| **Total Marks:** 100 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying the course students will be able to:**

1. Gather sufficient relevant data, conduct data analytics using scientific methods, and make appropriate and powerful connections between quantitative analysis and real-world problems.
2. Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using data analytics skills to provide constructive guidance in decision making.
3. Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
4. Show substantial understanding of the real problems; conduct deep data analytics using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
5. Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.

**Prerequisites:** Data Mining, Machine Learning, Programming skills in C/C++, Java, Soft Computing.
**Detailed Contents:**

1. Downloading and Installing R and R Studio.
2. Installation of relevant R packages.
3. Exploratory data analysis in R.
4. Data Manipulation in R
5. Perform correlation analysis in R.
6. Demonstrate Analysis of variance using R.
7. Implement Chi-Square Test in R.
8. Demonstrate T-test.
9. Predictive Modelling using R.
10. Descriptive Analysis using R.
11. Demonstrate Regression Analysis.
12. Project: Sentiment Analysis using R.

**Subject Code:** MCIT-114
**Subject Name:** Social Networking

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 40% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 Hours |
| **Total Marks:** 150 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying this course the student will be able to:**
1. Analyze dynamics and evolution of social networks
2. Demonstrate the development of social structures
3. Implement the framework of network analysis
4. Apply the concept of network centrality with various concepts like betweenness, closeness, page ranks etc.
5. Implement various community concepts like: clustering, community structure, modularity

**Prerequisites:** Data Mining, Recommender Systems.
**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)

**Detailed Contents:**

**Part-A**

**Random network models:**Nodes, edges, adjacency matrix, one and two-mode networks, node degree, Erdos-Renyi and Barabasi-Albert Concepts: connected components, giant component, average shortest path, diameter, breadth-first search, preferential attachment. [9 hrs]
**Network centrality and Community:**Betweenness, closeness, eigenvector centrality (+ PageRank), network centralization, clustering, community structure, modularity, overlapping communities. [9 hrs]

**Part-B**

**Small world network models, optimization, strategic network formation and search:** Geographic networks, decentralized search, Simple contagion, opinion formation, coordination and cooperation, threshold models, unusual applications of Social Network Analysis (SNA). [9 hrs]
**SNA and online social networks:** How services such as Facebook, LinkedIn, Twitter, Couch Surfing, using SNA to understand their users and improve their functionality [9 hrs]

**Text Books:**

1. John Scott, Social Network Analysis, 3rd Edition, SAGE Publications, 2013.
2. Song Yang, Franzisca B.Kellar, Lu Zheng, Social Network Analysis: Methods and Examples, SAGE Publications, 2017.
3. Wouter de Nooy, Andrej Mrvar, Vladimir Batagelj, Exploratory Social Network Analysis with Pajek, 2nd Revised Edition, Cambridge University Press, 2011.

**Reference Books:**
1. Patrick Doreian, Frans Stokman, Evolution of Social Networks, Routledge, 2013.
2. David Easley and Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010.

**Subject Code:** LMCIT-114
**Subject Name:** Social Networking Laboratory

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Practical | **Credits: 1** |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 100% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 Hours |
| **Total Marks:** 100 | **Course Type:** Programme Elective-III |

**Course Outcomes:**
**After studying this course, the student will be able to:**

1. Apply the basic function of loading, managing and visualizing the networks.
2. Demonstrate the development of social network structures through basic cohesion metrics.
3. Implement the framework of network analysis.
4. Apply the concept of network centrality with various concepts like betweenness, closeness, page ranks etc.
5. Implement various community concepts like: clustering, community structure, modularity

**Pre-requisites:** Basics of R, Data Mining, Recommender Systems.
**Detailed Contents:**

1. Install all packages need for Social Network Analysis in R.
2. Addition, Visualization and Export of Vertex Attributes of a Graph.
3. Acquisition of basic cohesion metrics of density, reciprocity, reach, path distance, and transitivity.
4. Develop triadic analyses and a measure of heterogeneity.
5. Calculation of Centrality Measures.
6. Find the correlations between different Centrality measures.
7. Community detection based on betweenness method.
8. Hierarchical Clustering On Social & Task Ties.
9. Case Studies on social network analysis for different social networks such as Facebook, Twitter, LinkedIn etc.

**Subject Code:** MCIT-115
**Subject Name:** Deep Learning

| | |
|---|---|
| **Programme:** M.Tech | **L:**3 **T:**0 **P:** 0 |
| **Semester:**2 | **Teaching Hours:** 36 Hours |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 30% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 hours |
| **Total Marks:** 150 | **Course Status: Programme** Elective |

**On completion of the course the student will have the ability to:**

| CO | Course Outcomes |
|---|---|
| 1. | Evaluate the Deep Learning Methodologies |
| 2. | Analyze the mathematical foundations for execution of different Deep Learning Algorithms |
| 3. | Implement Deep Feed forward Networks and Convolution Networks |
| 4. | Apply regularization for deep learning classifiers |
| 5. | Apply Deep Learning in real life problems. |

**Prerequisites:** Soft Computing, Machine Learning
**Additional Material Allowed in ESE:** Scientific Calculator

**Detailed Contents:**

**Part-A**

**Introduction:** Historical Trends in Deep Learning: Increasing Dataset Sizes, Increasing Model Sizes, Increasing Accuracy, Complexity and Real-World Impact, Mathematical Foundations of Deep Learning, Introduction to Tensors, Data pipelines, text processing. [8 hrs]

**Deep Feedforward Networks:** Gradient-Based Learning, Hidden Units, Architecture Design, Back Propagation and Other Differentiation Algorithms [4 hrs]

**Regularization for Deep Learning:** Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multitask Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representation, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop and Manifold Tangent Classifier [6 hrs]

**Part-B**

**Optimization for Training Deep Models:** Deep Learning vs Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates, Approximate Second-Order Methods, Optimization Strategies and Meta-Algorithms [7 hrs]

**Convolutional Networks:** The Convolution Operation, Pooling, Variants of the basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features, The Neuroscientific Basis for Convolutional Networks [7 hrs]

**Applications:** Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing. [4 hrs]

**Text Books:**

1. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville (2016). Deep Learning, MIT Press.
2. Sivanandam, S.N., Deepa, S.N. (2019). Principles of Soft Computing (3rd ed.), Wiley India Pvt. Ltd.
3. Josh Patterson, Adam Gibson (2017). Deep Learning: A Practitioner's Approach, O'Reilly Media, Inc.
4. Goodfellow, I., YoshuaBengio, Courville I., Bach, F. (2017). Deep Learning, Adaptive Computation and Machine Learning series, MIT Press.

5. AurelienGeron (2017). Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems (2nd ed.) Shroff/O'Reilly.

**Reference Books:**

1. Michie D., Spiegelhalter D. J., Taylor C. C. (2009) Machine Learning, Neural and Statistical Classification. Overseas Press.
2. Murphy, K. (2012). Machine Learning: A Probabilistic Perspective, MIT Press.
3. Hastie T., Tibshirani, R., Friedman, J. (2009). The Elements of Statistical Learning, Springer.
4. Bishop, C. (2007) Pattern Recognition and Machine Learning, Springer.
5. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009
6. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

**Subject Code**: LMCIT-115
**Subject Name:** Deep Learning Laboratory

| | |
|---|---|
| **Programme:** M.Tech | **L:**0 **T:**0 **P:** 2 |
| **Semester:**2 | **Teaching Hours:** 24 Hours |
| **Theory/Practical:** Practical | **Credits:** 1 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 70% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 3 hours |
| **Total Marks:** 100 | **Course Status: Programme** Elective |

On completion of course students have ability to:

| **CO** | **Course Outcomes** |
|---|---|
| 1. | Familiar with tensorflow and colab for implementing Deep Learning Algorithms. |
| 2. | Evaluate the Deep Learning Neural Network with changing parameters |
| 3. | Implement and Visualize Deep Learning Model using Neural Networks |
| 4. | Implement Convolutional Networks |
| 5. | Apply the appropriate Deep Learning technique for the problem under consideration |

**Prerequisites:** Programming in Python, Data Mining or Machine Learning or Data Science
**Additional Material Allowed in ESE:** Scientific Calculator

**Detailed Contents:**

1. Overview of Tensorflow.
2. Get Started with Google Colab.
3. Develop Classifier using MNIST Dataset. This involves training and testing data.
4. Build Neural Network with Tensorflow in Colab.
5. Utilizing Neural Network Playground for visualizing Deep Learning Algorithms.
6. Configure the Learning Rate when Training Deep Learning Neural Networks
7. To build Convolutional Networks and use them to classify images

**Mini Project:** Student will develop the individual projects that include building the Deep Learning Model addressing the issues faced in different areas.

**Subject Code:** MCIT-116
**Subject Name:** On-Chip Networks

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3 Hours |
| **Total Marks:** 150 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying this course the student will be able to:**

1. To learn On-chip concepts and demonstrate the principles for Designing of On-chip Networks.
2. To learn sample routing algorithms on a NoC with deadlock and live-lock avoidance
3. To demonstrate memory-subsystems and interconnects of Tiled Chip Multi-Core Processors.
4. To understand the role of system-level design and performance metrics in choosing a NoC Design.
5. To observe the relationship between the requirements and implications of parallel computing/programming tasks on a many-core processor

**Prerequisites:** Basics of Computer Architecture
**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)

**Detailed Contents:**

**Part-A**

**Introduction:** Advent of the Multi Core Era, On-Chip vs Off-chip Networks, On-Chip Network Building Blocks, Performance and Cost. Interface with System Architecture: Shared Memory Networks in Chip Multiprocessor, Message Passing, NoC Interface Standards. [9 hrs]
**Topology & Routing**: Metrics, Direct Topologies: Rings, Meshes and Tori, Indirect Topologies: Crossbars, Butterflies, Clos Networks and Fat Trees. Irregular Topologies, Hierarchical Topologies, Types of Routing Algorithms, Deadlock Avoidance, Deterministic Dimension- ordered Routing, oblivious Routing, Adaptive Routing, Multicast Routing, Routing on Irregular Topologies [9 hrs]

**Part-B**

**Flow Control & Router Microarchitecture:** Message, Packets, Flits and Phits, Message-based Flow control, Packet based Flow control, Flit-based Flow Control, Virtual Channels, Deadlock-free Flow Control, Buffer Back Pressure, Virtual Channel Router Microarchitecture. Buffers and Virtual Channels, Switch Design, Allocators and Arbiters, Pipeline, Low Power Microarchitecture. [9 hrs]
**Modeling and Evaluation**: Evaluation Metrics, On-chip Network Modeling Infrastructure, Traffic: Message classes, Virtual Networks, Message Sizes and Ordering, Application Traffic,SyntheticTraffic.
**Case Studies:** MIT Eyeriss, Princeton Piton, Intel Xeon-Phi, D E Shaw Research Anton 2. [9 hrs]

**Text Books:**

1. Jerger, Natalie Enright, Tushar Krishna, and Li-Shiuan Peh. "On-chip networks." Synthesis Lectures on Computer Architecture 12, no. 3 (2017): 1-210.
   Online Available at :
   https://www.morganclaypool.com/doi/abs/10.2200/S00772ED1V01Y201704CAC040
2. Ma, Sheng, Libo Huang, Mingche Lai, and Wei Shi. Networks-on-chip: from implementations to programming paradigms. Morgan Kaufmann, 2014.

**Reference Books:**

1. J Jeffers, J Reinders (2013). Intel Xeon Phi Coprocessor High-Performance Programming. Morgan KaufmannPublishing andElsevier.
2. 2. T Mattson, B Sanders, B Massingill(2004). Patterns for Parallel Programming. Addison Wesley Professional

**Subject Code:** LMCIT-116
**Subject Name:** On-Chip Networks Laboratory

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Practical | **Credits:** 1 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** 100% |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 Hours |
| **Total Marks:** 100 | **Course Type:** Programme Elective |

**Course Outcomes:**
**After studying this course the student will be able to:**

1. Understand the merits and pitfalls in computer performance measurements.
2. Understand ways to incorporate long latency operations in pipeline design
3. Implement deadlock free routing algorithms.
4. Implement and compare different topology .
5. Make robust on chip routing models and Use tools for modeling various on-chip routers

**Prerequisites:** Basic programming skills of C , C++.

**Detailed Contents**

1. Installation of Open Source Tool Gem5 and Garnet2.0
2. Build ALPHA ISA with gem5.opt binary and simulate in syscall emulation mode using se.py.
   Run the simulation for the following setup:
   CPU = Out-of-Order (OoO) Benchmark = namd , bzip2 Maximum instructions = 1000000

| Serial No. | Parameters | Benchmark bzip2 | Benchmark namd |
|---|---|---|---|
| 1 | Overall CPI | | |
| 2 | Number of CPU cycles simulated | | |
| 3 | Rate of instruction issue | | |
| 4 | Percentage of Branch Target Buffer(BTB) hits | | |
| 5 | Number of cache lines fetched | | |

3. Run synthetic traffic traces through its NoC simulator Garnet 2.0.

   2.1 Part I: Uniform Random Traffic
   You will run uniform random traffic at increasing injection rates through a 8x8 Mesh NoC for100000 cycles and plot the latency-throughput curve.
   2.2 Part II: Shuffle Traffic
   You will run shuffle traffic at increasing injection rates through a 8x8 Mesh NoC for 100000 cycles, and plot the latency-throughput curve.
4. Run Uniform Random (--synthetic=uniform_random), Tornado (--synthetic=tornado) and Neighbor (--synthetic=neighbor) traffic for Mesh Topology (called Mesh_XY in Garnet) and then plot the average packet latency vs injection rate across all three traffic patterns
5. Implement Deadlock Avoidance using

- West first turn model
- XY Routing
- Escape VC

6. Implement and study the effect of virtual channels, first Sweep the injection rate in increments of 0.02 and then run the simulation with --vcs-per-vnet equal to 1, 2, 4, 8, and 16.Plot all the latency vs injection rate curves.

**Minor Project:** Students are required to write projects related to Deadlock avoidance, Better Routing Techniques, Algorithms taking into consideration Memory Hierarchy, Better Interconnection Topology

**Online Learning Material:**

1. Multi core ComputerArchitecture Storage and Interconnects NPTEL: https://nptel.ac.in/courses/106/103/106103183/
2. https://www.gem5.org/
3. Setting up gem5/garnet : https://tusharkrishna.ece.gatech.edu/teaching/garnet_gt/

**Subject Code:** MCIT-117
**Subject Name:** Augmented Reality and Virtual Reality

| | |
|---|---|
| **Programme: M**.Tech. | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:**3 | **Teaching Hours:** 36 Hours |
| **Theory/Practical:** Theory | **Credits:**3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems: 20%** |
| **External Marks:**100 | **Duration of End Semester Exam(ESE): 03 hrs** |
| **Total Marks:**150 | **Course Status: Programme** Elective |

**On completion of the course the student will have the ability to:**

| CO # | Course Outcomes |
|---|---|
| 1. | Understand the basic concepts of Augmented and Virtual Reality. |
| 2. | Compare technologies in the context of AR and VR systems design and apply Environment Modeling in Mixed Reality |
| 3. | Develop interactive augmented reality applications for PC and Mobile based devices using a variety of input devices. |
| 4. | To learn and implement application of VR in Digital Entertainment: |
| 5. | Demonstrate the knowledge of the software technologies in augmented reality for both compositing and interactive applications. |

**Pre-Requisites:** Digital Image Processing
**Additional Material Allowed in ESE:** NIL (Mention anything like graph, calculator etc, if required in exam)
**Detailed Contents:**

**Part-A**

**Introduction of Virtual Reality:** Fundamental concept and components of Virtual Reality, primary features and present development on Virtual Reality. 3D user interface input hardware: Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home-Brewed Input Devices, Choosing Input Devices for 3D Interfaces. [08 hrs]

**Software technologies**: Database-World Space, World Coordinate, World Environment, Objects-Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment-VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts, Interaction-Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits, Available software in the market. [10 hrs]

**Part-B**

**Interactive Techniques in Virtual Reality**: Body Track, Hand Gesture, 3D Menus, Object Grasp. Introduction of Augmented Reality (AR): System structure of Augmented Reality, key technology in AR. [07hrs]

**Augmented and Mixed Reality,** Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.[ 11hrs]

**Text Books:**

1. Doug A. B., Kruijff E., LaViola J. J. and Poupyrev I. , 3D User Interfaces: Theory and Practice , Addison-Wesley (2005,2011p) 2nd ed.
2. Parisi T., Learning Virtual Reality, O'Reilly (2016) 1st ed.
3. Schmalstieg D. and Hollerer T., AugmentedAnd Virtual Reality, Addison-Wesley (2016).

**Reference Books:**

1. Alan B Craig, William R Sherman and Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, 2009.
2. Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.
3. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley, USA, 2005.
4. Oliver Bimber and Ramesh Raskar, Spatial Augmented Reality: Meging Real and Virtual Worlds, 2005.
5. Burdea, Grigore C and Philippe Coiffet, Virtual Reality Technology, Wiley Interscience, India, 2003.
6. John Vince, Virtual Reality Systems, Addison Wesley, 1995.

**Subject Code:** LMCIT-117
**Subject Name:** Augmented Reality and Virtual Reality Laboratory

| | |
|---|---|
| **Programme: M**.Tech | **L:** 0 **T:** 0 **P:** 2 |
| **Semester:** 7th | **Teaching Hours:** 24 Hours |
| **Theory/Practical:** Practical | **Credits:1** |
| **Internal Marks:** | **Percentage of Numerical/Design/Programming Problems: 100** |
| **External Marks:** | **Duration of End Semester Exam(ESE):** |
| **Total Marks:** | **Course Status: Programme** Elective |

**On completion of the course the student will have the ability to:**

| CO # | Course Outcomes |
|---|---|
| 1. | Understanding of virtual environment technology, including 3D rendering software, tracking hardware, and input/output functions for capturing user data. |
| 2. | Compare open source tools in the context of AR and VR systems design and use VR in real life applications |
| 3. | Working of Hololens for cost effective AR experience |
| 4. | To learn and implement application of VR in scientific applications : |
| 5. | Demonstrate the knowledge of AR/VR to the conduct of scientific research, training, and industrial design. |

**Pre Requisites**: Digital Image Processing
Tools: Unity 3D, Blender, and various Open source tools

1. Introduction to various Open sources VR Tools
2. Developing architecture of a house using Virtual Reality
3. Perform CRO based experiment using Virtual Reality.
4. Undertaking qualitative analysis in Chemistry using Virtual Reality.
5. Carry out assembly/disassembly of an engine using Virtual Reality.
6. Explore human anatomy using Virtual Reality.
7. Introduction to Blender importing standard assets, adding a player character, Objects, lighting, scenes, prefabs, asset store in Unity
8. Working of Hololens for AR
9. Study of various Open source tools for AR

**Subject Code:** MAC-106
**Subject Name:** Pedagogy Studies

| | |
|---|---|
| **Programme:** M. Tech. | **L:** 2 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 24 |
| **Theory/Practical:** Theory | **Credits:** 0 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design Problems:** Nil |
| **External Marks:** Nil | **Duration of End Semester Exam(ESE):** Nil |
| **Total Marks:** 50 | **Course Type:** Audit Course |

**On completion of the course the student will have the ability to:**

| CO # | Course Outcomes |
|---|---|
| 1. | Analyze the pedagogical practices being used by teachers in formal and informal classrooms in developing countries |
| 2. | Examine the effectiveness of the pedagogical practices, in what conditions, and with what population of learners. |
| 3. | Identify how school curriculum and guidance materials best support effective pedagogy. |
| 4. | Ability to design Research problems |
| 5 | Identify and explore barriers for learning |

**Detailed Contents:**

**Part-A**

**Introduction and Methodology:**
Aims and rationale, Policy background, Conceptual framework and terminology**,** Theories of learning, Curriculum, Teacher education, Research questions, Overview of methodology and Searching**,** Thematic overview: Pedagogical practices being used by teachers informal and informal classrooms in developing countries. [8 hrs]

**Pedagogical practices:**
Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies. [8 hrs]

**Part-B**

**Professional Development:**
Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to Learning: limited resources and large class sizes. [8 hrs]

**Research gaps and future directions:**
Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment and Dissemination and research impact. . [4 hrs]

**Text Books:**

1. Abraham Silberschatz, S. Sudarshan, Henry F. Korth, "Database System Concepts", 6th Edition, Tata McGraw - Hill Education, 2011.
2. Shamkant B. Navathe, RamezElmasri, "Fundamentals of Database Systems", 6th Edition, Addison Wesley Pub Co Inc, 2010.
3. Connolly, "Specifications of Database Systems : A Practical Approach to Design, Implementation and Management", 4th Edition, Pearson India, 2008.

**Reference Books:**

1. AkyeampongK, LussierK, PryorJ, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Doesteacher preparation count? International Journal Educational Development, 33 (3):272–282.
2. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
3. Chavan M(2003)Read India: Amassscale, rapid, 'learning to read' campaign.